Evaluation of Compost as an Amendment to Commercial Mixes used for Container-grown Golden Shrimp Plant Production

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Additional index words. *Pachystachys lutea*, biosolids, coir, tropical perennial

Summary. Growth of golden shrimp plant (*Pachystachys lutea* Nees.) transplants was evaluated in media containing 0%, 25%, 50%, 75%, or 100% compost derived from biosolids and yard trimmings. A commercial coir- or peat-based media was amended with compost. As compost composition in the peat or coir-based media increased from 0% to 100%, carbon/nitrogen ratios decreased; and media stability, nitrogen mobilization, pH, and electrical conductivity increased. Bulk density, particle density, air-filled porosity, container capacity, and total porosity increased as more compost was added to either peat- or coir-based media. Plants grown in media with high volumes of compost (75% or 100%) had less leaf area and lower shoot and root dry weight compared to the controls (no compost). Regardless of percentage of compost composition in either peat or coir-based media, all plants were considered marketable after 8 weeks.

Florida Agricultural Experiment Station journal series R-07291. Authors gratefully acknowledge Dawn Lucas for her technical expertise with organic media analysis. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

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Peat is used extensively in the greenhouse industry as a primary component in commercial soilless potting media. The increased use of peat as an organic amendment is challenged by economic and environmental pressures. Developing inexpensive and nutrient-rich organic media alternatives can potentially reduce fertilization and irrigation rates, and, ultimately, nursery costs (Rahmani et al., 1999). In addition, controversy over the effects of peat mining has inspired a national search for peat substitutes (Bright, 1993). With our burgeoning population increase, it is logical to evaluate waste products as potential alternatives to peat. Municipalities have upgraded wastewater treatment processes to comply with federal requirements, and the sludge or biosolids removed during wastewater treatment are mixed with processed and screened yard trimmings and then stabilized and converted to a usable material by composting (Wootton et al., 1981). Horticultural grade quality and quantities of composts derived from municipal solid waste (MSW) have become commercially available at very low costs in recent years from private and municipal landfills. Likewise, coir currently is being distributed by major growth medium producers (Wiethop, 1999). Coir is produced from the mesocarp tissue or husk of the coconut fruit (Cocos nucifera L.) and originates primarily from Sri Lanka, India, Philippines, Indonesia, Mexico, Costa Rica, and Guyana (Evans and Stamps, 1996). In the past several years, extensive research has been directed towards obtaining consistent coir and compost products. Consequently, organic materials have been used to successfully grow a wide range of ornamental crops including bedding annuals (Klock-Moore, 1999), vegetables (Roe, 1998), and woody shrubs and trees (Fitzpatrick et al., 1998). Researchers have reported that numerous container-grown ornamental species grown in MSW and yard trimming compost reach marketable size faster than plants grown in commercial soilless media. The desirable source and optimum percent of the compost in the final substrate differ with varying plant species. Siminis and Manios (1990) reported that container-grown Benjamin fig (*Ficus benjamina* L.) can be grown successfully in substrates of peat with 20% of refuse MSW compost from Greece. Lamanna et al. (1991) performed a study on various annuals and foliage plants and reported that for most of the species examined, the quantity of peat could be reduced to 1/3 of the total substrate, thereby creating a substrate with optimal physical characteristics. Evans and Iles (1997) reported that the growth of arrowwood viburnum (*Viburnum dentatum* L.) and lilac (*Syringa* ×*prestoniae* L.) in coir-based substrates was similar to or greater than that of plants grown in comparable peat-based substrates. Likewise, Meerow (1994) reported that the growth index and dry weights of pentas (*Pentas lanceolata* Schum.) and ixora (*Ixora coccinea* L.) were significantly higher in coir-based medium as compared with that of sedge peat-based medium. However, minimal research is available pertaining to the use of biosolid/yard-trimming compost and coir for containerized perennial plant production. The objectives of this investigation were to develop and evaluate organic media alternatives for peat in container-grown perennial crop production systems. Results from this investigation will provide pertinent, scientific information on the use of compost as a complete or partial additive to commercial, peat or coir-based media commonly used by the greenhouse industry.

Materials and methods

Plant material and media composition. Organic-waste compost was mixed with peat- or coir-based commercial media. Compost was generated by the Solid Waste Authority of Palm Beach County, Fla., using a 1:1 ratio (w:w) of biosolids and yard trimmings (screened to 1.3 mm, 0.5 inch). Materials were composted for 18 d in an agitated bed system, stockpiled, and then rescreened to 1.3 mm (0.5 inch). Peat-based soilless media consisted of 55% to 65% peat, 25% to 35% polystyrene beads, and 5% to 15% vermiculite (Poly-mix; The Scotts Co., Marysville, Ohio). Coir-based media consisted of about 65% coir, 15% perlite, and 20% vermiculite (Yoder Mix; The Scotts Co.). Plugs (approximately 6 cm (2.4 inch) tall; 103 cells/tray pack) of golden shrimp plant (Robrick Nursery, Hawthorne, Fla.) were transplanted into 4.5 L (1.2 gal) cylindrical, plastic pots filled with peat-based soilless media amended with 0%, 25%, 50%, 75%, or 100% (by vol.) compost. Additional 4.5 L (1.2 gal) cylindrical pots were filled with coir-based soilless media amended with 0%, 25%, 50%, 75%, or 100% (by vol.) compost. All plants were topdressed at a standard rate of 15 g/pot (0.53 oz) of 15N–3.9P–10K Osmocote Plus (The Scotts Co., Marysville, Ohio) and treated with a 1% granular systemic insecticide (imidacloprid) at a standard rate of 0.37 g/L (0.02 oz/gal). Plants were inspected daily and hand-watered as needed (3 to 4 times/week). Average minimum and maximum temperatures in the greenhouse were 24 and 35 °C (75.2 and 95.0 °F), respectively.

Three replications of each mixture were evaluated initially for pH, electrical conductivity (EC), total nitrogen (N), total carbon (C), percent moisture, bulk density (BD), particle density (PD), air-filled porosity (AFP), container capacity (CC), and total porosity (TP). Percent moisture was determined by drying a known amount of media at 105 °C (221 °F) for 24 h and weighing before and after. AFP was determined in 0.5-L (0.13-gal) pots using the Wolverhampton submersion method of measuring the volume of drainage water in relation to the substrate volume (Bragg and Chambers, 1988). Standard drying procedures were then used after volume displacement methods to determine CC, TP, BD, and PD (See Niedziela and Nelson, 1992, for equations). Container capacity was calculated by dividing the weight of the wet substrate by the volume of the pot. The pH and EC were determined using a pH-ion conductivity meter by preparing a saturated media extract having a water:media ratio of 2:1 (v:v). For C and N analysis, compost samples were air dried for 2 d at 60 °C (140 °F) and ground to a powder with a ball mill before combustion as described by Nelson and Sommers (1996). Total C and N concentrations were determined using a CNS analyzer (Carlo-Erba NA-1500; BICO, Burbank, Calif.).

PLANT GROWTH AND DEVELOPMENT. Chlorophyll content and stem length were measured every 2 weeks. Chlorophyll content was measured on the 4th, 5th, and 6th leaf from the apex of each plant using a Spad-502 chlorophyll meter (Spectrum Technologies Inc., Plainfield, Ill.). Leaf area was measured eight weeks after transplanting using a leaf area meter (LI-COR, LI-3000A, Lincoln, Nebr.). Growth index of plants was calculated as an average of the measured height and two widths ((height + minimum width + maximum width)/3). Shoots were severed at the crown and roots were hand-washed thoroughly. Mean days to flowering was monitored daily and recorded as the flower bud bracts turned yellow and reached about 1 cm (0.4 inch) in length. Shoot:root ratios were determined after shoots and roots were dried for 1 week at 50 °C (122 °F) in a drying oven.

A randomized complete block experimental design was used for each experiment (i.e., peat and coir-based media). Treatments (0%, 25%, 50%, 75%, 100% compost) were replicated five times. All data within each experiment were subjected to an analysis of variance (ANOVA), and main effects of treatments partitioned into orthogonal contrasts using the Statistical Analysis System (SAS Institute, 1989).

Results and discussion

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE MEDIA. As compost proportions in peat and coir-based media increased from 0% to 100%, a linear or quadratic increase occurred for total N and C (Table 1). Compost is a valuable source of N (Sims, 1995) and other nutrients and micronutrients (Hue and Sobieszczyk, 1999). However, N and some other elements in compost are mainly in organic forms and therefore may not be available to plants before they are mineralized. The ratios of C/N decreased as a greater volume of compost was added to either peat- or coir-based media. The lower C/N ratio of either media amended with a higher volume of compost was attributed to the low C/N ratio (12 to 14) of the 100% compost as compared to the 100% peat- or coir-based media. Generally, composts with C/N ratio less than 20 are considered to be optimal for plant production (Davidson et al., 1994). Composts with C/N ratio higher than 30 may be immature or unstable, which may result in subsequent plant phytotoxicity and mineral immobilization (Zucconi et al., 1981). Therefore the compost used in this study was considered to have an optimum C/N ratio.

The pH increased as the compost volume increased in the peat or coir media (Table 1). Acidity in the 100% peat (pH = 5.4) and 100% coir (pH = 6.5) media decreased as a greater volume of compost (pH 6.9 to 7.1) was added to either medium. Fitzpatrick et al. (1998) reported that pH values of commercially produced compost range from 6.7 to 7.7, which were close to the compost used in this study. Likewise, EC increased linearly as the compost proportion increased in either medium (Table 1). Golden shrimp plant has been reported to have a low salt tolerance (Broshcat and Meerow, 1994). Therefore, media with high compost volumes (75% or 100%) may

Table 1. Chemical characteristics and nutrient concentrations of peat- and coir-based media amended with compost.

Compost (% by vol)	pH	EC[z] (dS·m^{-1})	Elemental content of media: N (%)	C (%)	C/N ratio
Peat-based media					
0	5.4	1.26	0.81	32.3	39.9
25	6.2	1.40	1.50	30.2	20.1
50	6.4	1.74	1.94	35.7	18.4
75	6.6	2.07	2.23	31.6	14.2
100	6.9	2.43	1.99	25.7	12.9
Significance[y]	Q**	L**	Q**	Q*	C**
Coir-based media					
0	6.5	0.41	1.26	25.4	20.1
25	6.3	0.90	1.54	27.7	18.0
50	6.7	1.30	1.71	28.6	16.7
75	6.9	1.62	2.10	29.9	14.3
100	7.1	2.04	2.13	29.2	13.7
Significance[y]	L**	L**	L**	Q**	L**

[z]EC = electrical conductivity.
[y]L or Q indicates a significant linear or quadratic response.
*,**Significant at $P < 0.05$ or 0.01, respectively.

Table 2. Physical characteristics of peat- or coir-based media amended with compost.

Compost (% by vol)	Bulk density ($g \cdot cm^{-3}$)[z]	Particle density ($g \cdot cm^{-3}$)	Air-filled porosity (% by vol)	Container capacity (% by vol)	Total porosity (% by vol)	Moisture (%)
Peat-based media						
0	0.075	0.160	4.38	56	61	53
25	0.140	0.327	4.48	67	71	53
50	0.205	0.509	4.90	75	80	49
75	0.260	0.713	5.20	84	90	51
100	0.296	0.796	6.03	86	92	43
Significance[y]	Q**	L**	L*	Q**	Q**	L**
Coir-based media						
0	0.104	0.356	4.18	77	81	78
25	0.159	0.487	4.90	78	83	66
50	0.213	0.629	4.38	83	87	61
75	0.255	0.702	5.30	84	89	54
100	0.302	0.782	5.53	86	92	42
Significance[y]	Q*	Q*	L*	L**	L**	L**

[z]1 $lb/inch^3 = 27.7 g \cdot cm^{-3}$.
[y]L or Q indicates a significant linear or quadratic response.
*,**Significant at $P < 0.05$ or 0.01, respectively.

Table 3. Growth and development characteristics of golden shrimp plants grown for 8 weeks in compost amended peat- or coir-based media.

Compost (% by vol)	Chlorophyll (Spad units)	Stem length (cm)[z]	Leaf area (cm^2)[y]	Growth index (cm)	Days to flower	Shoot dry wt (g)[x]	Root dry wt (g)	Shoot: root ratio
Peat-based media								
0	61.5	34.1	3058	33.4	37	16.8	3.28	5.21
25	59.9	33.0	3201	34.7	35	16.1	3.06	5.29
50	62.0	29.8	3223	32.9	30	16.4	2.49	6.88
75	60.4	32.9	2658	34.6	35	14.2	2.02	7.27
100	59.7	28.8	2224	32.0	36	11.8	1.55	7.71
Significance[w]	NS	L*	Q*	NS	Q*	L**	L**	L**
Coir-based media								
0	59.0	35.9	3000	35.4	35	14.9	3.49	4.34
25	61.1	33.2	2977	32.0	36	15.5	2.72	5.75
50	62.4	32.2	2838	32.6	30	14.9	2.63	5.74
75	59.6	33.7	2635	33.5	32	13.3	2.28	6.14
100	58.2	27.9	2532	30.6	36	12.6	2.02	6.87
Significance[w]	NS	NS	NS	L**	NS	L*	L**	L*

[z]1 inch=2.54 cm.
[y]1 $inch^2 = 6.45 cm^2$.
[x]1 oz = 28.4 g.
[w]NS, L, or Q indicates a nonsignificant or significant linear or quadratic response.
NS,*,**Nonsignificant or significant at $P < 0.05$ or 0.01, respectively.

have an adverse effect on root growth and subsequent plant growth and development. Joiner (1981) recommended media for container-grown foliage plants to have concentrations of soluble salt in the range of 0.63 to 1.56 $dS \cdot m^{-1}$. Salt contents have been reported to be problematic in yard-waste biosolids (Shiralipour et al., 1996), sewage sludge compost (Chaney et al., 1980), and spent mushroom compost (Lohr et al., 1984).

Generally, as the compost composition increased in either the peat- or coir-based media, BD, PD, AFP, CC, and TP increased (Table 2), suggesting that even though media with a high volume of compost improves aeration, the higher BD and PD of the media may result in poor drainage. Wootton et al. (1981) reported that as compost particle size increased, AFP increased and growth of plants decreased. Initial moisture content (%) decreased as the compost proportion increased in either the peat- or coir-based media (Table 2). Similarly, Siminis and Manios (1990) showed that substrates with compost as the only organic component had a low water content, but satisfactory aeration.

Plant growth and development responses. Plant stem length, leaf area, and days to flower decreased linearly or quadratically as the proportion of compost increased in the peat media (Table 3). However, the growth index (plant height and width) and chlorophyll content were not affected. Chlorophyll, stem length, leaf area, and days to flower did not differ among

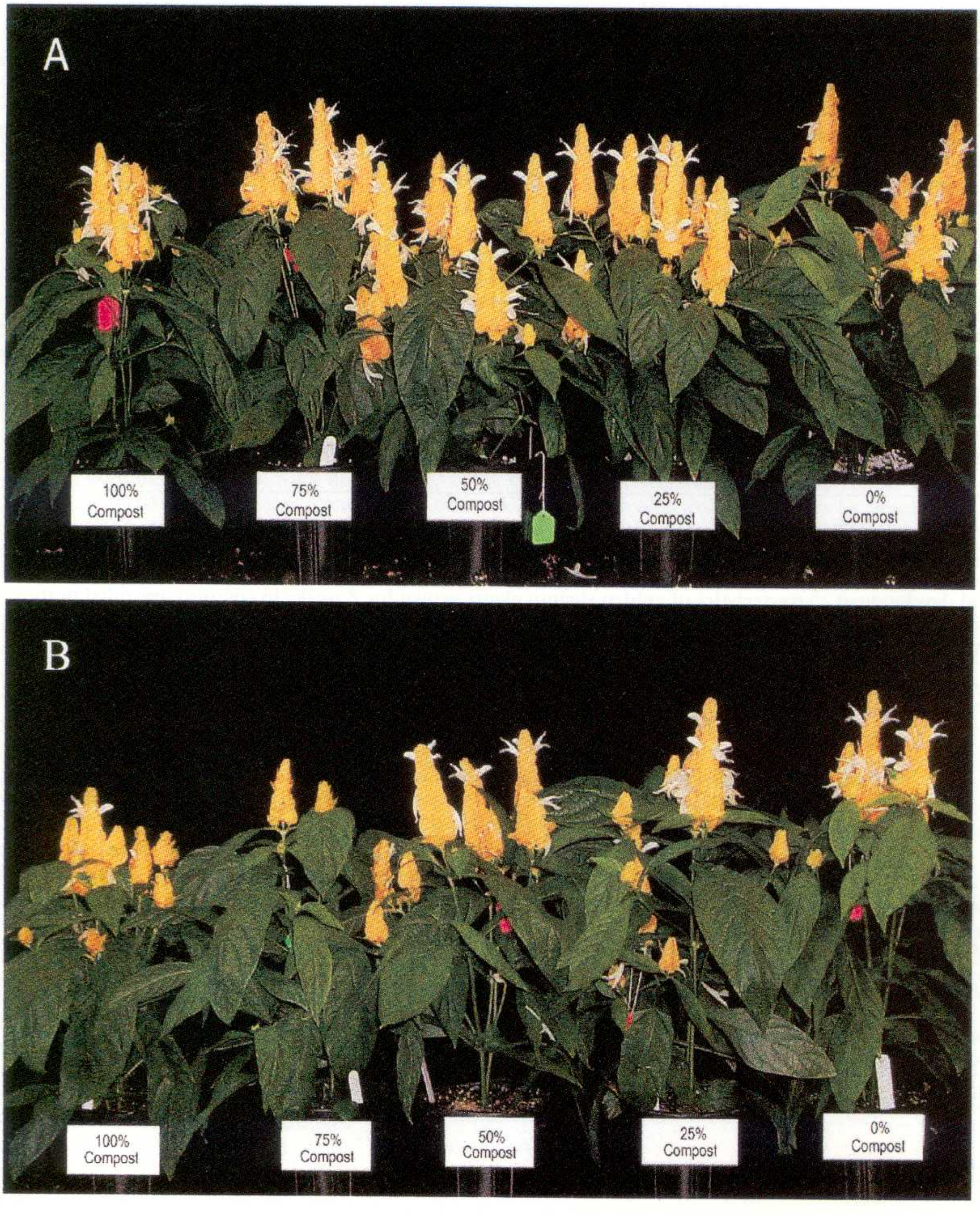

Fig. 1. Effects of media composition on performance of golden shrimp plant after 8 weeks. Commercial peat-based (A) or coir-based (B) media amended with 0, 25, 50, 75, or 100% (by volume) compost (biosolids and yard trimmings).

plants grown in the coir media amended with compost. However, a linear decrease in the growth index was detected as compost volume increased (Table 3). Growth differences in plants grown in the compost-amended coir media occurred as early as 4 weeks after transplanting (data not presented) and gradually became more pronounced during the additional 4 weeks in the greenhouse.

Plant shoot and root weights decreased and shoot:root ratios increased linearly eight weeks after transplanting as compost proportion of the peat- or coir-based media increased (Table 3). The higher shoot:root ratios of plants grown in media with high volumes of compost (75%, 100%) indicate that more photosynthates were used for developing shoots than roots as compared to media with lower volumes of compost (0%, 25%, 50%). Restricted root growth of plants grown in media with higher volumes of compost correlated with higher soluble salts and higher bulk and particle densities that may have reduced water availability. Roots were not as abundantly present in the center of pots with media con taining 75% and 100% compost as compared to pots with lower percentage of compost, regardless of media type (visual observation). Chaney et al. (1980) reported that up to 33% digested sewage sludge compost could be added to media without sacrificing plant quality or growth of marigolds (*Tagetes erecta* L.). However, results clearly differ with the sources of compost, media, and plant species. Klock (1997) reported that optimal growth of impatiens (*Impatiens wallerana* Hook.f) and snapdragon (*Antirrhinum majus* L.) occurred in media containing 100% compost produced from biosolids and yard trimmings.

In conclusion, regardless of the quantity of compost added to either peat or coir-based media, all plants were considered to be of marketable value after 8 weeks (Fig. 1). Either peat- or coir-based media amended with 25% or 50% compost produced plants comparable in growth, size, and color to plants grown in standard, commercial soilless mix. This alternative media may be more environmentally friendly to the ornamental industry than the traditional peat-based media.

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Vegetation-free Area Surrounding Newly Planted 'Niagara' Grapevines Affects Vine Growth

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Additional index words. weed control, vineyard floor management, *Vitis*

Summary. Varying amounts of vegetation-free area (VFA) were established around newly planted 'Niagara' (*Vitis labrusca* L. x *Vitis vinifera* L.) grapevines to determine their influence on vine growth during the first growing season. VFAs were either circular with radii from 0 to 5 ft (0 to 152 cm) in one experiment or in bands from 0 to 8 ft (0 to 244 cm) in width in a second experiment. VFAs were maintained with biweekly manual weeding for the entire growing season. Leaf, shoot and root dry weights as well as the number of primary shoots and the length of the longest root were measured at the end of their first growing season. The thresholds for maximum vine dry weight biomass accumulation occurred with a circular VFA of 4 ft (122 cm). When banded VFAs were used, total vine dry weight biomass continued to increase up to the widest treatment of 8 ft (244 cm). Therefore, no threshold was attained. These are greater VFAs than typically established around vines in commercial plantings. Therefore, growers who desire to maximize vine growth of newly planted vines, should consider larger VFAs around vines than has been traditional unless such a practice is likely to cause surface soil erosion.

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We thank James Ertman, Jerry Grajauskis, Fred Froehlich, and Gaylord Brunke for technical assistance, Diane Dings for preparation of the manuscript, and the Michigan Agricultural Experiment Station for financial support. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

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