Floriculture

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Vernalization effects on growth and flowering of re-blooming iris

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Index Words: Tall Bearded Iris, cold treatment

Significance to Industry: Tall bearded iris have a large, showy inflorescence that brings a high wholesale price as a cut flower. The use of re-blooming iris for cut flower production makes an otherwise spring only cut flower available over an extended season. Synchronization of flowering will enable greater control over production and timing for specific holidays increasing grower's profits.

Nature of Work: The wholesale market for cut flowers and foliage is over $512 million with the number of American cut flower growers continuing to increase each year (Laws, 2002). Growers in the United States have changed from traditional species for cut flowers to specialty cut flowers or lesser known/ used perennials and annuals as cut flowers. The specialty cut flower industry has proven to be profitable for American growers allowing them to compete with imports (Armitage, 1993). The specialty cut flower market is constantly seeking new species to help keep American growers profitable and competitive with foreign producers.

Tall bearded iris grow from a rhizome producing a large fan of sword shaped leaves. From the terminal growing point, a 29-40" flower stalk bearing several blooms is produced. Tall bearded iris is sought after as a cut flower due to its fragrance and showy display. However, iris have a short vase life and limited seasonal availability. As a cut flower, tall bearded iris wholesale for about $2.50 per stem. Tthe group of tall bearded iris classed as re-blooming has great potential for producing cut iris for the fall and winter holiday seasons thus extending the seasonal availability.

Vernalization can stimulate specific growth patterns in plants. Many species will not grow and flower without vernalization. In other species, vernalization acts as a facultative environmental factor reducing flowering time. This effect is often a function of the length of the cold treatment period. In some perennials, vernalization is required each year before flowering will commence (Leyser and Day, 2003). Tall bearded iris fall into two general categories, spring blooming which put out one bloom per year, and re-blooming which may bloom 2 or more times per year depending on environmental conditions.

The objective of this study was to determine if vernalization of re-blooming iris could be used to synchronize flowering or to increase the number of inflorescences produced.

Plants were obtained from a commercial iris propagator (Cooley's Iris Gardens, Silverton, OR). The varieties 'Immortality', 'Jennifer Rebecca', 'Total Recall', and 'Duo Dandy' were selected as reportedly reliable re-blooming varieties. The plants arrived in mid August and were divided into two groups for vernalization treatments. One group was packed in boxes or cases in moist moss peat. These plants to be case cooled were immediately placed in a cooler at 40□F for 0, 2, 4, or 6 weeks. The remaining group was potted in 8" pots 26 August 2006 in Sunshine mix 1 (Sun Gro Horticulture, Bellevue, WA) and grown in the greenhouse at a night temperature setting of 65°F for 2 weeks until well rooted. After rooting, the plants were placed in a cooler at 40□F for 0, 2, 4, or 6 weeks for vernalization. Six plants of each variety were used per vernalization treatment. Upon completion of the vernalization treatment, the plants were returned to the greenhouse or potted and placed in the greenhouse. The plants received 200 mg N/L from Peter's 20-10-20 (Scott's Company, Marysville, Ohio) at every irrigation during the greenhouse production phases. Data on date of blooming and number of inflorescences per plant were recorded.

Results and Discussion: For 'Duo Dandy', 'Immortality', and 'Total Recall', it was determined that vernalization was not necessary to induce re-blooming and was determined to be detrimental to growth and flowering. In particular, the vernalization did not result in a synchronized bloom but actually inhibited flowering and flower quality in most varieties (Table 1). This was the same whether vernalized in the case or potted then vernalized.

'Jennifer Rebecca' was the only variety to be influenced by method of vernalization producing more inflorescences when rooted before cooling. Length of vernalization time had no effect on the number of inflorescences for 3 of the varieties. However, 'Jennifer Rebecca' produced more inflorescences when vernalized for 6 weeks.

The lack of response to vernalization was likely tied to the fact that these varieties of iris re-bloom in the same growing season without a chilling period. Vernalization was thought to provide synchronization of flowering but this was not observed (data not shown).

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Table 1: Influence of vernalization at 40ºF on total number of inflorescences produced per plant by re-blooming iris. Vernalization was conducted for 0, 2, 4, or 6 weeks on plants that were either case cooled or potted and actively growing before receiving the vernalization treatment.

Weeks	Duo Dandy	Immortality	Jennifer Rebecca	Total Recall
0	1.4a	1.1a	1.0ab	0.5a
2	1.2a	0.8a	0.8b	0.6a
4	1.1a	0.8a	1.2ab	0.8a
6	1.1a	1.3a	1.6a	0.8a
Vernalization				
Case	1.2a	0.8a	0.8a	0.6a
Container	1.3a	1.1a	1.5b	0.8a

Means separation using SNK *P*=0.05.

Lime and Micronutrient Use in Clean Chip Residual Substrate Amended with Composted Poultry Litter or Peat for Use in Annual Production

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Index Words: *Petunia* x *hybrida* 'Dreams Sky Blue', greenhouse, alternative media, CCR

Significance to Industry: Clean Chip Residual (CCR) has been identified as possible replacement for pine bark (PB) in nursery and greenhouse production. Composted poultry litter (CPL) is a major waste problem in Alabama for which uses need to be explored. Pine bark, CCR, CPL and peat were tested in 7:1 v:v ratios with each other and with or without lime or micronutrients to determine the best substrates for annual production. Results indicate that *Petunia* x *hybrida* 'Dreams Sky Blue' can be grown in PB or CCR, but use of CPL is not recommended for *Petunia*. Lime and micronutrients did not produce substantial differences in plant growth.

Nature of Work: Finding an alternative to PB and peat as nursery and greenhouse substrates is an important area of research due to rising costs for growers and the demand for consumer product prices to stay the same. Reduced domestic forestry harvesting combined with use of PB as a source of fuel and other alternative uses (3) has and is continuing to lower supplies of PB available to the green industry. In addition, the high cost of shipping PB in the U.S. and peat from Canada has driven the need to develop alternative substrates.

Recent studies have identified a potential alternative substrate: CCR. This material is composed of limbs, needles and bark after pine plantations are thinned at about the 10-12 year age to produce pulpwood. Generally this material is left in the field or sold as boiler fuel. While CCR has a high wood content (~50%) it also has high bark content (~40%). The remaining 10% is composed of needles, and other miscellaneous forest materials. CCR has been evaluated in a fresh state to produce both annual (2) and perennial species (1).

Poultry litter is a major agricultural waste problem in Alabama. Developing uses for this material is an important environmental issue. Composted poultry litter has the potential to provide necessary macro- and micronutrients that may enhance plant growth. However, CPL can potentially harm some crops due to high pH and soluble salts (EC). Recommendations are that CPL must be used as an amendment in quantities less than 20% in order to avoid unnecessary substrate shrinkage and crop damage (4).

Lime and micronutrients are standard amendments in many nursery substrate mixes; however, they have not yet been tested in CCR to determine if their use is necessary. The objective of this study was to evaluate two substrates (aged PB and CCR), two amendments (peat and CPL), with and without lime and micronutrients in order to determine production practices for producing annuals in substrates containing CCR and/or CPL.

CCR was processed through a 4-inch screen in the field. A hammer mill was used to further process CCR to pass a 0.19 inch screen. The CPL was composted for three days in an in-vessel composter. Substrates were mixed in a 7:1 ratio with either of the two amendments creating four main substrate mixes. Substrates were mixed per yd^3 with 10 lb. 14-14-14 (14N–6.1P–11.6K) Osmocote 3-4 month fertilizer. Four combinations of lime (L, 5 lb. dolomitic limestone) and micronutrient (M, 1.5 lb. MicroMax) use were prepared per yd^3 for each of the four main substrate mixes: yes L, yes M; no L, yes M; yes L, no M; and no L, no M. Four-inch containers were filled and planted with two plugs (228 cell) of *Petunia* x *hybrida* ‘Dreams Sky Blue’. Containers were placed in a greenhouse, liquid fed initially (300 ppm N) to provide a starter nutrient charge and irrigated as needed thereafter. Four replications were harvested at 21 days after planting (DAP) and the remainder were harvested at 35 DAP.

Results & Discussion: There were few differences between PB and CCR. At 21 DAP, plants grown in PB had slightly more rootball coverage, with no difference 35 DAP. Leaf greenness was slightly higher for plants grown in pine bark at 28 DAP. Leaf greenness at 15 and 28 DAP was higher for plants grown in CPL. However, all other measurements were smaller for plants grown in CPL. At 21 and 35 DAP plant growth index (PGI), rootball coverage (RBC) and shoot dry weight (SDW) were greatest when substrates contained peat. Flower number (FN) at 35 DAP was also greater for plants in substrates containing peat. Composted poultry litter resulted in greater substrate shrinkage than peat (0.17 inch vs. 0.08 inch).

Shoot dry weight at 21 DAP was slightly higher for substrates containing lime, but those differences were not present by 35 DAP. At 35 DAP RBC was higher for substrates containing lime. Lime had no effect on leaf greenness at 15 or 28 DAP, PGI at 21 or 35 DAP or FN at 35 DAP.

Leaf greenness for plants grown in substrates containing micronutrients was lower than leaf greenness for plants grown in substrates without micronutrients at both 15 and 28 DAP. Plant growth index, RBC and SDW at 21 and 35 DAP were similar as were FN at 35 DAP.

Foliar nutrient content analysis (data not shown) indicated that all plants in the test were low in nitrogen, potassium, calcium and magnesium. There were no differences in nitrogen content for plants amended with either peat or CPL. Manganese was significantly high in substrates containing CCR or peat or no lime or micronutrients. Substrates containing CPL had higher pH and EC (6.3-6.5 and 5.00-0.65 vs. 4.8-5.2 and 2.66-034 for peat) (data not shown). Pine bark generally had a lower pH (5.1-5.7) than CCR (6.0-6.2), but EC showed a similar trend (3.8 at 1 DAP down to 0.5 at 28 DAP). Substrates containing lime had higher pH (6.0-6.3) than those not containing lime (5.1-5.5), while substrates with micronutrients had similar pHs throughout the study (5.5-5.9).

In summary, PB and CCR were similar in plant growth response while plants grown in substrates amended with CPL had less growth. Lime and micronutrient use did not make an appreciable difference in plant growth for *Petunia* 'Dreams Sky Blue'. Pine bark, CCR, and peat can therefore be recommended as substrates for *Petunia*. Composted poultry litter is not recommended for use as an amendment in production of *Petunia* x *hybrida* 'Dreams Sky Blue'.

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Table 1. Main effects of substrate, lime and micronutrient use on the growth of *Petunia* x *hybrida* 'Dreams Sky Blue'.

	15 DAP[z]	21 DAP			28 DAP	35 DAP			
Treatment	Leaf greeness[y]	GI (g)[x]	Rootball coverage[w]	Shoot dry weight (g)[v]	Leaf greeness	Flower number	GI (g)	Rootball coverage	Shoot dry weight (g)
Substrate									
Pine bark	36.8 a[u]	16.2 a	2.9 a	2.7 a	37.2 a	10.5 a	18.9 a	3.3 a	5.6 a
Clean chip resiual	37.4 a	15.7 a	2.6 b	2.7 a	34.7 b	11.1 a	18.1 a	3.0 a	5.2 a
Amendment									
Peat	35.2 b	18.8 a	4.0 a	3.4 a	34.2 b	16.7 a	21.5 a	3.8 a	7.5 a
Composted poultry litter	39.0 a	13.1 b	1.5 b	2.0 b	37.8 a	4.9 b	15.5 b	2.5 b	3.4 b
Lime									
Yes	37.4 a	16.4 a	2.8 a	2.9 a	36.5 a	11.0 a	18.6 a	3.3 a	5.6 a
No	36.9 a	15.6 a	2.8 a	2.5 b	35.5 a	10.6 a	18.4 a	3.0 b	5.3 a
Micronutrients									
Yes	36.2 b	16.1 a	2.9 a	2.7 a	35.0 b	10.7 a	18.5 a	3.1 a	5.4 a
No	38.1 a	15.9 a	2.6 a	2.7 a	37.0 a	11.0 a	18.5 a	3.2 a	5.5 a

[z]Days after potting.
[y]Leaf greeness of 4 recently matured leaves per plant using a SPAD 502 Chlorophyll Meter.
[x]Growth index = (height + width + perpendicular width) ÷ 3 (1 cm = 0.397 in.).
[w]Rootball coverage measured on a scale of 1-5 where 1 = no roots, 2 = 0-25% coverate, 3 = 26-50% coverage, 4 = 51-75% coverage, and 5 = 76-100%
[v]Shoots harvested at container surface and oven dried at 70°C for 48 h (1 g = 0.0035 oz.).
[u]Mean separation within column by Duncan's Multiple Range test (α = 0.05).

Snapdragon Production for Fresh Cut Flowers

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Index Words: *Antirrhinum majus*, snapdragon, high tunnel, cut flower, field production

Significance to Industry: Previous research in Mississippi has demonstrated production potential for spring-produced snapdragons (4). Informal surveys conducted in Tupelo, MS indicated that florists would prefer to purchase locally produced, fresh, cut flowers if quality and supply are acceptable and constant (5). Another survey of Mississippi consumers reported that they would pay a premium to purchase fresh, cut flowers that were grown in Mississippi (2). This potential crop could have an immediate impact in the local and regional retail outlets and farmer's markets.

Nature of Work: Snapdragon is a crop that shows potential for outdoor spring and summer production in high tunnel frames using traditional plastic culture techniques (3). Growing plants in a high tunnel gives growers an opportunity to provide the local market a flowering summer product earlier in the growing season (1). The objective of this study was to plant 2 different groups of snapdragons over multiple dates in the spring to evaluate the potential for continuous supply of cut flowers. Stem length, stem diameter, and number of stems per plant were measured. 'Monaco' (Group 2,3) and 'Potomac' (Group 3,4) cultivars were planted in ground beds in unheated hoop houses at the North Mississippi Research and Extension Center, Verona, Mississippi. The snapdragons were seeded in a greenhouse and then transplanted to the field beds. The seedlings were grown in cold frames until transplanting. The 'Monaco' cultivars were seeded on three dates; Nov. 22, Jan. 22, and March 12 and then transplanted to the field on March 14, March 21, and May 13, 2006. The 'Potomac' cultivars were seeded on Jan. 22, and March 12 and transplanted to the field on March 21 and May 13, 2006. Data collected during the trial were analyzed by SAS PROC MIXED (SAS Institute Inc, Cary, NC). Mean separation was conducted with Fisher's protected least significant difference (LSD) at the 0.05 significance level.

Results and Discussion: In this trial cultivar did not affect the number of stems produced per plant, while seeding date was significant. The November seeding date for Monaco cultivars produced more stems than the January date, which in turn, produced more stems than the March seeding date (Table 1). Likewise, the January seeding date for the Potomac cultivars produced more stems per plant compared to the March seeding date. The November and January seeding date for the Monaco cultivars did not affect the length of the harvest period, 68.4 and 65.9 days (Table 2). The March seeding date for the Monaco cultivars produced a much shorter harvest period. The same effect of seeding date on the length of harvest period was seen in the Potomac cultivars where the January seeding, 54.9 days, was much longer than the March date, 10.0 days. The results of this study indicate that Monaco and Potomac snapdragons planted for spring harvest should be seeded in January rather than March for maximum production of cut flower stems.

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Table 1. Stems per plant for Monaco and Potomac snapdragons 2006.

Cultivar	Stems Per Plant	Cultivar	Stems Per Plant
Monaco Baltimore Rose	12.6 a [y]	Potomac Cherry Rose	8.6 a
Monaco Red	14.1 a	Potomac Early Orange	13.6 a
Monaco Rose	12.9 a	Potomac Early Pink	9.6 a
Monaco Violet	11.6 a	Potomac Orange	9.6 a
Monaco White Improved	9.4 a	Potomac Pink	14.8 a
Monaco Yellow	14.0 a	Potomac Red Improved	7.1 a
LSD	NS	Potomac Rose	10.1 a
		Potomac Royal	7.4 a
		Potomac Soft Yellow	9.7 a
		Potomac White Improved	10.3 a
		Potomac Yellow	6.6 a
		LSD	NS
Seeding date		Seeding Date	
January	12.9 b	January	14.2 a
March	6.1 c	March	5.0 b
November	18.3 a	LSD = 2.8803	
LSD = 3.1517			

[y] Mean comparison by Fisher’s Protected LSD at P=0.05. Means with the same lower-case letter in a column do not differ at the 5% significance level

Table 2. Number of days of the harvest period for Monaco and Potomac snapdragon cultivars 2006.

Cultivar	Number of Days of Harvest	Average Harvest Period	Cultivar	Number of Days of Harvest	Average Harvest Period
Monaco Baltimore Rose	46.8 a [y]	May 8 – Aug 1	Potomac Cherry Rose	30.4 a	May 25 – Aug 1
Monaco Red	52.8 a	May 8 – Aug 1	Potomac Early Orange	41.5 a	May 25 – Aug 1
Monaco Rose	48.5 a	May 8 – Aug 1	Potomac Early Pink	27.1 a	May 25 – Aug 1
Monaco Violet	59.5 a	May 8 – Aug 1	Potomac Orange	45.0 a	May 25 – Aug 1
Monaco White Improved	42.0 a	May 8 – Aug 1	Potomac Pink	36.6 a	May 25 – Aug 1
Monaco Yellow	49.7 a	May 8 – Aug 1	Potomac Red Improved	26.0 a	May 25 – Aug 1
LSD	NS		Potomac Rose	38.5 a	May 25 – Aug 1
			Potomac Royal	24.7 a	May 25 – Aug 1
			Potomac Soft Yellow	24.7 a	May 25 – Aug 1
			Potomac White Improved	24.9 a	May 25 – Aug 1
			Potomac Yellow	32.7 a	May 25 – Aug 1
			LSD	NS	
Seeding Date			Seeding Date		
November	68.42 a	May 8 – Aug 1	January	54.9 a	May 17 – Aug 1
January	65.96 a	May 17 – Aug 1	March	10.0 b	June 26 – Aug 1
March	15.33 b	June 26 – Aug 1	LSD	13.6982	
LSD	13.1268				

[y] Mean comparison by Fisher's Protected LSD at P=0.05. Means with the same lower-case letter in a column do not differ at the 5% significance level.

Heat and Drought Tolerance of Selected Bedding Plants

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Index Words: Landscape irrigation, water conservation

Significance to Industry: Numerous species and varieties of bedding plants exist for landscape use. However, the number of these bedding plants for landscapes in hot and dry regions seems limited, possibly due to lack of reliable information on species and cultivars that tolerate the extended summer heat and drought stresses. In this study, 15 bedding plant species were grown in a typical hot and dry desert environment under two irrigation regimens: 50% to 67% or 100% to 135% reference evapotranspiration (ET_0). Among them, seven species or cultivars were found to be heat and drought tolerant and can be used in landscape in hot and dry climate.

Nature of Work: In addition to climate and soil conditions, landscape plant performance is depended on irrigation management. Substantial variations exist in literature on minimum water requirements and performance of landscape plants (1, 2, 3). For example, Henson et al. (2) reported that the minimum amount of irrigation for acceptable landscape performance ranged from 0% to 100% ET_0 among 17 herbaceous ornamental plants grown in three locations of Colorado. In this study, fifteen bedding plant species and cultivars were selected based on their popularity and potential tolerance to heat and drought stresses. The objective of this study was to identify ornamental plant species or cultivars that tolerate heat and drought stress for landscape use in hot and dry regions.

Seeds of *Ageratum houstonianum* 'Blue', *Angelonia angustifolia* 'Lavender Pink', *A*. *angustifolia* 'White', *Capsicum annuum* 'Black Pearl', *Catharanthus roseus* 'Rose' (Titan Series), *C. roseus* 'Rose Halo' (Pacifica Series), *Helenium amarum* 'Dakota Gold', *Helichrysum bracteatum* 'Silver Mist', *Petunia × hybrida* 'Purple' (Wave Series), *P. × hybrida* 'Silver' (Tidal Wave Series), *Plumbago auriculata* 'Escapade Blue', *Portulaca grandiflora* 'Rosita' (Margarita F1), *P. grandiflora* 'Yellow' (Tequila Series), *Salvia splendens* 'Vista Red', and *Zinnia violaceae* 'Yellow' were germinated and grown in the greenhouse until transplanting. Plants were transplanted to the field raised beds on 25 April for most species and on 25 May for *H. bracteatum* and *P. auriculata*, based on the size of seedlings. There were 8 raised beds, each with a dimension of 1.5 x 6 x 0.2 m and filled with Blue Point loamy sand mixed with Canadian sphagnum peat moss at 2 to 1 volumetric ratio. Two irrigation treatments with two replications were created by irrigating the raised beds for 1 min or 2 min daily, which corresponded to approximately 50% to 67% ET_0 (50% ET_0) or 100% to 135% ET_0 (100% ET_0) from early June to the end of August. Plant height and two perpendicular canopy widths were measured monthly to calculate the growth index: Growth index = ((height + (canopy width1 + canopy width 2)/2)/2. Visual quality was assessed on all plants three times during the experiment on a scale of 1 to 5, where 1 = severely stunted growth with over 50% foliage damage (discoloring, burning, curling, etc.) caused by drought or heat stress and/or by insect or disease; 2 = somewhat stunted growth with moderate (25-50%) foliage damage; 3 = average quality with slight (<25%) foliage damage; 4 = good quality with acceptable growth reduction and little foliage damage (acceptable as landscape performance); 5 = excellent with vigorous growth and no foliage damage.

Results and Discussion: *Capsicum annuum*, *C. roseus* 'Rose', *C. roseus* 'Rose Halo', *H. amarum*, *Petunia* 'Silver', and *P. auriculata* had the highest visual quality throughout the summer season (Fig. 1). Irrigation treatments affected visual scores of *A. angustifolia* 'White' and *P. grandiflora* 'Yellow' in late June, *Petunia* 'purple' in late July, and *S. splendens* in late August. The visual scores of all other species were not affected by the irrigation treatment. The performance of *A. houstonianum*, *S. splendens*, and *Z. violaceae* was poor in June and July regardless of irrigation treatment, indicating that the temperatures were too high for these species to grow well; heat stress was more dominant than drought stress (climatic data not shown).

Significant differences were found in growth index between the treatments in *A. angustifolia* 'White' from late June to July, *C. roseus* 'Rose' in July and August, *C. roseus* 'Rose Halo' in July, *H. amarum* in August, *H. bracteatum* in August, and *S. splendens* in August (Fig. 2). All other growth indices were not influenced by the irrigation treatment. *Angelonia angustifolia* 'Lavender Pink' and 'White', *C. annuum*, *C. roseus* 'Halo Rose' and 'Rose', *H. amarum*, *H. bracteatum, Petunia,* and *P. auriculata* had rapid growth from June to July, regardless of high temperature, compared to other species. *Ageratum houstonianum*, *P. grandiflora* 'Rosita', *S. splendens*, and *Z. violaceae* were especially sensitive to extremely high temperatures and they hardly grew during the hottest period in June and July. *Petunia* 'Purple' seemed less tolerant to stress than 'Silver'. Some plants of *A. angustifolia* 'Lavender Pink' and 'White', *Petunia* 'Purple', *S. splendens* and *Z. violaceae* died during June and July, possibly due to the extreme high temperatures. However, *P. grandiflora* 'Rosita' died after the heavy rainfall in early August, indicating that this species was susceptible to high soil moisture contents for extended time.

We conclude that *C. annuum*, *C. roseus* 'Rose' and 'Rose Halo', *H. amarum*, *H. bracteatum*, *Petunia* 'Silver', *P. grandiflora* 'Yellow', and *P. auriculata* were heat and drought tolerant and performed visually acceptable with 50% ET_0 irrigation. *Ageratum houstonianum*, *S. splendens* and *Z. violaceae* were less tolerant to heat and drought. Heat stress was more dominant than drought stress on plant performance and growth. Further study is needed to confirm the tolerance of two *Angelonia* cultivars.

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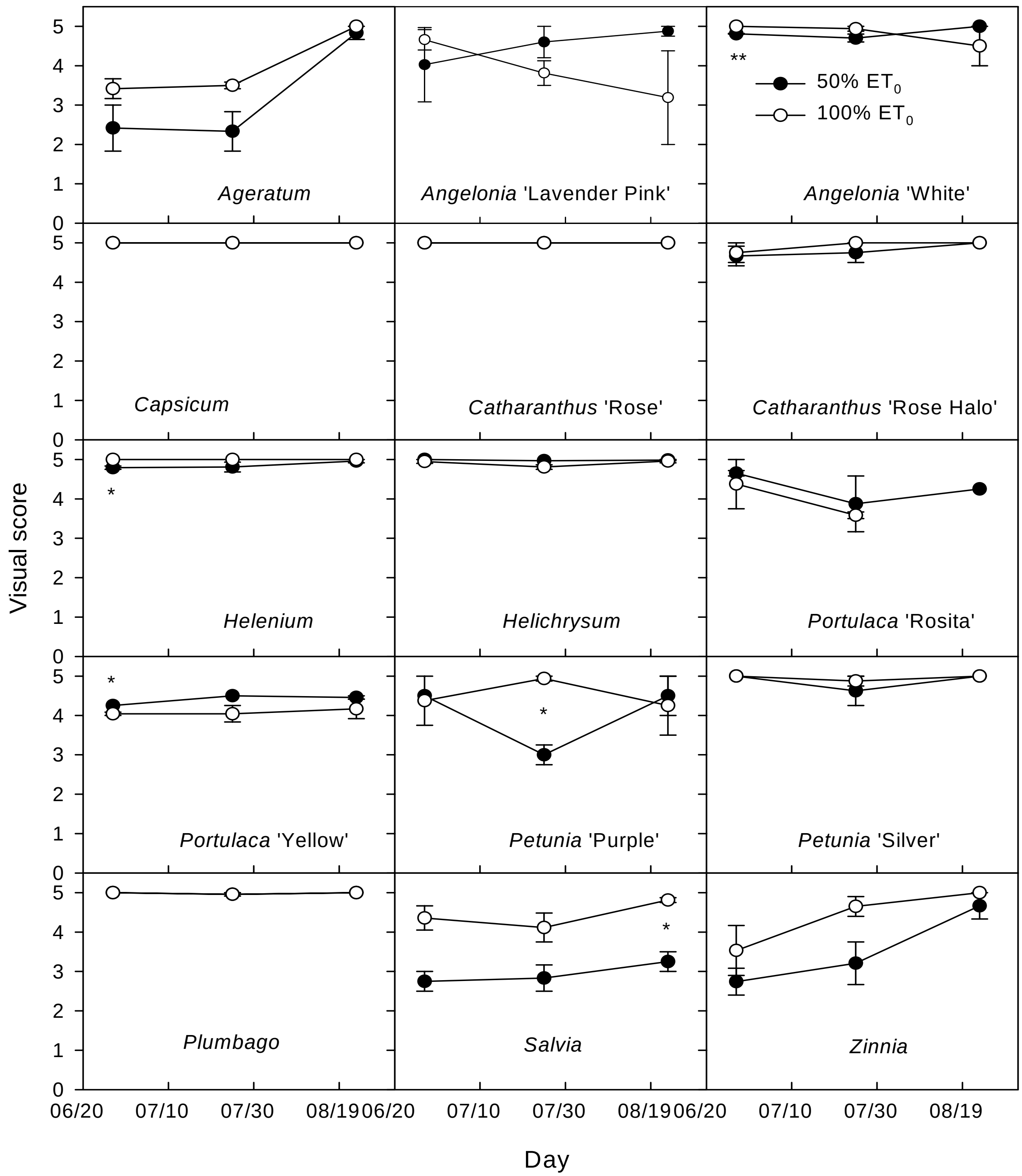

Figure 1. Visual scores of the 15 bedding plant species taken at three different times during the experiment based on a scale of 1 through 5. *, **, *** indicate significant differences between the two irrigation treatments by *t*-test at 5%, 1% and 0.1%, respectively. There were no statistical differences between the two irrigation treatments for all other data points and "NS" was not shown. Vertical bars represent standard errors.

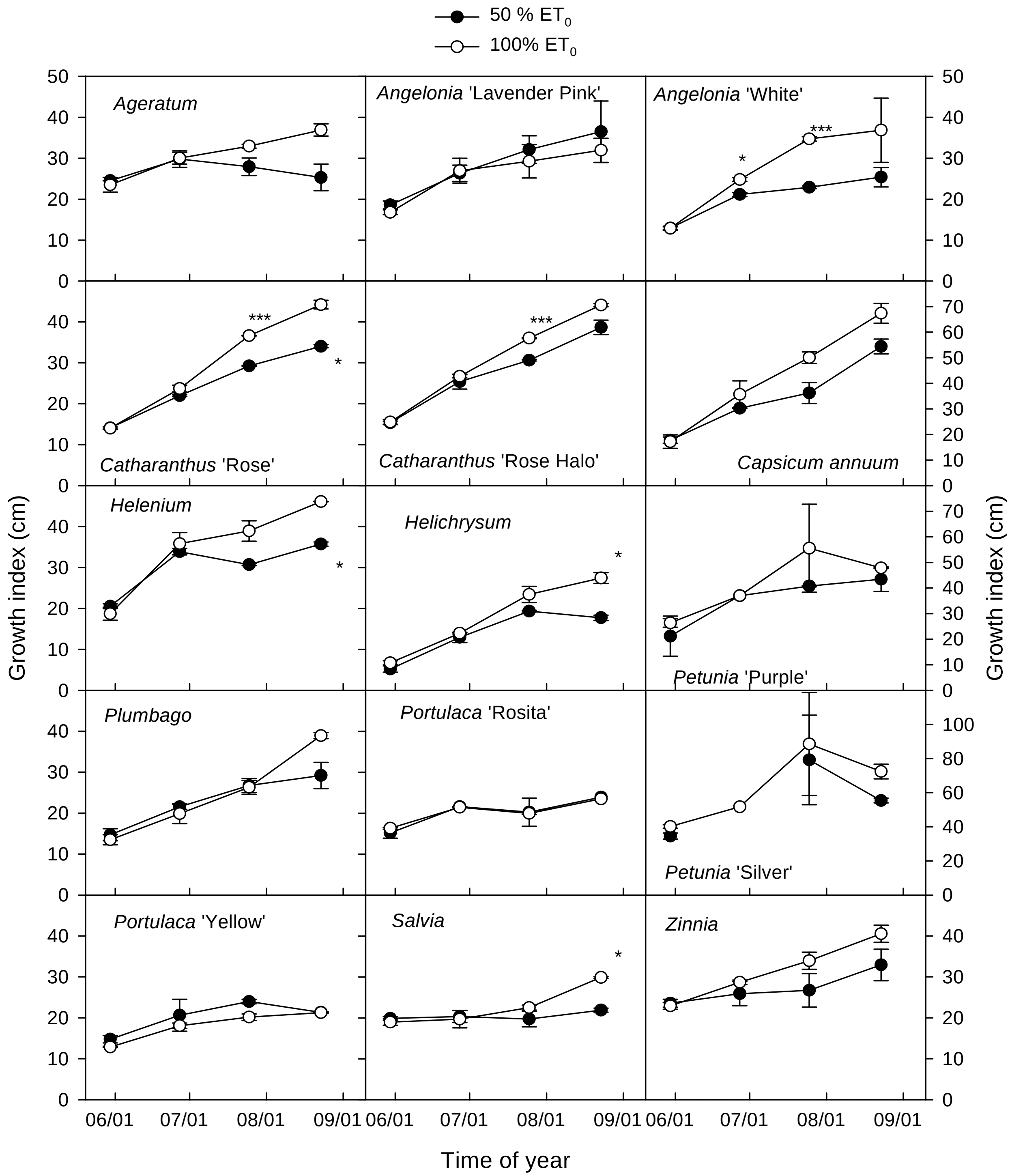

Figure 2. Growth index of 15 bedding plants taken at four different times during the experiment. *, **, *** indicate significant differences between the two irrigation treatments by *t*-test at 5%, 1% and 0.1%, respectively. There were no statistical differences between the two irrigation treatments for all other data points and “NS” was not shown. Vertical bars represent standard errors.

Field Performance of ‘Romantica’ Rose Cultivars

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Index Words: Cut flower, field production, fresh flower, rose, fragrant rose

Significance to Industry: Roses are one of the three main flower crops produced and distributed worldwide, and the large majority of roses purchased in the U.S are produced in South America (1). A survey of Mississippi consumers reported that they would pay a premium to purchase fresh, cut flowers that were grown in Mississippi (3). The survey indicated that the flowers that Mississippi consumers most often purchased are roses, followed by daisies, carnations, iris, lilies, and gladiola. They also reported that Mississippi consumers would pay a premium price for flowers with fragrance. Several specialty cut flower growers have published the results of their efforts to produce fragrant, cut roses for local consumption (2, 4). There appears to be opportunities for production of fragrant roses for local sales.

Nature of Work: The objective of this trial was to evaluate the harvest period, number of stems produced per plant, and stem length of nine ‘Romantica’ rose cultivars planted in field beds at the North Mississippi Research & Extension Center in Verona, Mississippi. Meilland Star Roses provided rose bushes that were planted in field beds in April 2005. All rose cultivars were budded onto ‘Dr. Huey’ rootstock. The rose plants were planted 2 feet apart within the row. Experimental units consisted of one plant of each cultivar. The cultivars were arranged in a randomized complete block design with six replications. Rose stems were harvested as the petals began to open. The stem length at harvest was determined by cutting to the second or third bud above point where the stem arose from the parent cane. If the stem length was less than 30 cm, the stem was not included in the data set. Data collected during the trial were analyzed by SAS PROC MIXED (SAS Institute Inc, Cary, NC). Mean separation was conducted with Fisher’s protected least significant difference (LSD) at the 0.05 significance level.

Results and Discussion

Stem production in 2006. ‘Frederic Mistral’ and ‘Michelangelo’ produced more stems per plant, 19.8 and 18.5, in May compared to the other cultivars except ‘The McCartney Rose’, 16.7 (Table 1). In June, ‘Frederic Mistral’ and ‘The McCartney Rose’ produced more stems, 20.5 and 15.2, than the other cultivars, while in July ‘The McCartney Rose’ produced more stems per plant, 13.2, than the other cultivars except ‘Traviata’, 9.7. ‘Guy de Maupassant’ and ‘Jean Giono’ consistently produced fewer stems per plant during the growing season compared to the other cultivars. 'Peter Mayle' produced longer stems, 38.6 cm, in May compared to the other cultivars except 'Frederic Mistral' and 'The McCartney Rose' (Table 2). In June, 'Peter Mayle' and 'Traviata' produced longer stems, 39.1 and 38.5 cm, than the other cultivars except 'Frederic Mistral' and 'The McCartney Rose', 36.5 and 36.3 cm. 'Frederic Mistral', 'Michelangelo', 'Peter Mayle', 'The McCartney Rose', and 'Traviata' were in the statistical grouping of cultivars that had the longest stem length in July and August. In September, 'Frederic Mistral' produced longer stems, 40.6 cm, than the other cultivars except 'The McCartney Rose', 36.7 cm. 'Frederic Mistral' and 'The McCartney Rose' produced vigorous, healthy bushes and large numbers of long stems during the 2006 growing season.

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Acknowledgement: The authors gratefully acknowledge the donation of plant material and technical support from Mr. Jacques Ferare of Meilland Star Roses.

Table 1. Number of stems produced per plant in 2006. There was a cultivar x harvest date interaction (P>F < 0.0001).

	Harvest Date					
Cultivar	May	June	July	August	September	LSD = 7.4155
Frederic Mistral	19.8 b A [z]	20.5 b A	5.0 c BC	42.5 a A	8.5 c A	
Guy de Maupassant	9.3 a C	1.2 b B	0.5 b C	0.2 b D	1.2 b BC	
Jean Giono	1.5 a D	0.3 a B	0.3 a C	0.2 a D	0.2 a C	
Johann Strauss	10.5 a BC	0.7 b B	1.5 b C	0.2 b D	7.5 ab AB	
Michelangelo	18.5 a A	2.2 c B	5.0 bc BC	5.5 bc B-D	10.7 b A	
Peter Mayle	6.7 a CD	3.8 a B	4.3 a BC	3.5 a CD	8.7 a A	
Rouge Royale	6.8 a CD	2.8 ab B	1.5 b C	1.3 b D	10.0 a A	
The McCartney Rose	16.7 a AB	15.2 a A	13.2 a A	10.3 a BC	9.5 a A	
Traviata	6.7 a CD	5.7 a B	9.7 a AB	11.2 a B	6.7 a A-C	

LSD = 7.0939

[z] Mean comparison by Fisher's Protected LSD at P=0.05. Means with the same upper-case letter in a column do not differ at the 5% significance level. Means with the same lower-case letter in a row do not differ at the 5% significance level.

Table 2. Stem length of 'Romantica' roses in 2006. There was an interaction between cultivar x harvest date (P>F = 0.0038).

	Stem length for harvest dates (cm) [z]					
Cultivar	May	June	July	Aug	Sept	LSD = 4.5926
Frederic Mistral	35.2 b A-C [y]	36.5 ab AB	33.9 b A-C	38.5 ab A	40.6 a A	
Guy de Maupassant	32.2 a CD	32.8 a B-D	33.8 a A-C	29.9 a C	31.0 a CD	
Jean Giono	30.4 ab D	31.0 ab D	34.9 a AB	29.7 b C	29.3 b D	
Johann Strauss	31.2 a CD	30.7 a D	30.7 a BC	29.7 a C	31.0 a CD	
Michelangelo	33.5 a B-D	31.9 a D	34.6 a AB	34.8 a AB	35.4 a BC	
Peter Mayle	38.6 ab A	39.1 a A	33.9 c A-C	34.4 bc AB	33.6 c B-D	
Rouge Royale	32.2 ab CD	33.2 ab B-D	29.9 b C	30.4 b BC	35.0 a BC	
The McCartney Rose	37.3 a AB	36.3 a A-C	35.9 a A	34.3 a AB	36.7 a AB	
Traviata	31.8 b CD	38.5 a A	34.9 ab AB	37.0 a A	35.6 ab B	

LSD = 4.4629

[z] 1 cm = 0.3937 inch

[y] Mean comparison by Fisher's Protected LSD at P=0.05. Means with the same upper-case letter in a column do not differ at the 5% significance level. Means with the same lower-case letter in a row do not differ at the 5% significance level.

Making Greenhouse Irrigation More Efficient: Effects of Substrate Water Content on the Growth and Physiology of Vinca (*Catharanthus roseus*)

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Index words: drought, leaf expansion, photosynthesis, water relations

Significance to Industry: Efficient irrigation is increasingly important in the greenhouse industry to reduce leaching and runoff. Soil moisture sensors can be used to control irrigation and to irrigate based on how much water is lost through transpiration and evaporation . This can be achieved without leaching. Our results indicate that vinca growth increases as the substrate water content increases. The amount of irrigation water needed was surprisingly small: 810 mL/plant was necessary to maintain a substrate water content of 0.47 m^3/m^3 (close to container capacity) for 40 days, or on average 20 mL/plant/day. Leaf expansion was a sensitive indicator of drought stress and plant growth. Leaves that are smaller than normal indicate that plants are drought stressed and plant growth is reduced. Thus, growers may use the size of the uppermost, fully-expanded leaves to monitor crop water status.

Nature of Work: Many states regulate the amount of runoff from agricultural production, so it is becoming increasingly important for greenhouse growers to reduce leaching and runoff. Availability of good quality irrigation water also is an increasingly important issue, especially in urban areas. Automating irrigation by applying water according to plant water use increases irrigation efficiency and reduces water waste, leaching, and runoff. Applying water based on plant use also provides growers with better control over plant elongation and quality and may reduce disease. Water can be applied according to plant use by measuring the substrate water content and applying water at the same rate it is used by the plants. By maintaining a constant substrate water content, irrigation automatically provides the same amount of water as is lost through transpiration and evaporation. Although technically this irrigation approach is relatively simple, there currently is no information on how plants respond to different substrate water contents. The objective of this research was to quantify growth and physiological responses of annual vinca (*Catharanthus roseus*) to different substrate water contents.

Twenty-four vinca 'Titan Burgundy' seedlings were transplanted into containers with 10 L of a peat-perlite growing medium (Fafard 2P; Fafard, Anderson, SC). To allow the seedlings to establish, the growing medium was kept well-watered (water content at least 0.47 m^3/m^3) for one week, after which the treatments were started. The substrates were irrigated at the following water content set points: 0.05, 0.11, 0.17, 0.23, 0.29, 0.35, 0.,41, or 0.47 m^3/m^3. When the substrate water content dropped below the target level, 62 mL of fertilizer solution (200 ppm N, Peter's 20-10-20; Scotts, Marysville, OH) was added to the container. Each treatment was replicated twice. The irrigation system used in this study was based on the system described by Nemali and van Iersel (2006); however EC-5 rather than EC-10 soil moisture probes (Decagon, Pullman, WA) were used. The EC-5 probes were used because they are much less sensitive to EC and temperature, and thus do not need temperature compensation.

Data collected include leaf gas exchange parameters (CIRAS-1; PP Systems, Amesbury, MA), leaf water, osmotic and turgor potential (leaf cutter psychrometers; JRD Merrill, Logan, UT), and the area of the uppermost, fully-expanded leaf at the end of the experiment (LI-3100; Li-Cor, Lincoln, NE). Shoot dry weight also was measured at the end of the experiment. Data were analyzed using regression analysis.

Results and Discussion: The irrigation system functioned well throughout the experiment. It took approximately three weeks for the substrate to dry to a water content of 0.05 m^3/m^3, but after the target substrate water content was reached, the water content remained stable throughout the experiment (Fig. 1). This shows that irrigating plants based on the substrate water content is feasible. No leaching was observed in any treatment.

Plant growth was strongly correlated with the substrate water content. The average shoot dry weight ranged from 0.6 g at a substrate water content of 0.05 m^3/m^3 to 1.8 g at a water content of 0.47 m^3/m^3 (Fig. 2). The different irrigation set points also resulted in large differences in the amount of irrigation water applied. At a substrate water content of 0.05 m^3/m^3, plants received 100mL/plant during the last 40 days of the experiment, as compared to 810 mL per plant in the 0.47 m^3/m^3 treatment.

Substrate water content strongly affected leaf physiology; leaf water and osmotic potential generally increased with increasing substrate water content, but turgor potential was not affected. Stomatal conductance and transpiration were reduced at substrate water contents of 0.05 or 0.11 m^3/m^3. Surprisingly, leaf photosynthesis was not affected by the treatments, and there was no correlation between leaf photosynthesis and plant dry weight (P = 0.49). Although this may seem surprising, it has long been known that there often is little or no correlation between leaf photosynthesis and plant growth (Evans, 1975). The main reasons for this are that leaf photosynthesis measurements do not take into account the total photosynthetically-active leaf area, the efficiency of conversion of photosynthates into dry matter, or the dry matter distribution within the plant.

Leaf expansion was a sensitive indicator of drought stress; the size of the uppermost, fully-expanded leaf was strongly correlated with the substrate water content (Fig. 3). Leaf size also was strongly correlated to shoot dry weight (Fig. 4). This suggests that leaf area, rather than leaf photosynthesis is an important factor controlling growth. Leaf area development may be important because it determines the total area of photosynthetically-active tissue; i.e. if leaf photosynthesis rates are similar, a plant with a large total leaf area will photosynthesize more, and grow faster, than a plant with a small total leaf area. We recently found that the growth of salt-stressed tomato plants also was better correlated with the area of the uppermost, fully-expanded leaf than with leaf photosynthesis (Montesano and van Iersel, 2007).

This strong correlation between leaf size and plant growth gives growers a simple method to monitor whether drought stress may be affecting plant growth: if the leaf size is less than that of a well-watered plant, drought is likely reducing growth.

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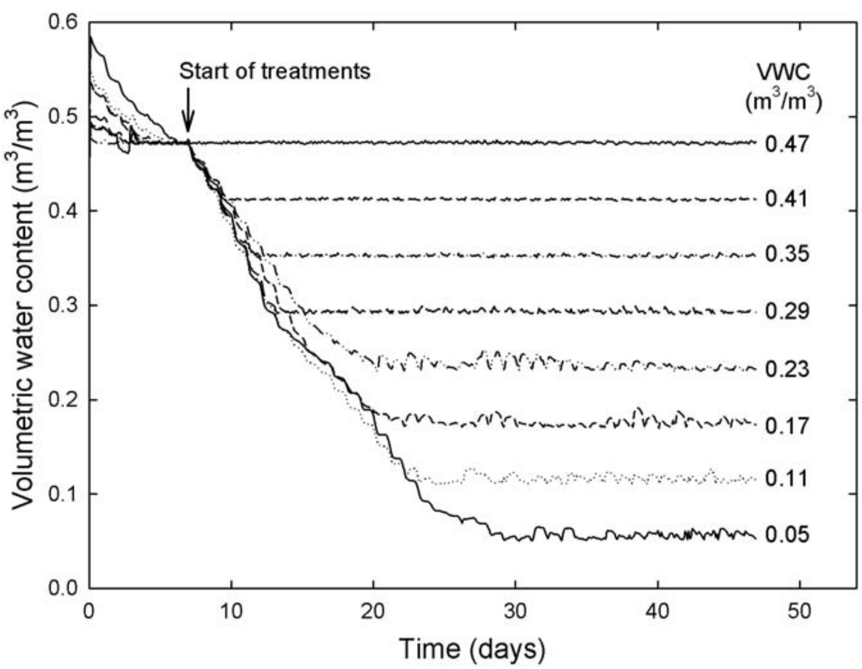

Figure 1. Substrate water content throughout a seven week production period of annual vinca.

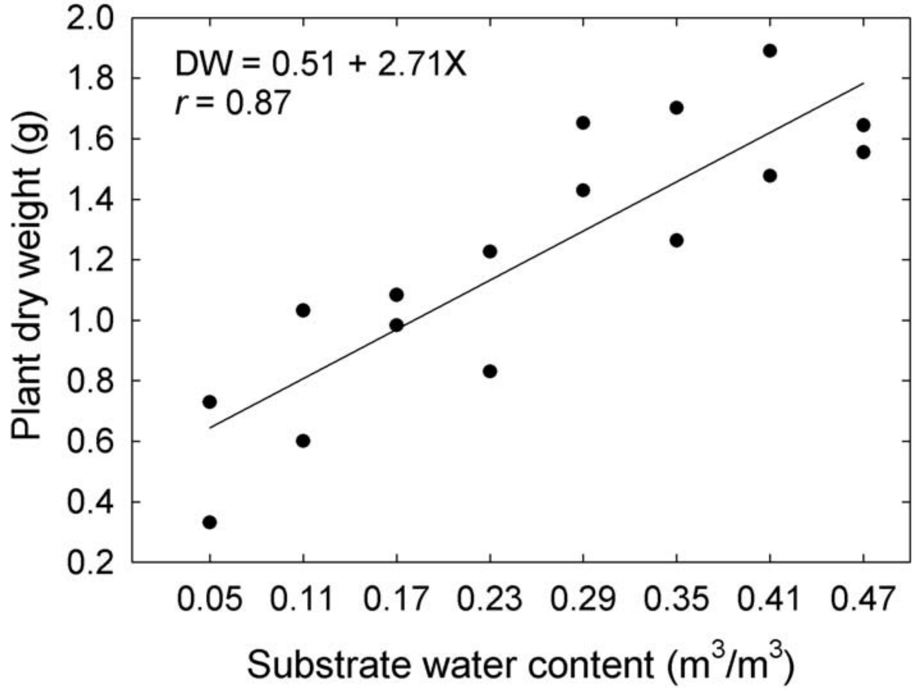

Figure 2. The correlation between substrate water content and shoot dry weight (DW) of vinca. Plant dry weight was higher for plants grown at a higher substrate water content.

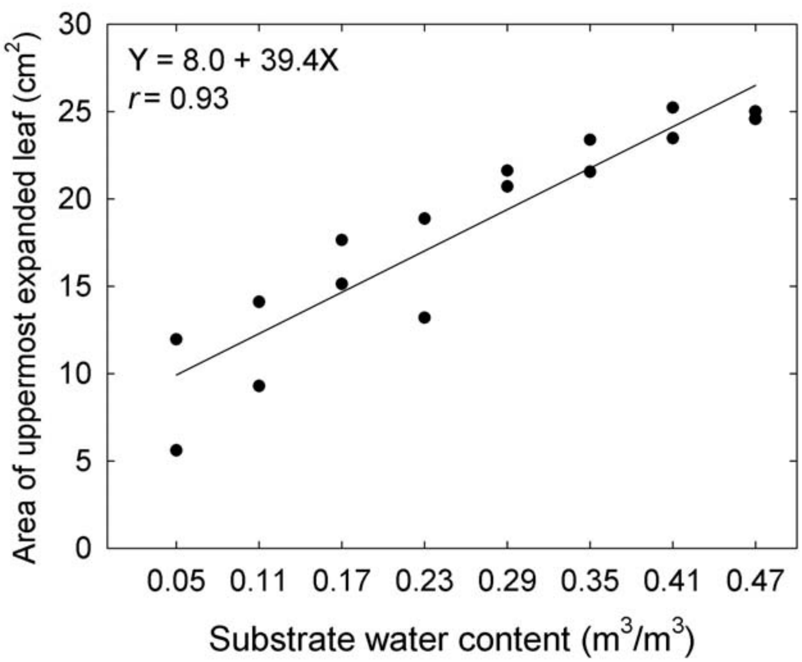

Figure 3. The correlation between substrate water content and the area of the uppermost, fully-expanded vinca leaf.

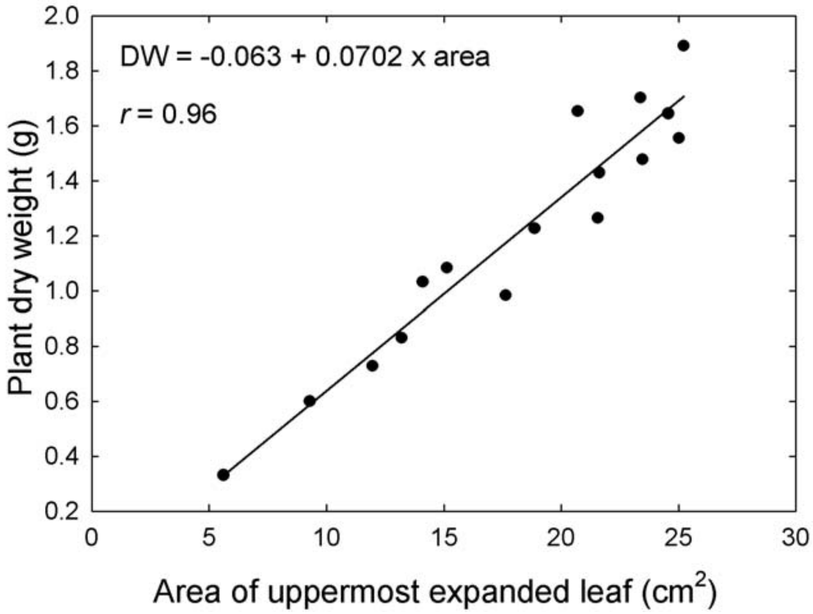

Figure 4. The correlation between the area of the uppermost, fully-expanded vinca leaf and shoot dry weight (DW). These results suggest the leaf expansion and leaf area development are crucial for growth.

Evaluation of Spent Tea Grinds as a Substrate Component

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Significance to Industry: 'New Gold' lantana (*Lantana camara* 'New Gold') and boston fern (*Nephrolepis exaltata* 'Bostoniensis') were grown in substrates containing various amounts of spent tea grinds. Results suggest that spent tea grinds, used in the proper proportions, can replace standard industry mixes that contain pine bark and sphagnum peat moss. By utilizing spent tea grinds as a substrate component, growers may be able to reduce the amount of pine bark and peat used.

Nature of Work: Pine bark (PB) and peat (P) are major substrate components used in nursery and greenhouse production. The steadily increasing costs of these components are of major concern to growers. Future availability of PB for horticulture production is also predictably low (2). Rising fuel costs have had an impact on the cost of importing P from Canada. These factors have led to a search for alternative substrate components. Composted green materials have proven to be a beneficial substrate component in conjunction with PB (3). Tea brewers are generally faced with disposal problems of their waste materials. These materials are most often dumped into landfills at the tea brewer's expense. Spent tea grinds (STG) is a term used to describe the organic waste product of the tea-brewing process. STG contains finely ground tea leaves that have a high water holding capacity, with peat-like qualities, offering the potential to replace P as a substrate component. Composts of agroindustrial wastes, including some brewing waste products, have proven to be potential replacements for P (1). STG and PB were co-composted (50:50 STG:PB) in an in-vessel digester compost machine for one week to yield a material referred to as TBC. Composting work was conducted at Auburn University's E.V. Smith Research Center in Tallassee, AL.

Materials and Methods: Seventy four-inch liners of 'New Gold' lantana and 70 liners of boston fern, from 36-cell market flats, were planted into six inch pots containing various substrate blends. Seven treatments were 100% TBC with supplemental fertilizer (+F), 100% Fafard 3B™ (+F), 80:20 TBC:perlite (+F), 100% Fafard 3B™ without supplemental fertilizer (-F), 100% TBC (-F), 100% STG (+F), and 50:50 STG:PB (+F). The two treatments containing 100% Fafard 3B™ were used as the control groups. Standard horticultural grade perlite was used. For treatments containing supplemental fertilizer, 2.5 lbs/yd of 12-6-6 Nursery Special ™ was pre-plant incorporated along with 1.5 lbs/yd Micromax ™ (Scotts Company), which was added to all treatments. Growth indices of each species were measured at 1 day after planting (DAP) and 70 DAP. Chlorophyll content was measured using a SPAD-502 Chlorophyll Meter at 28 DAP and 70 DAP. The Virginia Tech pour-through method was employed for measuring pH and EC of the treatments on a weekly basis (4) (data not shown). Upon closure of the study, tissue samples from both species were analyzed for nutrient content (Auburn University, Soil Testing Laboratory, Auburn, AL) (data not shown). The study was a completely randomized design (CRD), conducted at the Paterson Greenhouse Complex in Auburn, AL. Data was analyzed in SAS using Duncan's Multiple Range Test (P = 0.05).

Results and Discussion: Substrate pH measurements were initially high (6.5-7.0) for treatments containing 100% TBC (+F), 80:20 TBC:perlite (+F), 100% Fafard 3B™ (-F), and 100% TBC (-F). Treatments of 100% TBC (+F), 80:20 TBC:perlite (+F), and 100% TBC (-F) continued to have high pH measurements throughout the duration of the study. All other treatments fell into the acceptable pH range (5.5-6.5) by 14 DAP. By 28 DAP, the EC value for the treatment containing 100% Fafard 3B™ (-F) was below the acceptable range (0.5-2.5 mS/cm). All other treatments had acceptable EC values throughout the duration of the study.
Boston fern exhibited similar growth in all treatments (Table 1). Lantana exhibited superior growth in 100% TBC (+F), 80:20 TBC:perlite (+F), and 50:50 STG:PB (+F) (Table 1).

Leaf chlorophyll content of boston fern at 26 DAP was highest in 80:20 TBC:perlite (+F), and was similar in100% TBC (+F) and 50:50 STG:PB (+F) (Table 1). At 70 DAP, leaf chlorophyll content in boston fern was highest in 80:20 TBC:perlite (+F) and 50:50 STG:PB (+F), and was similar in 100% TBC (-F), and 100% STG (+F) (Table 1). At 26 DAP, leaf chlorophyll content in lantana was highest in 80:20 TBC:perlite (+F), and was similar in 50:50 STG:PB (+F) (Table 1). At 70 DAP, plants in 50:50 STG:PB (+F) had the highest leaf chlorophyll content, and plants in 80:20 TBC:perlite (+F) were similar (Table 1). Shoot dry weights of boston fern were highest in 50:50 STG:PB (+F), and were similar in 100% TBC (+F), 80:20 TBC:perlite (+F), and 100% Fafard 3B™ (-F) (Table 1). Lantana had the highest shoot dry weight in 80:20 TBC:perlite (+F) and 50:50 STG:PB (+F) was similar (Table 1).

Results suggest that STG blended with PB in proper proportions can produce marketable plants. Furthermore, TBC is a viable substrate for greenhouse production. Further tests should be conducted to document the responses of other species grown in STG and TBC substrates, and to manipulate pH levels in these substrates.

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Table 1. Effects of various substrates on two species (*Lantana camara* 'New Gold' and *Nephrolepis exaltata* 'Bostoniensis').

	Growth Indices		Leaf chlorophyll content [z]				Shoot Dry Weight (g)	
	Lantana	Boston Fern	Lantana		Boston Fern		Lantana	Boston Fern
Treatment[y]	70 DAP[x]	70 DAP	26 DAP	70 DAP	26 DAP	70 DAP	70 DAP	70 DAP
100% TBC w/ fertilizer	22.7a[w]	22.53a	39bc	43.82abc	31.95ab	31.92b	8.5b	8.23ab
100% Fafard 3B w/ fertilizer	12.73bc	21.23a	36.33cd	30.59d	28.74b	22.88c	5.53c	6.03b
80:20 TBC:Perlite w/fertilizer	20.93a	22.17a	42.57a	47.08ab	35.61a	40.68a	11.77a	7.4ab
100% Fafard 3B no fertilizer	6.58c	18.37a	35.21de	25.76d	27.63b	17.41c	4.17c	6.8ab
100% TBC no fertilizer	6.33c	18.4a	27.22f	41.13bc	17.54c	35ab	3.07c	5.57b
100% STG w/ fertilizer	14.28b	18.5a	32.84e	39.72c	19.79c	35.84ab	4.47c	5.13b
50:50 STG:PB w/ fertilizer	25.53a	20.9a	39.99ab	47.74a	33.53ab	41a	9.53ab	9.83a

[z]Leaf chloropyll content determined using a SPAD-502 Chlorophyll Meter

[y]Treatments were PB = pine bark, STG = spent tea grinds TBC = STG and PB co-composted (50:50 STG:PB), fertilizer is 25lbs (12-6-6)/yd^3

[x]DAP = days after planting

[w]Values in columns followed by different letters are significantly different using Duncan's Multiple Range Test P = 0.05

Floriculture, branch of ornamental horticulture concerned with growing and marketing flowers and ornamental plants as well as with flower arrangement. Much of the production of flowers and potted plants occurs in greenhouses, though many flowers are cultivated outdoors in nurseries or crop fields.Â An immigrant worker tending a ranunculus field at a flower farm in Carlsbad, Calif., in April 2006. Jobs in American agriculture have long been filled by migrants from Mexico and Central America.