Landscape

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Cultivars of Native Plants Can Support Biodiversity in Landscapes

J.C. Poythress and James M. Affolter

Department of Horticulture, University of Georgia, Athens, GA 30605

jpoythre@uga.edu

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Significance to Industry: Native plants are an important food resource for wildlife in landscapes. Concerns over declining biodiversity in suburban areas have prompted some homeowners to incorporate more native plants into their landscapes. However, it is unknown whether the native plants that are available through the nursery trade, typically cultivated varieties (cultivars) of a single genotype, are the ecological equivalents of the local, wild-type plants in terms of supporting wildlife. We compared the hemipterans (a group of predominantly herbivorous insects that are an important component of food webs) associated with cultivars and seed-propagated wild-type plants of five species of native ornamental plants. Our results suggested that the source of the plant material can affect organisms that depend on the plants for food, but overall, cultivars fulfill similar ecological roles as wild-type plants. This research also provided insights into which characteristics of plants should be avoided when developing new cultivars of native plants and identified other characteristics as potential targets for selection that may actually improve the wildlife value of cultivars relative to the wild type.

Nature of Work: Residential development can result in homogenization of the vegetation found in landscapes. The naturally-occurring native vegetation is often replaced by a relatively small number of species of mostly exotic ornamentals and lawn grasses, and this homogenization at the first trophic level (i.e. at the plant level) may be associated with the recent trend of declining biodiversity at higher trophic levels (e.g. birds) in suburban areas (5). Here, exotic means plant species that are introduced into a region in which they did not evolve. One reason that exotic vegetation would be associated with declines in overall wildlife diversity is that exotic plants are a poor food resource for native herbivores, and herbivores fulfill the key ecological role of transferring energy from plants to higher trophic levels (7). For example, one group of herbivores that makes up a large portion of food webs is native herbivorous insects. Plant-insect interaction theory predicts that insects are adapted to eat plants with which they share a coevolutionary history (3). Because native insects have not coevolved with exotic plants, exotic plants should represent an inferior food resource for native insects versus the native plants that the insects are adapted to eat. A substantial amount of empirical evidence supporting this prediction has accumulated in recent years [see (1) and (2) for examples]. Consequently, gardeners concerned about declining biodiversity in suburban areas are attempting to improve the ecological functioning of their landscapes by incorporating more native ornamental plants. By providing plants in landscapes that native insects are adapted to eat, gardeners hope to enhance the insect abundance and diversity supported by their landscapes, which will then translate to higher overall wildlife diversity.

One question gardeners have asked is: Are the native plants available commercially, typically cultivated varieties (cultivars) of a single genotype, equally effective as the local, wild-type plants for providing food for native herbivorous insects? Many cultivars are propagated asexually (e.g. by division, cutting, or tissue culture), and therefore contain less genetic diversity than most plants propagated from seed. Several studies have shown that insect diversity is positively correlated with the genetic diversity of the host plants [e.g. (4) and (8)], so clones may support less diverse insect communities than seed-propagated, wild-type plants. In addition, cultivars are usually selected for some characteristic that distinguishes them from the wild form. Popular characteristics to select for include compact form, altered leaf or flower color, sterility, etc. Insects are highly sensitive to changes in their host plant material, especially changes that alter leaf chemistry, so selecting for any of these traits could affect the ability of insects to feed on the plants. We investigated whether these theoretical consequences of selecting cultivars actually affect the ability of cultivars to serve as a food source for native insects. We compared the herbivorous hemipteran communities associated with cultivars and wild-type plants of five species of native perennials that are commonly used as ornamentals in landscaping. We focused on hemipterans instead of other groups of herbivorous insects because preliminary data suggested they were the most abundant and species diverse group associated with herbaceous plants in our area.

The study was conducted at the State Botanical Garden of Georgia, a public garden in Athens, Clarke Co., GA. The five plant species used in the study were eastern bluestar (*Amsonia tabernaemontana*), large-flowered coreopsis (*Coreopsis grandiflora*), wild bergamot (*Monarda fistulosa*), southern sundrops (*Oenothera fruticosa*), and little bluestem (*Schizachyrium scoparium*). The wild-type plants were propagated from seed collected in natural populations occurring within Clarke County (except those of bluestar, which were collected in Stephens Co., GA). The cultivars were purchased as liners from North Creek Nurseries in Landenberg, PA (except the little bluestem cultivars, which were donated by Hoffman Nursery in Bahama, NC). The cultivars used in the study and the characteristics that distinguish them from the wild forms are summarized in Table 1.

The experiment followed a fully-randomized two-way analysis of variance (ANOVA) design. The first factor was plant species with five levels (i.e. the different plant species used in the study were the levels). The second factor was plant source and included two levels: cultivar and wild-type. There were five replicates for each treatment, giving a total of 50 experimental units. Each experimental unit was a 2 m x 2 m plot containing 16 plants evenly spaced, and plots were placed 1.5 m apart. The planting density per plot was chosen to be 16 individuals so that percent cover would be close to 100% by the time insects were collected. Plots were kept weed-free throughout the growing season and wood mulch was used in-between plots.

Insects were vacuumed from plots on three dates in 2014: 8 July, 15 August, and 20 September. We recorded two types of data for each sampling date: counts of each adult hemipteran species and total hemipteran biomass (which included both adults and nymphs). The counts were used to calculate total abundance of adult hemipterans for each date. We analyzed total abundance and total hemipteran biomass as a repeated measures two-way ANOVA. We also divided the insects into four feeding guilds based on information about their life histories, allowing species to belong to multiple guilds if they were recorded as feeding from multiple plant tissues. The guilds were xylem-feeding insects, phloem-feeding insects, stem/leaf mesophyll-feeding insects, and fruit-/seed-feeding insects. We pooled the counts across the three sampling dates, calculated the total abundance of adult hemipterans for each guild, and analyzed the data as a two-way ANOVA. Dividing the insects into guilds allowed us to investigate whether a treatment affected one group of insects more than the others. To assess hemipteran diversity, we pooled the counts across the three sampling dates and calculated the species richness (i.e. the total number of insect species collected) for each treatment over the entire growing season. We analyzed species richness as a two-way ANOVA.

Results and Discussion: Over the entire study, we collected almost 12,000 individuals of adult hemipterans representing 130 different species. However, for 65 of these species, 5 or fewer individuals were found. Because these species made such a small relative contribution to the insect community and placed so little feeding pressure on the plants, we removed them from all of our analyses. In addition, only a single insect species, the broad-headed sharpshooter (*Oncometopia orbona*), was found feeding on *Amsonia*. Only nine total individuals of the sharpshooter were found, so we also removed the *Amsonia* cultivar and wild-type treatments from the analyses.

For both total abundance and total hemipteran biomass, repeated measures ANOVA indicated a significant three-way interaction between plant species, plant source, and time, hence we broke up the analyses at each level of plant species and compared the cultivar and wild-type treatments at each sampling date (Fig. 1). Generally, there was a strong correspondence between total abundance and total biomass. The major exception was for the *Monarda* treatments, where insect abundance was consistently higher on the wild-type plants, but insect biomass never differed between cultivars and wild-type plants. The plots of insect abundance and biomass suggest two primary conclusions. First, the insect community is dynamic over time. For most treatments, the insect community associated with the plants either decreased in size (e.g. *Oenothera* wild-type plants) or increased (e.g. *Coreopsis* cultivars); there were few treatments where the size of the insect community appeared static throughout the growing season (e.g. *Oenothera* cultivar). Second, there was no consensus with regard to the effect of plant source; in some instances, the cultivar of a given plant species supported more insects, and in other instances the wild-type plants supported more insects. Moreover, when there was a difference between cultivars and wild-type plants, the effect usually did not persist over all three sampling dates. Overall, these data suggest that cultivars are not inherently inferior to wild-type plants as a food sources for herbivorous insects.

When we divided the insects into different feeding guilds, there was an effect of plant source for some plant species (Fig. 2). For xylem-feeding insects, there was no evidence that insect abundance differed between cultivars and wild-type plants for any plant species. However, for phloem-, mesophyll-, and fruit-/seed-feeding insects, there was strong evidence that insect abundance differed between cultivars and wild-type plants for several plant species. For phloem feeders, abundance was higher on the *Oenothera* wild-type plants than the cultivars; there were no differences between cultivars and wild-type plants for the other plant species. For mesophyll feeders, abundance was higher on the *Monarda* wild-type plants than the cultivars, but higher on the *Coreopsis* cultivars than the wild types; there were no differences for the other plant species. For fruit/seed feeders, abundance was higher on the *Coreopsis* and *Oenothera* wild-type plants than their respective cultivars; there were no differences for the other two plant species.

We did not measure characteristics of the plants (e.g. nitrogen content, leaf chemistry, degree of leaf pubescence, etc.) that might help us explain why cultivars and wild-type plants of some plant species differed in their abilities to support insects belonging to particular feeding guilds. Hence, there are no obvious explanations for why cultivars and wild-type plants of several plant species supported different numbers of phloem- and mesophyll-feeding insects. However, the two cultivars that supported fewer fruit-/seed-feeding insects than their wild-type counterparts were both sterile. *Oenothera* 'Cold Crick' was specifically selected for sterility and *Coreopsis* 'Tequila Sunrise,' while not marketed as sterile, apparently was (at least in the setting of this study). The cultivars of *Monarda* and *Schizachyrium* both produced viable seeds, and neither differed from the respective wild-type plants in terms of the number of fruit-/seed-feeding insects they supported. These data provide a clear example of selection for a trait that removes an essential food resource of a large group of insects, and hence causes strong negative consequences for that group of insects.

While sterility appears to be an undesirable trait in the context of developing cultivars that are beneficial for wildlife, our results suggest there are also traits that plant breeders could select for to develop cultivars that are actually superior to the wild-type plants in terms of their abilities to support insect diversity. For example, both the *Coreopsis* cultivar and *Schizachyrium* cultivar supported more insect biomass than their respective wild-type plants on at least one sampling date (Fig. 1). One trait that may affect a plant's ability to support herbivorous insects is architectural complexity. Generally, plants with more structural complexity support higher insect diversity (6), possibly because there are more niches available or because there are more areas for insects to feed (e.g. higher surface/area to volume ratio). Although we did not measure structural complexity quantitatively, the *Schizachyrium* cultivar clearly had finer vegetation structure (i.e. thinner stems and culms) and higher stem/culm density than the wild-type *Schizachyrium*, which may explain why the cultivars supported more insects than the wild-type plants by the last sampling date. Additionally, the wild-type plants of several plant species exhibited significant variation in the degree of branching, size of stems, and stem/culm density, suggesting there is ample opportunity to breed for these traits and create improved selections. Although many other traits are likely influencing the insects that feed on the plants, and hence represent potential breeding opportunities, plant architecture is at least a clear place to start.

More people are becoming aware of the connection between wildlife diversity in suburban areas and the plants that are used in landscaping. Consequently, there is a growing demand for ornamental plants that are both aesthetically pleasing and fulfill an ecological role. One of the most important ecological roles a plant can fulfill is serving as a food source for other organisms. At first glance, this appears at odds with a goal of many plant breeders: selecting plants for pest resistance (including resistance against herbivorous insects). The results of this study, however, show that native plants can support diverse insect communities without suffering noticeable feeding damage that would detract from their aesthetic value. We captured 130 different insect species over the course of this study, and the few species we collected that have been recorded as serious pests (e.g. the tarnished plant bug, *Lygus lineolaris*) never became so abundant that they damaged the plants. Though there are certainly insect species that cause extensive damage to plants, these species are the exception, not the rule. The vast majority of insects cause negligible damage when they feed on plants, and hence go unnoticed. Despite their nearly invisible existence, these species make up much of the base of food webs and should be encouraged rather than exterminated if the goal is to create landscapes that sustain wildlife.

Native ornamental plants have proven to be better food sources for herbivorous insects than exotic ornamentals, and this implies natives are superior to exotics in the context of sustaining wildlife. However, a concern of some conservation-savvy gardeners is that herbivorous insects may not recognize the native plants available commercially (i.e. cultivars) as suitable host plants because cultivars have been selected to be so distinct from the wild form. Our results show that altering a plant's form to improve its horticultural value does not necessarily diminish its ecological value. Particular traits may be detrimental to some groups of insects (e.g. sterility and seed-feeding insects), but overall, cultivars are just as effective food sources for insects as wild-type plants are. Moreover, our results suggest the possibility of new opportunities in plant breeding. Just as plants can be selected for traits such as flower size, foliage color, etc., it appears they can be selected for traits that improve their value to wildlife as well. Future research should investigate which of these traits are the highest priorities to target. Plant breeders can then use this information to develop cultivars that are superior both from a horticultural and ecological perspective.

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Table 1. Plant species and cultivars used in this experiment and summary of the characteristics that distinguish the cultivars from the wild form.

Plant Species	**Common Name**	**Cultivar**	**Family**	**Cultivar Origin**	**Difference from Wild-type**
Amsonia tabernaemontana	Eastern bluestar	'Blue Ice'	Apocynaceae	Interspecific hybrid[1]	Longer bloom, darker flowers, compact form
Coreopsis grandiflora	Large-flowered tickseed	'Tequila Sunrise'	Asteraceae	Interspecific hybrid	Variegated leaves, compact form
Monarda fistulosa	Wild bergamot	'Claire Grace'	Lamiaceae	Straight species	Powdery mildew resistant, darker flowers
Oenothera fruticosa	Southern Sundrops	'Cold Crick'	Onagraceae	Interspecific hybrid[1]	Sterile, compact form
Schizachyrium scoparium	Little bluestem	'Prairie Blues'[2]	Poaceae	Straight species	Blue-green foliage turning wine-red in fall

[1] purported hybrid
[2] propagated from seed

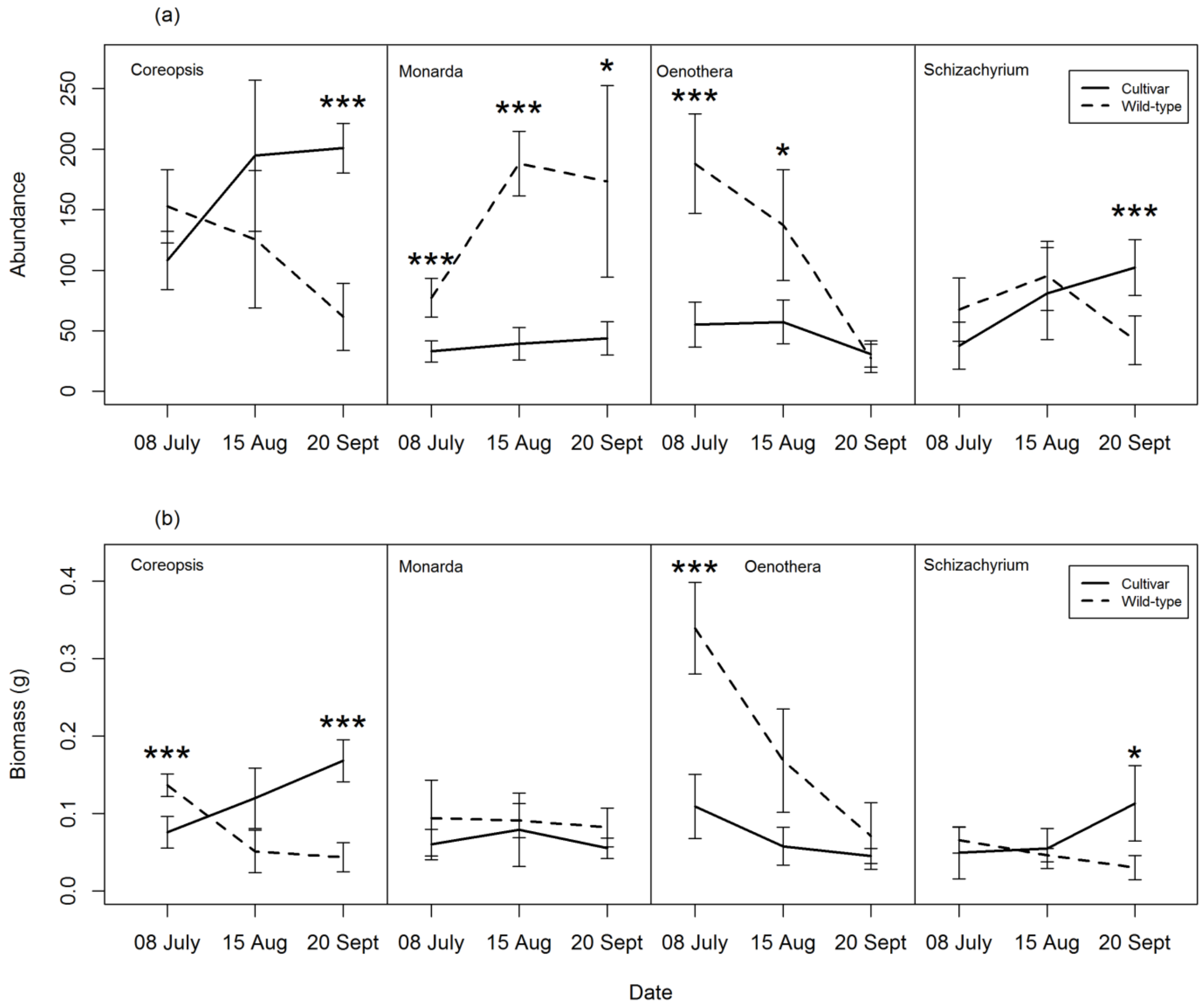

Figure 1. Plots of (a) total abundance of adult hemipterans and (b) total hemipteran biomass for cultivars and wild-type plants of each plant species at three sampling dates. Asterisks indicate significant differences in means between cultivars and wild-type plants for a given plant species on a given date. Three asterisks represent differences that were significant after a Bonferroni correction for multiple comparisons with an experiment-wise α=.05 (p-value<0.00417). One asterisk represents differences that were significant after a Bonferroni correction with an experiment-wise α=.10 (p-value<0.00833). Error bars are SD.

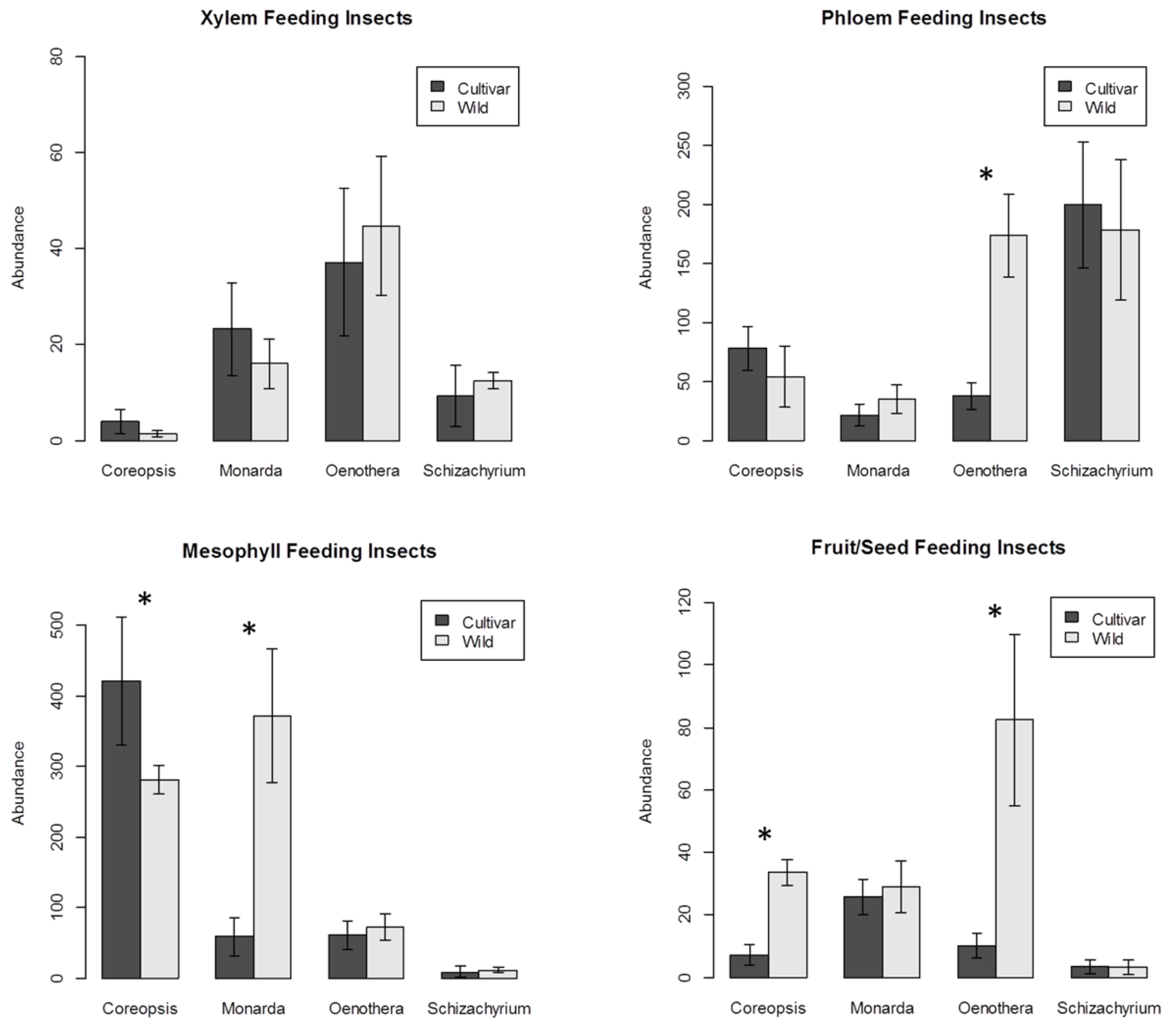

Figure 2. Total abundance of adult hemipterans in four feeding guilds for cultivars and wild-type plants of each plant species pooled across three sampling dates. There were strong violations of the normality and homogeneity of variances assumptions of parametric ANOVA, so differences in means were tested with permutation-based two-way ANOVA with 1000 permutations. Asterisks represent significant differences in mean abundance between cultivars and wild-type plants for a given plant species after a Bonferroni correction with an experiment-wise α=.05 (p-value<0.0125). Error bars are SD.

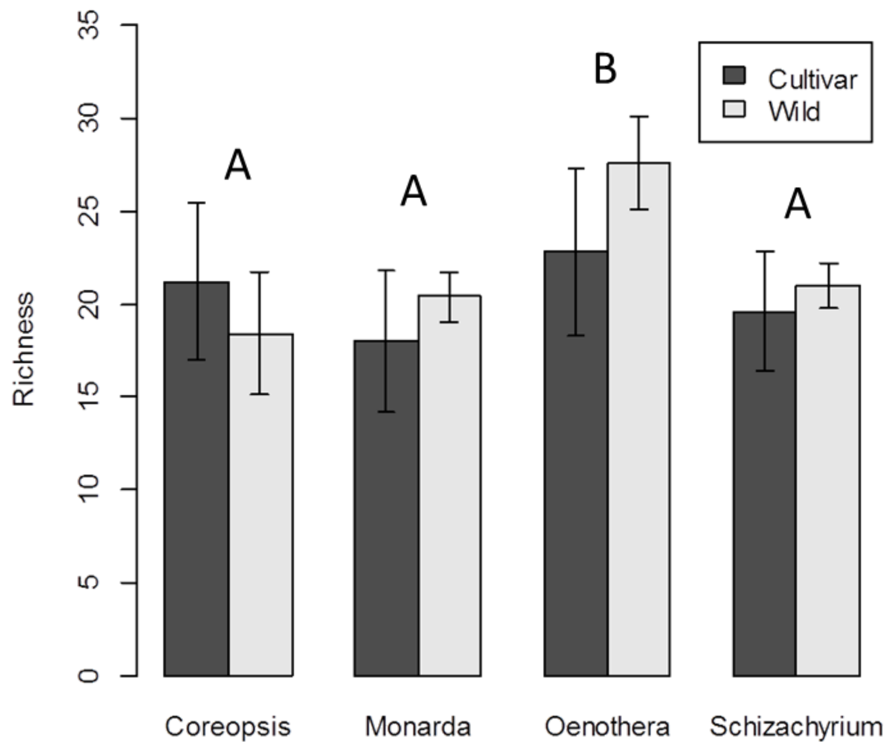

Figure 3. Species richness for cultivars and wild-type plants of each plant species pooled across three sampling dates. Species richness was used as a measure of diversity of adult hemipterans for each treatment. Different letters denote means of plants species that were significantly different at α=.05 after correcting for multiple comparisons with Tukey's HSD test. *Oenothera* had higher average species richness than the other three plant species. There was no evidence for a difference in richness between wild-type plants and cultivars for any plant species. Error bars are SD.

Substrate Impact on Nitrogen and Phosphorus Remediation in Rain Garden Systems

Elizabeth D. Riley[1], Helen T. Kraus[1], James S. Owen Jr.[2] and Julie Brindley[2]

[1]Department of Horticultural Science
North Carolina State University, Raleigh, NC 27695-7609
[2]Deparment of Horticulture, Hampton Roads Agricultural Research and Extension Center
Virginia Tech, Virginia Beach, VA 23455

edbridge@ncsu.edu

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Significance to the Industry: The engineered filter bed substrate of a rain garden system is a critical component for stormwater runoff remediation (11) in order to prevent preferential flow paths, detain peak flows, and retain stormwater runoff volumes (20). This study had one engineered filter bed substrate (sand), two organic matter amendments [composted yard waste (CYW) and pine bark (PB)], two combination methods (banded and incorporated), and four amounts (v/v; 1in/5%, 2in/10%, 3in/15%, and 4in/20%). Total nitrogen (NO_2^-+NO_3^-+NH_4^+) and phosphate (PO_4^{3-}) remediation efficiency in the sand engineered filter bed substrate was highest when the organic matter amendments were banded instead of incorporated regardless of organic matter amendment utilized (CYW or PB). The amount of organic matter amendment did not impact total nitrogen (TN) remediation efficiencies; however for PO_4^{3-} the remediation efficiency was greatest when the organic matter amendments were added as a 1in band or incorporated at 5%. The cumulative TN concentration in the effluent was highest with the banding combination method while PO_4^{3-} concentration was lowest with banding.

Nature of Work: With an increase in urbanization, there are more impervious infrastructures (roads, driveways, parking lots, sidewalks, and rooftops) that reduce infiltration of precipitation through native vegetation and soils, leading to surface runoff (1). As water moves along these impervious surfaces it picks up pollutants, such as nitrogen (N), phosphorus (P), zinc (Zn), copper (Cu), cadmium (Cd), lead (Pb), and total suspended solids (TSS), that degrade the quality of water (3,10). Rain gardens (bioretention cells or bioinfiltration devices) are one of the most commonly utilized stormwater control measures (SCMs) in the country (4,8). Rain gardens can be installed into various types of residential or commercial landscapes. After excavation of the existing landscape soil, rain gardens are generally refilled with 2-3 ft of a sand/soil/organic matter engineered filter bed substrate (4).

The engineered filter bed substrate is a crucial component of a rain garden system because remediation occurs primarily as polluted stormwater runoff moves through and is stored within (11). Wardynski and Hunt (20) emphasized the importance of the correct engineered filter bed substrate, as it can prevent preferential flow, to detain peak flows, retain stormwater runoff volumes, as well as achieve remediation of pollutants and proper drainage in between events. Engineered filter bed substrates also need to support plant growth, which can have a positive impact on remediation of pollutants from stormwater runoff (2,5,7,12,13,16,17,18).

Turk et al. (18) reported that a slate engineered filter bed substrate had better remediation of N (86% initially and 99% finally) than a sand and soil engineered filter bed substrate. It was also reported that slate and sand engineered filter bed substrates had better P removal (99% and 96%, respectively) when compared to a soil engineered filter bed substrate (18). Fewer remediation differences were reported between the sand, slate, and soil substrates during the second season, indicating that plant uptake was impacting remediation more than the engineered filter bed substrates (18). Also, Hatt et al. (6) found similar results where there was moderate N and high P reduction by a sand filter while a soil filter leached N and P.

Compost utilization in engineered filter bed substrates may provide benefits, such as plant growth enhancement, pollutant removal, and a carbon source for the creation of an anaerobic zone. There is concern over the amount of pollutants that may be exported out of the rain garden system when compost is utilized within the engineered filter bed substrate. Liu et al. (11) found that there was not an extensive amount of pollutants exported when there was an addition of 25% yard waste compost added to an engineered filter bed substrate in combination with 3% spent alum sludge, 15% saprolite, and 57% sand. These researchers reported that with the addition of the 25% yard waste compost, N removal increased, possibly due to denitrification (11). In contrast, other researchers found that an increasing volume of compost in a sand engineered filter bed substrate caused a significant export of P (15). Also, layering of various engineered filter bed substrate components can cause an anaerobic zone within the rain garden system (9). Hsieh et al., (9) reported that by placing a permeable sand layer over a less permeable soil layer resulted in increased stormwater retention time within the engineered filter bed substrate, allowing nitrification in the well-aerated sand portion and denitrification in the low permeable soil layer. Therefore the objectives of this study were to evaluate the impact of (1) different organic matter amendments, (2) varying amounts of organic matter amendments, and (3) two combination methods for adding the organic matter amendments on remediation of nitrogen and phosphors in a rain garden system.

The experimental design was a randomized complete block design with a factorial treatment arrangement of sixteen substrates that resulted from combinations of one filter bed substrate, two organic matter amendments, two combination methods, and four amounts. The engineered filter bed substrate used was sand (80% washed sand, 15% clay and silt fines, and 5% pine bark v/v/v) (Wade Moore Equipment Company, Louisburg, NC). Sand was amended with two different organic matter amendments, pine bark (PB) or composted yard waste (CYW) (City of Raleigh Yard Waste Recycling Center, Raleigh, NC). PB and CYW were added as either a band in the depths of 1, 2, 3, or 4 inches or by incorporation using approximately the same amounts of organic matter in the amounts of 5, 10, 15, and 20% (v/v) (Figure 1). For the banded treatments, four inches of sand was added to the bottom of the container. Next, a 1, 2, 3, or 4 inch band of CYW or PB was added and the container was topped off with sand to within one inch from the top of the container to allow for irrigation ponding. Black Pecan King 1020 containers (6.06 gallons) (Haviland Plastic Products, Haviland, OH) were filled with the sixteen filter bed substrate compositions and *Panicum virgatum* L. 'Shenandoah' was planted on June 1, 2012. The plants were watered without added nutrients for the first two weeks daily to allow establishment. Thereafter, plants received simulated stormwater runoff applications with an average of 1.6 $mg \cdot L^{-1}$ of P (supplied by diammonium phosphate, 18-46-0) and 5.1 $mg \cdot L^{-1}$ of N (supplied by ammonium sulfate 21-0-0-24) (14). One inch of simulated polluted stormwater runoff was applied once a week (June 2012 – October 2012), once a month (November 2012 – March 2013), and every two weeks (April 2013 – May 2013) using a low-volume spray stake (PC Spray Stake, Netafim, Ltd., Tel Aviv, Israel) to mimic rainfall patterns for Raleigh, NC. Pots were placed into five gallon buckets with a hole drilled into the bottom sitting on bricks to allow for the collection of effluent from simulated polluted stormwater runoff applications. Three replications had volume of effluent measured and samples collected for nutrient concentration analysis on June 19, July 3, August 29, September 26, October 24, November 19, December 18, 2012, January 18, February 21, March 21, April 19, and May 2, 2013. Samples collected were analyzed for PO_4^{3-}, NO_2^-, NO_3^-, and NH_4^+ using an ICS-1600 ion chromatography system (Thermo Scientific, Madison, WI). All nitrogen species were combined (NO_2^-+NO_3^-+NH_4^+) to estimate total nitrogen (TN). Cumulative totals over all sample dates were used for analyses. Remediation efficiency (%) = [(Influent Content – Effluent Content) ÷ Influent Content] x 100. This study was conducted at North Carolina State University's Horticultural Field Laboratories, Raleigh, NC (longitude: 35°47'29.57"N; latitude: 78°41'56.71"W; elevation 136 m). Regression analyses and Tukey's honestly significant difference means separations procedures were used where appropriate ($P \leq 0.05$) (19).

Results and Discussion: The cumulative TN concentration in the effluent had no significant interactions between combination method, amount, and organic matter amendment with only the main effect of combination method being significant (P=<.0001). Banded treatments had higher amounts of TN present in the effluent than incorporated treatments (Figure 2). Cumulative total of PO_4^{3-} concentration in the effluent also had no significant interactions, while the main effects of amount (P=0.0248) and combination method (P=0.0005) were significant while organic matter amendment was not. There were higher amounts of PO_4^{3-} in the effluent of incorporated treatments than banded treatments (Figure 3). There was also a linear increase in the total amount of PO_4^{3-} concentration in the effluent with increasing amounts of organic matter amendment (Figure 4).

TN remediation efficiency did not have a significant interaction among organic matter amendment x combination method x amount. However, the two-way interactions combination method x amount and organic matter amendment x combination method were significant. When analyzed by combination method and averaged over organic matter amendment, the main effect of amount was not significant for TN remediation efficiency. However, when analyzed by organic matter amendment and averaged over amount, combination method was significant for both CYW (P=0.0097) and PB (P=0.0001). For both CYW and PB, banded treatments had higher TN remediation efficiencies than incorporated treatments (Figure 5). Remediation efficiency factored in the volume of water for both the influent and effluent. This can explain why cumulative TN had greater amounts in the effluent with banding (Figure 2). PO_4^{3-} remediation efficiency results varied from TN remediation efficiency. There were no significant interactions for PO_4^{3-} remediation, however the main effects of amount (P=0.0038) and combination method (P=<.0001) were significant. Increasing amounts of organic matter amendments caused a linear decrease in PO_4^{3-} remediation efficiency (Figure 6). For PO_4^{3-} remediation efficiency, similar to TN remediation efficiency, banded treatments had higher remediation efficiencies than incorporated treatments (Figure 7). Riley et al. (17) reported that *P. virgatum* 'Shenandoah' had no significant differences between shoot dry weights for banding or incorporating treatments when grown in a sand engineered filter bed substrate. However, shoot growth was greatest for *P. virgatum* 'Shenandoah' when the organic matter amendment utilized was CYW compared to PB (17). This may explain why banding had lower PO_4^{3-} in the effluent and higher PO_4^{3-} and TN remediation efficiencies.

In conclusion, banding with either CYW or PB increased TN and PO_4^{3-} remediation efficiencies compared to incorporation method. However, the PO_4^{3-} the remediation efficiency was best when the organic matter amendments were added as a 1 inch band or incorporated at 5%. The cumulative TN was lowest with the incorporation combination method while PO_4^{3-} was highest with incorporation. It is important to take into consideration the main pollutants to be remediated within a rain garden system. Different locations may have different pollutants of concern and the rain garden system can be designed to specifically target pollutants of concern.

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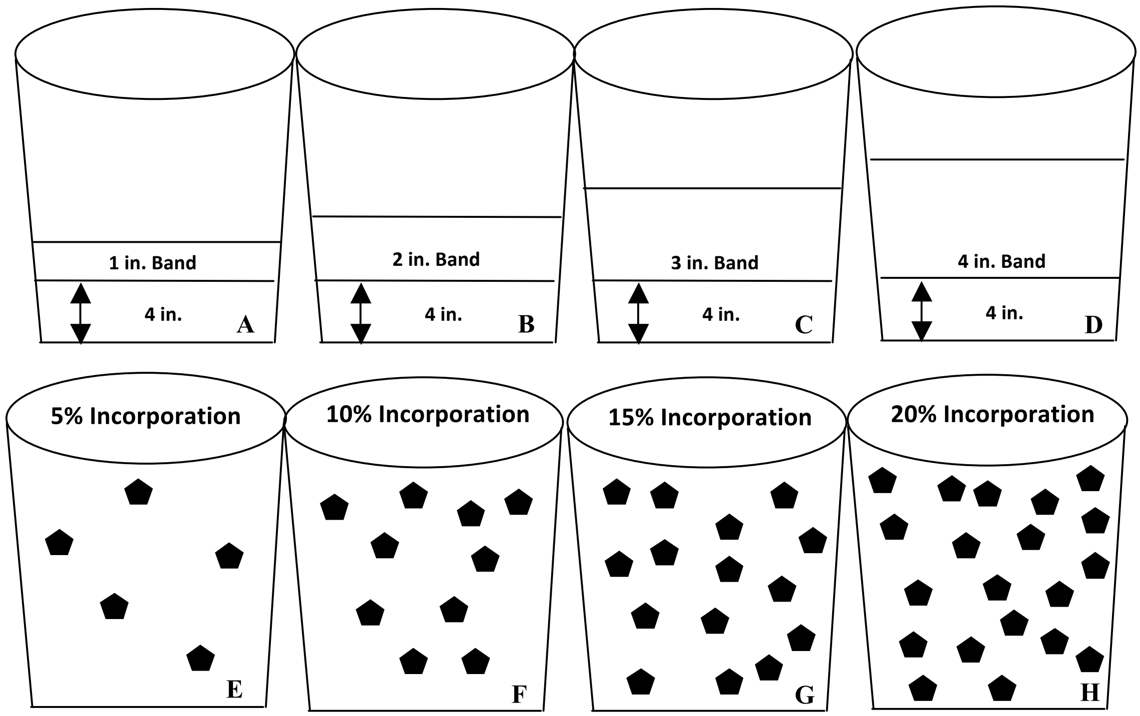

Figure 1. Schematic of different filter bed substrate combination methods and organic matter amounts. The two organic matter amendments were added as either a band in the depths of 1, 2, 3, or 4 inches or by incorporation at 5, 10, 15, and 20% (v/v). A: Combination method of banding with combination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

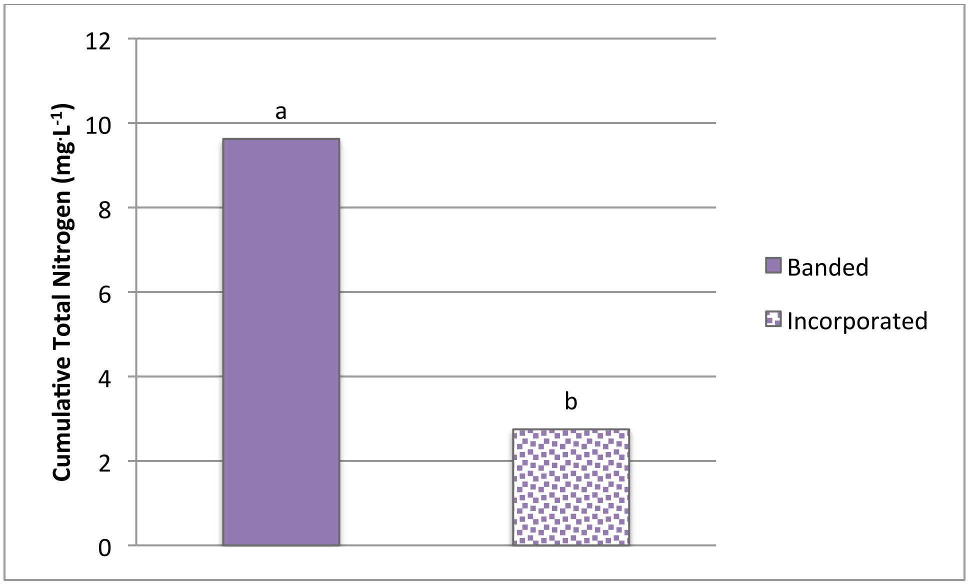

Figure 2. Effect of combination method (banded and incorporated) of organic matter amendments to sand filter bed substrate on cumulative (June 2012 - May 2013) total nitrogen (NO_2^-+NO_3^-+NH_4^+) in effluent. Means between combination methods with different letters are significantly different from each other based on Tukey's honestly significant differences means separation procedures ($P \leq 0.05$).

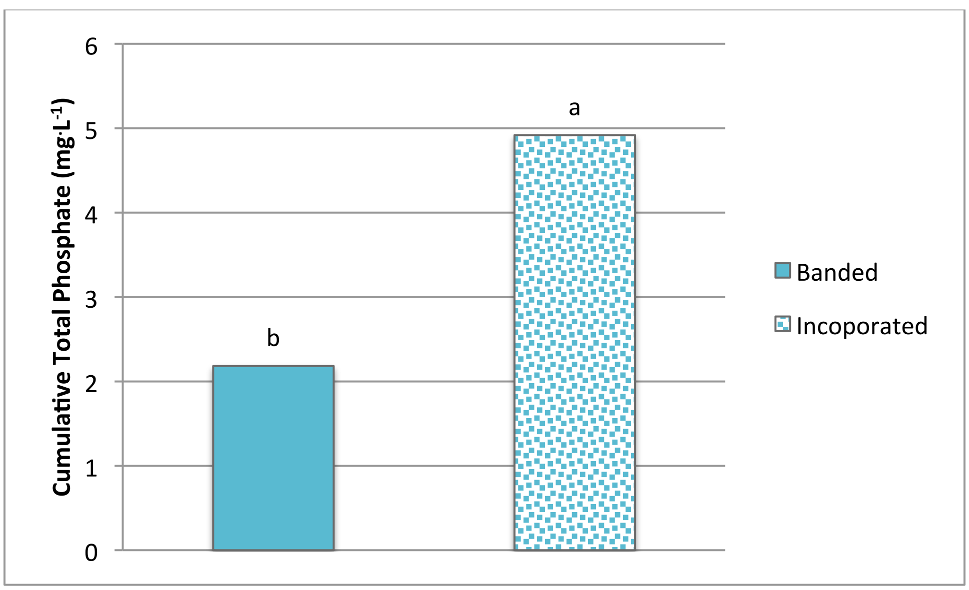

Figure 3. Effect of combination method (banded and incorporated) of organic matter amendments to sand filter bed substrate on cumulative (June 2012 - May 2013) total phosphate (PO_4^{3-}) in effluent. Means between combination methods with different letters are significantly different from each other based on Tukey's honestly significant differences means separation procedures ($P \leq 0.05$).

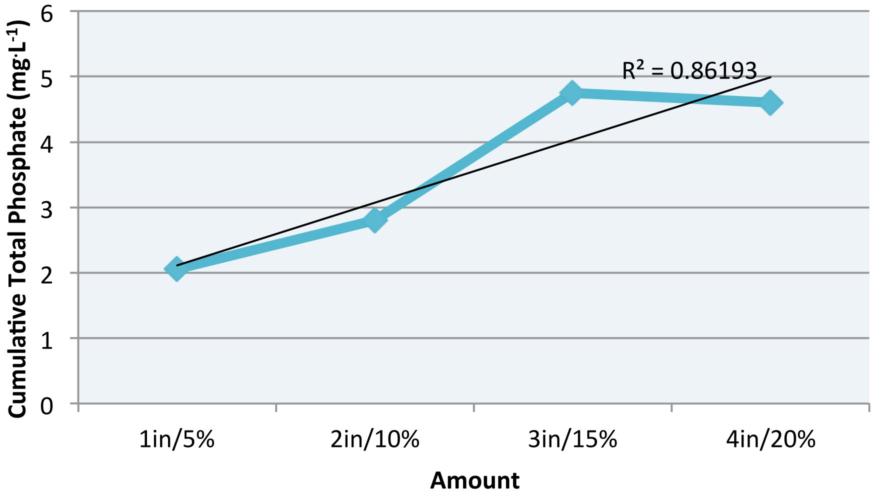

Figure 4. Effect of organic matter amendment amount to sand filter bed substrate on cumulative (June 2012 - May 2013) total phosphate (PO_4^{3-}) in effluent. The two organic matter amendments were added to the sand engineered filter bed substrate as either a band in the depths of 1, 2, 3, or 4 inches or by incorporation using approximately the same amounts or organic matter in the amounts of 5, 10, 15, and 20% (v/v). Linear line (R^2=0.86) represents fitted linear regression ($P \leq 0.05$) with positive trend of increasing organic matter amounts.

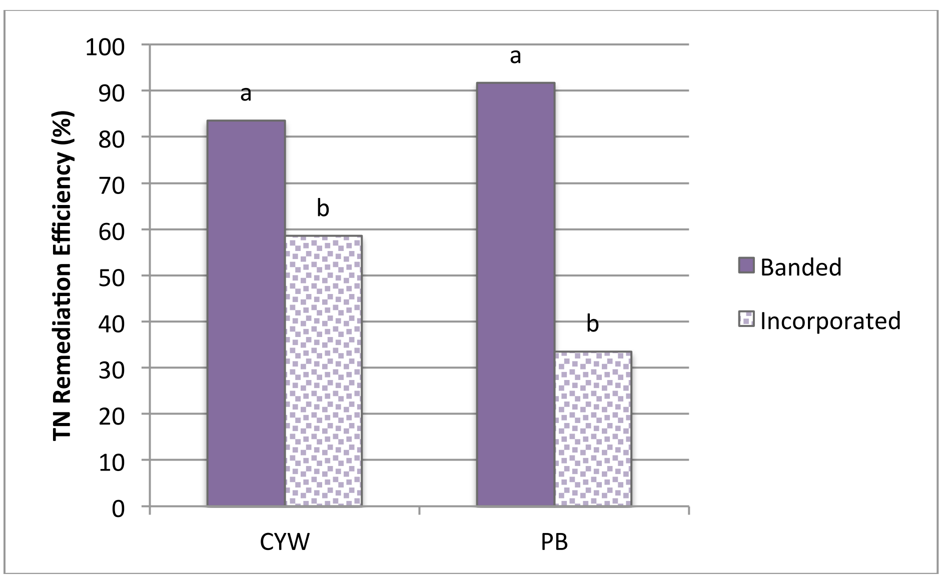

Figure 5. Effect of combination method (banded and incorporated) for two organic matter amendments, composted yard waste (CYW) and pine bark (PB) to sand filter bed substrate on cumulative (June 2012 - May 2013) total nitrogen (NO_2^-+NO_3^-+NH_4^+) remediation efficiency (%). Remediation efficiency = [(Influent Content – Effluent Content) ÷ Influent Content] x 100. Means between organic matter amendments with different letters are significantly different from each other based on Tukey's honestly significant differences means separation procedures ($P \leq 0.05$).

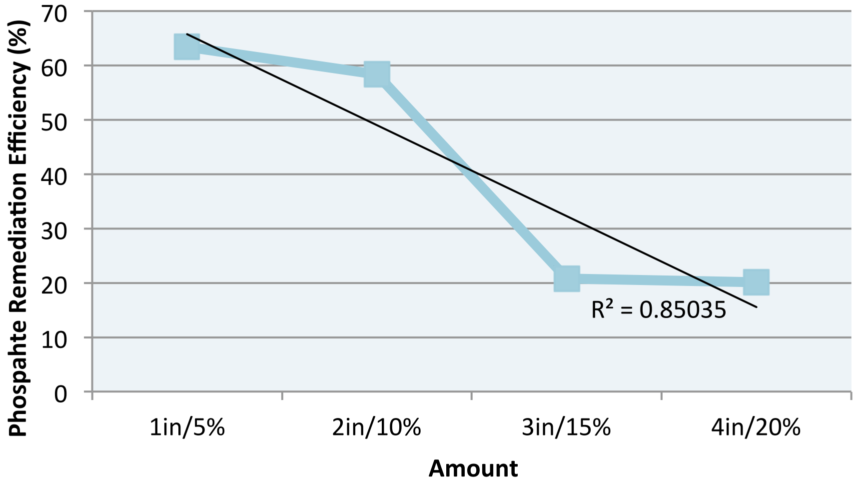

Figure 6. Effect of organic matter amendment amount to sand filter bed substrate on cumulative (June 2012 - May 2013) phosphate (PO_4^{3-}) remediation efficiency (%). Remediation efficiency = [(Influent Content – Effluent Content) ÷ Influent Content] x 100. The two organic matter amendments were added to the sand engineered filter bed substrate as either a band in the depths of 1, 2, 3, or 4 inches or by incorporation using approximately the same amounts or organic matter in the amounts of 5, 10, 15, and 20% (v/v). Linear line (R^2=0.85) represents fitted linear regression (P≤0.05) with negative trend of increasing organic matter amounts.

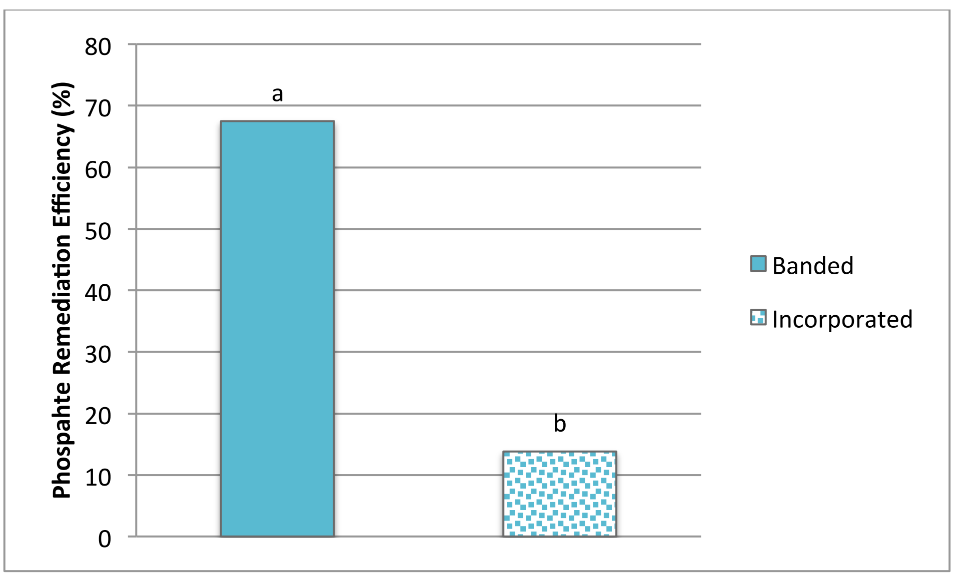

Figure 7. Effect of combination method (banded and incorporated) of organic matter amendments to sand filter bed substrate on cumulative (June 2012 - May 2013) phosphate (PO_4^{3-}) remediation efficiency (%).Remediation efficiency = [(Influent Content – Effluent Content) ÷ Influent Content] x 100 Means between combination methods with different letters are significantly different from each other based on Tukey's honestly significant differences means separation procedures ($P \leq 0.05$).

Summer Evaluation of Wax Begonias for Full Sun Landscape Use in Southern Mississippi

Eugene K. Blythe[1], Cecil Pounders[2], and Michael Anderson[1]

[1]Coastal Research and Extension Center, Mississippi State University,
South Mississippi Branch Experiment Station, Poplarville, MS 39470
[2]USDA-ARS, Thad Cochran Southern Horticultural Laboratory, Poplarville, MS 39470

blythe@pss.msstate.edu

Index Words: *Begonia ×sempervirens-cultorum*, *Begonia ×benariensis*, wax begonia, fibrous-rooted begonia, bedding begonia

Significance to Industry: Wax begonias are popular, warm-season annuals for the landscape. Some newer varieties have been bred for heat tolerance, a distinct benefit in warm summer areas of the southeastern U.S. A study was conducted to evaluate 32 (mostly red/scarlet-flowered) varieties of wax begonias for landscape performance under full sun conditions in southern Mississippi. The best performance over 6 months was exhibited by 'BIG Bronze Leaf Red Improved', 'BIG Green Leaf Red', 'Dragon Wing Red', 'Whopper Bronze Leaf Red', and 'Whopper Green Leaf Red', making these varieties a good choice for long-term color in warm summer climate.

Nature of Work: Wax begonia are popular in gardens as they tend to exhibit a compact growth habit, display almost continuous flowering during the growing season, and are available in an assortment of leaf and flowers colors (1). In mild winter regions, wax begonias may be planted in late winter for spring display or early fall for fall display (2). In commercial production, wax begonia seed is most commonly sown in the winter for spring bedding plant sales (3). In the warmer areas of the southeastern U.S., summer performance of wax begonias can vary from poor to good, depending upon variety (4). The present study was conducted to examine survival and landscape performance of selected varieties of wax begonia (including some newer heat-tolerant varieties) in full sun in southern Mississippi.

Plants of 32 (mostly red/scarlet-flowered) varieties of wax begonia were propagated from seed in 72-cell trays during winter 2012, transplanted into 4-inch pots when seedlings were large enough to handle, and planted into the ground on May 31, 2012. Plants were grown in field rows in a sandy loam soil with 1 Tbsp. of Osmocote 15-9-12 (3-4 month) fertilizer worked into the bottom of each planting hole. Plants were irrigated daily with drip tubing and no mulch was used. The study was conducted at the South Mississippi Branch Experiment Station in Poplarville, Mississippi with 12 replicates per variety in a completely randomized design. Plants were evaluated for overall appearance (foliage quality and flower display) on August 13, 2013 and November 20, 2013 using a 0 to 5 rating scale: 0=dead; 1=poor, 2=minimal, 3=fair, 4=good, 5=excellent.

Results and Discussion: Summer conditions during the summer were notably warm with regular rainfall (Table 1). By mid-August, over one-half of the varieties had died, whereas 'Cocktail Vodka', 'Dragon Wing Red', 'Eureka Bronze Leaf Scarlet', and 'Harmony Scarlet' were still in acceptable condition (Table 2). 'BIG Bronze Leaf Red Improved', 'BIG Green Leaf Red', 'Whopper Bronze Leaf Red', and 'Whopper Green Leaf Red', varieties bred for heat tolerance, were showing good or excellent performance in mid-August. By mid-November, only plants of 'BIG Bronze Leaf Red Improved', 'BIG Green Leaf Red', 'Dragon Wing Red', 'Whopper Bronze Leaf Red', and 'Whopper Green Leaf Red' remained alive and were still showing good to excellent performance (Table 2), making these varieties good choices for long-duration landscape performance under full sun conditions in southern Mississippi.

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Table 1. Average minimum and maximum temperatures and rainfall from June 1, 2012 to November 20, 2012 in Poplarville, MS.

Month	Avg. minimum temp. (ºF)	Avg. maximum temp. (ºF)	Rainfall (in.)
June	70	90	5.2
July	72	90	10.8
August	71	89	21.0^z
September	67	86	5.7
October	54	77	2.3
November 1 to 20	45	67	1.4

^{z}Includes 16.2 in. of rainfall from Hurricane Isaac in late August.

Table 2. Landscape ratings for 32 varieties of wax begonias grown in full sun in a sandy loam soil in Poplarville, MS. Plants were planted in the ground from 4-inch pots on May 31, 2012.

Cultivar	Median rating (Aug. 13, 2012)[z]	Median rating (Nov. 20, 2012)[z]
Ambassador Green Leaf Scarlet	0	0
Baby Wing Pink	2.5	0
Bada Bing Scarlet	0	0
Bada Boom Scarlet	0	0
Bayou Scarlet	0	0
BIG Bronze Leaf Red Improved	5	5
BIG Green Leaf Red	5	4
Braveheart Rose Bicolor	2	0
Cocktail Vodka	3	0
Dragon Wing Red	3	3.5
Emperor Red	2	0
Encore Red	1	0
Eureka Bronze Leaf Scarlet	3	0
Eureka Green Leaf Scarlet	2	0
Harmony Scarlet	3	0
Havana Pink	0	0
Inferno Red	2	0
Lotto Scarlet	0	0
Monza White	0	0
Nightlife Red	0	0
Party Bronze Leaf Red	4	0
Party Green Leaf Scarlet	0	0
Pizzazz Red	0	0
Prelude Scarlet	0	0
Senator Bronze Leaf Scarlet	0	0
Sprint Red	0	0
Super Olympia Red	0	0
Volumia Scarlet	0	0
Whopper Bronze Leaf Red	5	4
Whopper Green Leaf Red	4	3
Yang Red	0	0
Yin Red	0	0

[z]Rating scale for overall appearance (foliage quality and flower display): 0-dead; 1-poor, 2-minimal, 3-fair, 4-good, 5-excellent (n = 12).

Evaluation of Camellias in Zone 6b

Donna C. Fare

US National Arboretum, 472 Cadillac Lane, McMinnville, TN 37110

Donna.fare@usda.ars.gov

Index Words: Cold hardiness, winter damage, camellias, *Camellia japonica*, *C. sasanqua*, *C. cuspidata*, *C. chekiangoleosa, C. crassissima*

Significance to Industry: Recent hybridization of camellias has yielded several selections recognized as cold hardy to USDA Hardiness Zone 6. Several of the cold hardy camellias, in an established camellia evaluation since 2004, were damaged with foliar bronzing and stem dieback after a severe freeze in November 2013 in McMinnville, Tenn. Though these selections are recognized as cold hardy in Zone 6, a quick temperature drop before plants were acclimated, affected plant hardiness and reduced or eliminated the flower display.

Nature of Work: Camellias are one of the most desirable winter flowering shrubs for southeastern US (4). There are over a thousand selections available in the trade of both deciduous and evergreen foliage and over 400 new registrations with the American Camellia society since 2000 (2, 6). With flowering primarily during late fall, winter and early spring, camellias can be used to extend the period of colorful flowers in landscape from October to May. In the past years, the northern boundaries have been challenged and more plants historically recommended for USDA Hardiness zones 7a and 7b (1, 3) have been planted in zone 6. However, middle Tennessee which is zone 6b, is considered a transition zone between zones 6 and 7 and marginal plants often have winter damage associated with rapid temperature drop. An anecdotal comment is not how low the temperature goes, but how quickly the temperature drops. In the past 20 years, camellia breeders have concentrated on improving cold hardiness and several selections hardy to zone 6 have been released (1). The objective of this research was to evaluate winter hardiness, growth and flowering of twenty selections of Camellia in zone 6b (Table 1).

Camellia selections including *C. japonica*, *C. cuspidata*, *C. crassissima*, *C. chekiangoleosa*, and inter-specific hybrids of *C. japonica*, *C. sasanqua*, and *C. oleifera* were planted in full sun in a field plot at the Otis Floyd Nursery Research Center in McMinnville, TN in April 2002 (5). Original plantings were made in April 2002 to evaluate cold hardiness in USDA Plant Hardiness zone 6 and AHS Plant Heat-Zone 7 and thus plants were well established in the field setting. Height and width was measured each fall to obtain growth indices (GI) [GI=(height+width at widest point+width perpendicular to widest point)/3]. The flowering period was recorded each week from the onset of flowering in the fall to the latest flowering in the spring.

In the fall of 2013, there were very few frosts or temperatures below 32F to promote winter dormancy. On November 12, 2013 an extremely hard freeze occurred (November 12 and

13, low temperature 19F; November 27 and 28, low temperature 14F). On April 24, 2014, winter damage was accessed using the following scale: foliar damage: 1= no damage, 2=brown/bronzed leaves on one third of the plant, 3=brown/bronzed leaves on two-thirds of plant, 4= brown/bronzed leaves on entire plant, 5=defoliation. Stem dieback was assessed by the following scale: 1=no dieback, 2= tip dieback (< 6 inches), 3= stem dieback (> 6 inches), and 4 = dead. On June 25, 2014, the foliar rating as described above was used and stem recovery was rated with the following scale: 1= no damage, 2=regrowth from stems, 3= regrowth only from base of plant, 4= dead. Three evaluators independently rated the damage and their ratings were pooled due to no statistical differences. The statistical design was a randomized block design with 5 single plant replications. Data were analyzed using PROC GLM of SAS statistical package (SAS Institute, Cary NC). Means were separated using Fisher's Protected LSD at $\alpha = 0.05$.

Results and Discussion

Growth. Most cultivars were increasing in growth from 2009 until 2013 (Table 1). Arctic Snow and Pink Icicle, both C. *oleifera* hybrids, were the only two selections with fastigiate growth habit and had the greatest growth indices compared to other selections. However, camellias with a large globe shape that had similar growth indices to the *C. oleifera* hybrids during 2009 to 2012 were *C. cuspidata* and April Remembered. By November 2013, *C. chekiangoleosa* and many of the Ackerman hybrids, April Dawn, April Kiss, and April Tryst had similar growth indices as *C. cuspidata* and April Remembered. CM Hovey, a small statue upright selection, was the smallest cultivar in the evaluation.

Winter damage. On April 24, 2014, *C. chekiangoleosa*, *C. crassissima* and April Snow had the least leaf and stem damage after the 2013-2014 winter; however, statistically Artic Snow, CM Hovey and Kumasaka had similar damage (Table 2). April Blush, April Remembered, Bernice Boddy, Pink Icicle, Spring's Promise and Turandot had the most leaf and stem damage. The plants response to this winter's fluctuating temperature is in contrast to a spring freeze in 2007, when April Remembered, Berenice Boddy, Pink Icicle, Spring's Promise, and *C. cuspidata* had the least freeze damage and Kumasaka and C.M. Hovey had the most stem dieback (5). By June 25, 2014, the winter damage was imperceptible due to the new flush of growth and the natural shedding of the old damaged leaves with several cultivars (Table 2). However, it was obvious that April Blush, April Remembered, Bernice Boddy, Pink Icicle, Spring's Promise and Turandot had branches that died as a result of the freeze. Renewal pruning was conducted after the rating.

Flowering. With the exception of Artic Snow, which blooms in the fall, this collection of camellias flower in late winter or early spring. Pink Icicle, Kumasaka, and *C. chekiangoleosa* have the best overall flowering displays, with blooming periods in March and April. Many of the other selections have had sporadic flowering with an occasional display of color, but often flower buds will bull nose without opening completely or flowers that do open are located on the inside of the canopy or low on the plant. *C. cuspidata* has fine textured leaves and flowers are not as large or showy as previously mentioned selections; however, the fragrant, pendulous white flowers cover the entire plant in spring. Camellia selections that do not flower well will not be popular in Zone 6 due to other hardy broadleaf evergreens.

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Table 1. Growth index of camellia selections evaluated in McMinnville, TN from 2009-2014.

	Growth index, cm[Z]											
Camellia Selections	**2009**		**2010**		**2011**		**2012**		**2013**		**2014**	
April Blush	140	g[Y]	160	g	178	h-k	181	h	187	gh	132	hi
April Dawn	177	cd	200	cde	214	def	220	b-e	229	b-e	220	b-e
April Kiss	170	cde	194	c-e	202	e-h	217	b-f	221	b-f	221	b-e
April Remembered	194	abc	212	bcd	230	bcd	228	bcd	240	bc	220	b-e
April Snow	158	d-g	183	efg	193	f-k	206	d-g	215	c-h	219	b-e
April Tryst	168	de	190	def	201	f-h	217	b-f	226	b-e	234	bc
Arctic Snow	211	a	238	ab	254	ab	282	a	285	a	300	a
Berenice Boddy	182	bcd	219	cd	227	cde	231	bc	233	bcd	100	i
Betty Sette	141	fg	170	fg	185	g-k	194	fgh	198	e-h	190	ef
Blood of China	169	cde	194	c-e	198	f-i	193	fgh	192	fgh	195	def
CM Hovey	138	g	161	g	168	k	178	h	184	h	174	fg
Kumasaka	145	efg	169	fg	173	jk	182	gh	201	d-h	197	def
Paulette Goddard	166	def	187	d-g	197	f-j	213	c-f	217	c-g	215	b-e
Pink Icicle	213	a	248	a	270	a	286	a	288	a	283	a
Prof. Charles S. Sargent	140	g	160	g	178	ijk	180	h	215	c-h	196	def
Spring's Promise	181	bcd	199	cde	208	e-g	219	b-e	229	b-e	153	gh
Turandot	152	efg	176	efg	184	g-k	201	e-h	212	c-h	201	c-f
C. chekiangoleosa	167	de	196	c-f	218	def	233	bc	243	bc	246	b
C. crassissima	148	efg	183	efg	204	efg	214	c-f	215	c-h	227	bcd
C. cuspidata	204	ab	232	ab	250	abc	253	a	251	b	239	b
LSD	25		28		25		25		32		34	

[Z]Growth index, measured in late fall each year, is calculated using the following formula: [height+width1 (widest point)+width2 (perpendicular to width1)]/3.
[Y]Means in the column followed by the same letters are not significantly different at α = 0.05, Fisher's protected LSD.

Table 2. Foliar and stem damage assessment of camellia selections from winter 2013-14 in McMinnville, TN.

	Rating, April 2014				Rating, June 2014			
Camellia Selections	**Foliar damage[Z]**		**Stem damage[Y]**		**Foliar damage[Z]**		**Stem recovery[X]**	
April Blush	3.4	bc[W]	2.4	cd	2.3	b	3.0	b
April Dawn	2.8	c-f	1.9	e-h	2.0	bc	2.8	bc
April Kiss	3.5	b	1.9	e-h	2.0	bc	2.2	cd
April Remembered	3.4	bc	2.5	c	2.0	bc	3.0	b
April Snow	1.9	hij	1.7	gh	1.3	de	1.3	ef
April Tryst	2.3	e-i	1.7	gh	2.0	bc	2.0	de
Arctic Snow	2.2	f-j	1.9	e-h	1.0	e	1.0	f
Berenice Boddy	4.7	a	3.6	a	3.0	a	3.8	a
Betty Sette	2.2	e-i	1.8	fgh	2.0	bc	2.5	bcd
Blood of China	2.8	c-f	2.1	def	2.0	bc	2.8	bc
CM Hovey	2.0	g-j	2.2	cde	2.0	bc	2.5	bcd
Kumasaka	2.6	d-g	1.7	gh	1.5	cd	2.0	de
Paulette Goddard	2.3	e-i	1.7	gh	1.3	de	1.3	ef
Pink Icicle	3.2	bcd	2.0	d-g	2.0	bc	3.0	b
Prof. Charles S. Sargent	2.0	g-i	1.7	gh	2.0	bc	2.0	de
Spring's Promise	4.2	a	2.9	b	2.3	b	3.0	b
Turandot	2.9	b-e	2.2	cde	2.0	bc	3.0	b
C. chekiangoleosa	1.6	j	1.2	i	1.5	cd	1.3	ef
C. crassissima	1.8	ij	1.0	i	1.0	e	1.0	f
C. cuspidata	2.5	d-h	2.9	b	2.0	bc	2.7	bcd
LSD	0.7		0.4		0.5		0.7	

[X]Rating scale for stem recovery: 1= no damage, 2=regrowth from stems, 3= regrowth only from base of plant, 4= dead.

[Z]Rating scale for foliar damage: 1= no damage, 2=brown/bronzed leaves on one third of the plant, 3=brown/bronzed leaves on two-thirds of plant, 4= brown/bronzed leaves on entire plant, 5=defoliation.

[Y]Rating scale for stem dieback: 1=no dieback, 2= tip dieback (< 6 inches), 3= stem dieback (> 6 inches), and 4 = dead.

[W]Means in the column followed by the same letters are not significantly different at $\alpha = 0.05$, Fisher's protected LSD.

Plants with Potential 2015: Ornamentals for Industry Consideration

Allen Owings, Gina Hebert and Jason Stagg

LSU AgCenter, Hammond Research Station
21549 Old Covington Hwy, Hammond, LA 70403

jstagg@agcenter.lsu.edu

Index Words: ornamental plants, plant introductions, landscape performance potential, wholesale and retail nurseries, landscape professionals

Significance to Industry: This is the inaugural year of a new LSU AgCenter program to introduce unfamiliar, non-patented plants to wholesale growers, retail garden centers and landscape professionals in Louisiana. Plant species or varieties selected for the program currently have limited or no distribution and use in the state, but evidence suggests they have excellent landscape performance potential in our challenging climate. The industry may benefit from learning about and receiving these stock plants for evaluation of growth characteristics or customer interest. Nurseries may be able to broaden their product lines and landscapers could diversify their plant material palettes to enhance profitability. Use of non-patented plant material free from propagation restrictions can present a significant cost savings and lower risk of offering these new selections.

The LSU AgCenter's Hammond Research Station benefits from an extensive network of plant professionals, allowing us to discover and acquire underutilized plants that may already be performing well under our demanding growing conditions. This program is designed only to increase awareness and distribution of such plants and is therefore not an official trial study, but instead is an additional support mechanism offered to the industry. The station is already an engaged industry partner and trusted source of reliable landscape performance information for ornamentals, and the industry can now plan for an annual "Plants with Potential" introduction at our spring industry open house and lecture series held each May.

Nature of Work: Nine plant species or varieties were chosen in fall 2014 to be included in the program's launch the following spring. Choices were generally made based on observed landscape performance of unfamiliar plant material previously acquired by the Hammond Research Station. Plant sources range from "pass along" or heirloom plants to varieties offered for sale on a very limited commercial basis. Some plants in the program will perform only as annuals while others are true herbaceous perennials in Louisiana's climate. Future years' introductions will diversify to include grasses and woody ornamentals. No patented plant materials are considered for the program.

Vegetative propagation of plants began in late fall and continued through early winter and spring. Plugs or liners of some selections were ordered due to lack of sufficient propagation material. The goal was to produce 100 trade gallon or quart size propagules for all nine plants. Production space was limited, but propagation targets were achieved except for one tropical copper plant that struggled in the greenhouse during the winter. The names of the nine plants are provided below along with a brief description of growth characteristics and background source information (if known).

1. *Acalypha wilkesiana* 'Kapioloni Bronze' EUPHORBIACEAE (Kapioloni Bronze Copper Plant) – Tropical shrub producing a dense mass of small reddish-bronze leaves. Plant in full sun for best performance. Upright growth habit to 5' x 3'. Commercially available from Kartuz Greenhouses in California. Propagated by cuttings. Usually not winter hardy in Zone 8. May over-winter in warmer regions of Zones 8 and 9. The LSU AgCenter provided this plant to the Louisiana Society for Horticultural Research (LSHR) for its 2014 annual plant release.

2. *Acalypha wilkesiana* 'Musaica' EUPHORBIACEAE (Musaica Copper Plant) – Tropical shrub with very large multi-colored leaves in shades of orange, bronze and green with red to orange markings. Performs best in full sun. Upright growth habit to 3-4' x 3'. Commercially available from Kartuz Greenhouses in California. Propagated by cuttings. Usually not winter hardy in Zone 8. May over-winter in warmer regions of Zones 8 and 9. The LSU AgCenter provided this plant to the LSHR for its 2015 annual plant release.

3. *Begonia* 'Barbara Rogers' BEGONIACEAE (Barbara Rogers Begonia, possibly Friendship Begonia) – Believed to belong to the semperflorens group of begonias, this vigorous upright garden begonia collected from South Carolina can grow 2-3' x 2'. Glossy/waxy, dark green foliage is enhanced by flowers of very light-pink to white from spring to fall. Landscape performance is comparable to the BabyWing series. Can be planted in full sun, but prefers part sun. Limited availability commercially (Georgia, Florida, Carolinas). Sold at retail by Tallahassee Nurseries. Propagated by cuttings. Perennial in Zones 8 and 9.

4. *Lantana camara* 'Belle Starr Gold' VERBENACEAE (Belle Starr Gold Lantana) – Vibrant yellow and gold flower clusters bloom from spring to frost. Plant in full sun. Grows to 2'x 2-3'. Excellent butterfly attractant. Propagated by cuttings. Available from Southwest Perennials in Dallas, TX. Reliable perennial in Zones 8 and 9.

5. *Pelargonium* 'Mary Helen' GERANIACEAE (Mary Helen Geranium) – Drought-tolerant heirloom variety from south Texas. Produces medium-red to orange-red flowers spring to fall. Prefers good drainage and protection from the afternoon sun. Plants are vigorous (3-4' with support). Currently being considered for Texas Superstar plant trials. Brought to the university system by Texas A&M horticulturist Jerry Parsons. Not available commercially. Propagated by cuttings. Has shown varied over-wintering potential in Zones 8 and 9. The LSU AgCenter provided this plant to the LSHR for its 2015 annual plant release.

6. *Pentas lanceolata* 'Nova' RUBIACEAE (Nova Pentas, Nova Pink Pentas, Egyptian Star Flower, Egyptian Star Cluster) – This 1999 Georgia Gold Medal Winner is reportedly one of the hardiest and most vigorous Pentas varieties. Grows to 3'x 2' in full sun. Large

clusters of 3-4” rose-pink, star-shaped flowers appear atop dark green leaves from late spring through fall. Excellent butterfly attractant. Limited commercial availability. Grown in small numbers by Cindy Moran, Moran’s Nursery, Baton Rouge, LA. Propagated by cuttings. Perennial in warmer regions of Zone 9. The LSU AgCenter provided this plant to the LSHR for its 2014 annual plant release (named the top 2014 LSHR trial plant).

7. *Portulaca oleracea* ‘Florida Dwarf Rose’ PORTULACACEAE (Florida Dwarf Rose Purslane) – Trailing/creeping prostrate growth habit forms a dense mat of succulent foliage which bears fuchsia/ magenta-colored flowers. Pass along annual that prefers full sun and well-drained soil. Use as a border or in containers. Propagated by cuttings. Grown by one wholesale nursery in Texas. Retail availability from Arbor Gate, Tomball, TX. Not winter hardy. The LSU AgCenter provided this plant to the LSHR for its 2014 annual plant release (named the second highest LSHR 2014 trial plant).

8. *Salvia* ‘Silke’s Dream’ LAMIACEAE (Silke’s Dream Salvia) – Beautiful perennial salvia found in Texas from a cross of *S. darcyi* x *S. microphylla.* Produces 15” long spikes of dark orange-red flowers. Attracts hummingbirds and butterflies. Blooms from summer to frost and performs best in full sun. Prefers good drainage and will grow 2’ x 3’. Propagated by cuttings. Commercially available from limited sources, including Southwest Perennials in Dallas, TX. Winter hardy in Zones 8 and 9.

9. *Turnera ulmifolia* ‘Trailing Yellow’ TURNERACEAE (sometimes also listed in PASSIFLORACAEA) (Trailing Yellow Turnera, Creeping Buttercup Turnera, Trailing or Creeping Yellow Alder) – Trailing/creeping form of the yellow-flowering tropical shrub turnera. Bright yellow flowers bloom mid-spring through fall atop small, serrated, dark green leaves. Needs protection from the afternoon sun. Prostrate growth habit up to 8” tall and 2’ wide making it great for hanging baskets, containers or borders. Propagated by cuttings. Poor winter hardiness below 40°F. Limited commercial availability. Grown in Louisiana by Cindy Moran, Moran’s Nursery, Baton Rouge, LA. The LSU AgCenter provided this plant to the LSHR for its 2015 annual plant release.

Results and Discussion: After propagation was complete, sample plants were assembled and made available for the industry to inspect at the May 8, 2015 industry open house and lecture series at the Hammond Research Station. Three to five examples of each plant type were also planted in display beds at the station to help industry members visualize possible landscape applications.

Interest surveys were given to over 90 industry members attending, with 20 surveys being returned expressing various levels of interest in the plants. Based on those surveys, it is expected that a minimum of three plants of each selection will made available to interested partners. Additional plants might be offered of the most popular selections, including ‘Silke’s Dream Salvia,’ which received the highest level of interest according to survey responses. Recipients of these first-year plants may be asked to complete a brief survey at the end of the 2015 growing season to measure their impressions, customer interest and overall satisfaction with the plants.

Crape Myrtle Cultivar Evaluations In Northern Mississippi

R.C. Sloan and S.S. Worthey

rcsloan@ext.msstate.edu

North Mississippi Research and Extension Center
Mississippi State University; Verona, MS 38879

Significance to Industry: Crape myrtle, *Lagerstroemia*, trees are a staple in municipal and residential landscapes. New cultivars are available every year that possess many desirable attributes of small urban trees. This long term field trial evaluated the plant size, bloom period, bloom size, and disease resistance of crape myrtles.

Nature of Work: Thirty three crape myrtle cultivars were planted at the North Mississippi Research & Extension Center in Verona, Mississippi in 2004. Field beds were prepared in a Quitman silt loam soil. The rows were spaced 15 feet apart and the crape myrtles were spaced 15 feet between plants. Weeds were controlled by pre-emergence and post-emergence herbicides. Water was supplied by drip irrigation the first growing season to ensure survival. In the subsequent growing seasons of the trial no supplemental irrigation was supplied. Plants were fertilized one time a month (April- September) at the rate of 1 lb. per plant using 13-13-13.

The experimental design was a randomized complete block with six replications. The experimental unit was one plant. The data recorded in this experiment was the growth of the plants for the year. Data were analyzed by SAS PROC GLM (SAS Institute Inc, Cary, NC). Mean separation was conducted with Fisher's Protected LSD at the 0.05 significance level.

Results and discussion: The crape myrtle cultivars were grown at NMREC from 2004 to 2010. The plant size and bloom descriptions are shown in Tables 1 and 2. 'Choctaw', 'Muskogee', 'Sarahs Favorite', 'Sioux', and 'William Toovey' were in bloom from June through August 2008 – 2010 (Figure 1). 'Raspberry Sundae' was consistently at the top of for powdery mildew susceptibility ratings; but was not significantly different from several other cultivars. On the low end of powdery mildew susceptibility ratings were 'Townhouse', 'Kiowa', and 'Acoma'; but again there were several cultivars that were not statistically different

Table 1. Height, width, bloom length, bloom width of crape myrtle cultivars on September 1, 2010 at Verona, MS.

Cultivar	Tree height (feet)	Tree width (feet)	Bloom length (inches)	Bloom width (inches)
Woodlanders Chocolate Soldier	17.8	18.9	5.2	4.8
Kiowa	16.2	18.1	8.5	6.6
Fantasy	14.7	16.7	5.8	5.3
Muskogee	14.4	18.6	4.3	3.8
Tuskegee	13.3	18.6	6.6	6.3
Townhouse	12.8	17.1	6.5	5.7
Sioux	12.4	13.4	6.6	6.5
Miami	12.0	15.6	7.5	5.9
Sarah’s Favorite	11.5	18.5	7.2	7.6
Tuscarora	11.4	14.8	9.6	8.4
Osage	11.2	15.3	8.1	7.4
Country Red	11.1	13.3	8.1	5.9
Red Rocket	10.9	12.6	7.5	5.1
Raspberry Sundae	10.3	9.5	8.0	5.9
Carolina Beauty	10.3	12.4	6.8	4.6
Natchez	10.2	17.8	5.6	4.7
Twilight	9.7	13.7	7.6	6.5
Apalachee	9.5	13.4	6.4	5.2
Centennial Spirit	8.4	8.7	7.6	5.6
Dynamite	8.3	8.9	8.5	5.6
William Toovey	8.2	15.3	7.4	5.4
Tonto	8.1	12.2	5.9	4.5
Catawba	7.8	10.6	6.2	5.5
Burgundy	7.2	9.6	6.8	5.7
Choctaw	7.0	11.3	8.9	5.9
Arapaho	6.7	7.3	10.3	7.4
Velma’s Royal Delight	6.6	8.2	4.9	4.4
Christiana	6.2	8.8	6.1	4.7
Siren	6.0	6.4	8.1	5.9
Powhatan	6.0	6.6	7.2	5.1
Splash of Pink	5.9	8.5	5.6	4.5
Acoma	5.8	13.7	5.4	4.0
Cheyenne	5.2	6.9	8.9	6.8

Table 2. Description of crape myrtle cultivars

Cultivar	Description	Color
Acoma	low spreading	white
Apalachee	upright,dense growth	lavender
Arapaho	broad vase shape	red
Burgundy Cotton	broad ,upright	white
Carolina Beauty	upright	dark red
Catawba	upright,dense shrub	violet purple
Centennial Spirit	upright	red
Choctaw	tree form,rounded	bright pink
Christiana	upright	deep red
Country Red	upright	red
Dynamite	upright	deep red
Fantasy	narrow, vase shaped	white
Kiowa	tall ,arching tree	white
Miami	upright	dark pink
Muskogee	broad tall tree form, rounded	lavender
Natchez	broad tall tree form, rounded	white
Osage	low globose	medium pink
Powhatan	compact globose, upright rounded	medium purple
Raspberry Sundae	upright	dark pink, white
Red Rocket	upright	cherry red
Sarah's Favorite	upright	white
Sioux	upright	dark pink
Siren Red		dark red
Splash of Pink		white, pink
Tonto	compact globose, upright rounded	red
Townhouse	wide, spreading	white
Tuscarora	broad vase	dark pink
Tuskegee	broad spreading	dark pink
Twilight	broad upright	medium purple
Velma's Royal Delight	compact	vivid magenta
William Toovey	vase shaped	pink-red
Woodlander's Chocolate Soldier	upright	white

Table 3. Powdery mildew ratings 2006, 2008, and 2009

Cultivar	Late August	Early August	Late July	Early July	Late June	Early June
Raspberry Sundae	3.0 a	1.9 a	2.1 a	1.8 a	1.6 a	1.1 a
Carolina Beauty	2.6 ab	1.5 ab	1.4 b	0.8 bc	0.8 b	0.6 bc
Red Rocket	2.6 ab	1.3 a-c	1.0 b-f	0.9 b	0.9 b	0.3 c-e
Tuscarora	2.6 ab	1.2 a-d	1.2 b-d	0.8 bc	0.3 de	0.2 de
Velma’s Royal Delight	2.3 a-c	0.6 c-f	0.8 c-i	0.7 b-d	0.6 b-d	0.1 de
Christiana	2.3 a-c	1.3 a-c	1.0 b-g	1.0 b	1.6 a	0.8 ab
Catawba	2.3 a-d	1.1 b-e	0.3 i-l	0.5 b-e	0.3 de	0.2 de
Tuskegee	2.2 a-d	0.6 c-f	0.6 e-k	0.3 c-e	0.3 c-e	0.2 de
Centennial Spirit	2.2 a-d	1.3 a-c	0.9 b-h	1.1 b	0.7 bc	0.2 de
Siren	2.2 a-d	0.2 f	0.4 h-l	0.3 c-e	0.6 b-d	0 e
Splash of Pink	2.2 a-d	1.3 a-c	1.3 bc	1.0 b	0.3 de	0.4 cd
Burgundy Cotton	2.1 b-d	1.3 a-c	0.8 c-i	0.9 b	0.6 b-d	0.2 de
Tonto	2.0 b-d	0.9 b-f	1.0 b-g	0.9 b	0.1 e	0.05 de
Dynamite	1.8 b-e	0.7 b-f	0.7 d-i	0.6 b-d	03. c-d	0 e
Twilight	1.8 b-e	0.4 d-f	0.3 j-l	0.3 c-e	0.2 de	0 e
Arapaho	1.8 b-e	0.8 b-f	0.4 l	0.2 de	0.04 e	0.1 de
Country Red	1.7 b-e	0.7 b-f	0.7 e-k	0.6 b-d	0.9 b	0.05 de
Miami	1.7 b-f	0.6 c-f	0.4 g-l	0.8 bc	0.3 c-e	0.3 c-e
Powhatan	1.7 c-f	0.6 c-f	1.1 b-e	1.0 b	0.8 b	0.4 cd
Apalachee	1.5 c-f	0.7 b-f	1.4 b	0.2 de	0.3 c-e	0.05 de
William Toovey	1.5 c-f	0.3 ef	0.6 f-l	0.3 c-e	0.3 de	0.1 de
Sioux	1.3 d-g	0.2 f	0.4 i-l	0.3 c-e	0.2 de	0.05 de
Muskogee	1.1 e-h	0.2 f	0.2 j-l	0.1 de	0.05 e	0.2 de
Natchez	1.1 e-h	0 f	0.1 l	0 e	0.05 e	0.05 de
Osage	0.8 f-i	0.3 ef	0.2 kl	0 e	0.05 e	0 e
Sarah’s Favorite	0.7 f-i	0 f	0.2 j-l	0.2 de	0.1 e	0.1 de
Woodlanders Chocolate Delight	0.5 g-i	0 f	0 l	0.2 de	0 e	0.1 de
Cheyenne	0.4 ih	0.1 f	0.2 j-l	0 e	0.2 de	0.1 de
Choctaw	0.2 ih	0.3 ef	0.2 j-l	0.1 de	0.05 e	0.05 de
Townhouse	0.2 i	0.1 f	0 l	0 e	0 e	0.05 de
Kiowa	0.2 i	0 f	0 l	0 e	0 e	0.1 de
Acoma	0 i	0.3 ef	0.05 l	0 e	0 e	0 e

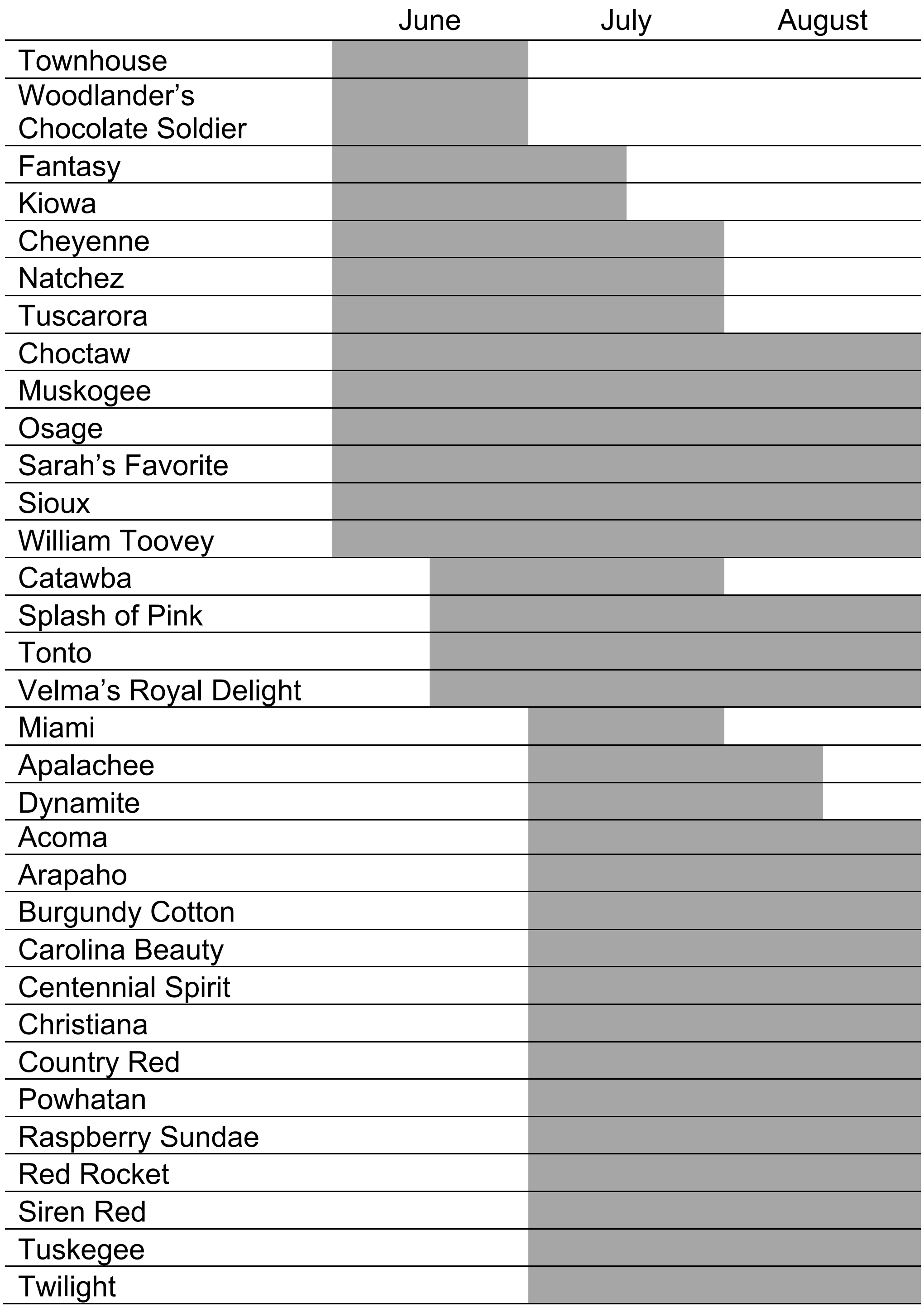

Figure 1. Average bloom period 2008 - 2010