Use of Compost as a Media Amendment for Containerized Production of Two Subtropical Perennials[1]

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Abstract

Growth of *Orthosiphon stamineus* (cat whiskers) and *Angelonia angustifolia* Benth. (angelonia) was evaluated in media containing 0, 25, 50, 75, or 100% compost (biosolids and yard trimmings mixture, 1:1, by weight). Compost was added to a commercial coir- or peat-based medium. As % compost increased, pH, electrical conductivity (EC), % nitrogen (N), and % carbon (C) increased, and the initial moisture content decreased. *Orthosiphon* and *Angelonia* growth was reduced when grown in peat or coir-based media amended with high rates of compost (75 or 100%), but flowering time was generally not affected. All plants were considered visually acceptable, except *Angelonia* grown in 100% compost.

Index words: biosolids, coir, organic media.

Species used in this study: *Orthosiphon stamineus* (cat whiskers), *Angelonia angustifolia* Benth.

Significance to the Nursery Industry

Peat is used extensively in the nursery industry as a primary component in commercial soilless potting media. The increased use of peat as an organic amendment with superior water holding capacity is challenged by economic and environmental pressures. To stay competitive and satisfy environmental concerns, potential alternatives to peat need to be investigated. Commercially available peat- and coir-based soilless mixes were amended with 25%, 50%, 75% or 100% organic compost generated from biosolids and yard trimmings. Results suggest that compost can be a viable partial alternative to peat or coir as a substrate for containerized herbaceous perennial production. Media amended with 50% compost (v:v) provided plants of similar appearance to unamended media. A higher compost amendment (75 or 100%) reduced plant growth. Partially amending peat- or coir-based media with compost may have positive economic consequences for commercial perennial production due to the rising costs of peat.

Introduction

Many states have mandated that several biodegradable wastes not be landfilled. The majority of these wastes are being recycled or composted in an array of feedstock mixtures, including biosolids. Subsequently, landfill numbers have decreased and the number of compost facilities has increased in the United States over the past 10 years (10). Since municipal and private compost facilities have access to a variety of available feedstocks, including biosolids, scientifically based production systems and an agricultural-rich marketplace have attributed to a dramatically improved horticultural grade of compost. Horticultural-grade compost is now available in sufficient quantity at economical costs to meet the growing demands of ornamental industries.

A large segment of the ornamental nursery industry is dependent on peat moss as a major constituent of their potting media. The physical and chemical characteristics of peat have made it an excellent potting media for a variety of ornamental plants (5). In recent years, environmental concerns (1) and cost of peat have escalated. Therefore, other organically-based, inexpensive materials are beginning to be evaluated and used as total or partial peat substitutes in ornamental nursery production systems. For example coir, produced from husks of coconut fruit (*Cocos nucefera* L.) that are grown in many tropical countries (8), has been used successfully as a potting medium (23).

Inbar et al. (12) have discussed the physical, chemical, and biological properties of a compost-based media. Some composts may be unsuitable as a media constituent due to high salt content, pH, phytotoxicity, or high heavy metal content. However, composts, depending on feedstock composition, can be a valuable source of nutrients (11). Composts utilized as media for ornamental nursery production systems must be stable, have readily available and consistent market supplies, support consistent and uniform plant growth, and be less expensive than the traditional peat-based media. Meeting these criteria, composts have been used successfully in media to grow bedding annual plants (14, 15), foliage plants (16), and woody shrubs and trees (7, 9). Likewise, compost may be a potential peat substitute in commercial media designed for subtropical herbaceous, perennial crop production systems.

The purpose of this investigation was to determine the growth and development of container-grown *Orthosiphon* and *Angelonia* perennial ornamentals as influenced by compost-amended media. These plant species were chosen based on commercial availability, increased popularity, moderate water and nutrient usage, and sub-tropical temperature requirements.

Materials and Methods

Plant material and media composition. Organic waste compost (Solid Waste Authority, Palm Beach County, FL)

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Table 1. Chemical characteristics and nutrient content of peat- and coir-based media amended with 0, 25, 50, 75, or 100% compost.

Compost (% by vol)	pH	EC (dS × m^{-1})	Moisture (%)	Nitrogen (N) (%)	Carbon (C) (%)	C/N (ratio)
			Peat			
0	5.3	2.5	59.7	0.62	31.3	50.9
25	6.4	3.1	48.4	1.62	30.8	19.4
50	6.7	5.0	44.5	1.87	29.9	16.0
75	6.9	5.2	43.5	2.20	30.3	13.8
100	7.0	6.4	34.9	2.31	28.1	12.2
Significance[z]	L**	L**	C**	Q**	L**	C**
			Coir			
0	6.0	0.7	73.3	0.38	23.1	60.7
25	6.8	2.6	63.5	1.41	27.4	19.4
50	7.0	3.2	54.0	1.82	28.5	15.6
75	6.9	5.2	46.3	2.13	29.8	14.0
100	7.0	7.4	38.0	2.28	28.9	12.7
Significance[z]	L*	L**	Q*	C**	Q**	C**

[z]Significant linear (L), quadratic (Q), or cubic (C) response at P < 0.05 (*) or 0.01 (**).

was mixed with peat- or coir-based commercial media. The compost consisted of a 1:1 ratio, by weight, of biosolids (polymer dewatered) and yard trimmings screened to 1.3 cm (0.51 in). Compost was made using an in-vessel agitated bed system (Solid Waste Authority, Palm Beach County, FL). On September 13, 1999, plugs (approximately 6 cm (2.4 in) tall; 103 cell pack) of *Orthosiphon stamineus* and *Angelonia angustifolia* (Robrick Nursery, Hawthorne, FL) were transplanted into 4.5 liter (1.2 gal) round, plastic pots filled with peat-based soilless media (Metro-Mix 200; The Scotts Co., Marysville, OH) amended with 0, 25, 50, 75, or 100% (by vol) compost. Additional 4.5 liter (1.2 gal) round pots were filled with coir-based soilless media (Yoder Mix, The Scotts Co., Marysville, OH) amended with 0, 25, 50, 75, or 100% (by vol) compost. All plants were topdressed with 15 g/pot (0.5 oz/pot) of 15N–3.9P–10K (Osmocote Plus®) and treated with a 1% Marathon® granular systemic insecticide at a standard rate of 0.37 g/liter (0.018 oz/gal) (Olympic Horticultural Products™, Bradenton, FL). Plants were inspected daily and watered as needed (3–4 times/week). Plants were grown in a glass greenhouse with mean minimum and maximum temperatures of 22 and 35C (72 and 95F), respectively.

Three replicates of each medium were evaluated initially for pH, electrical conductivity (EC), percent moisture, and total carbon (C) and nitrogen (N). Percent moisture was determined by drying a known weight of water-saturated media at 105C (221F) for 24 hr and weighing before and after. pH and EC were determined by preparing a saturated media extract and using a pH/ion/conductivity meter. Total C and N concentrations were determined by a CNS analyzer (Carlo-

Table 2. Growth and development characteristics of *Orthosiphon stamineus* plants grown for 8 weeks in peat- or coir-based media amended with 0, 25, 50, 75, or 100% compost.

Compost (% by vol)	Chlorophyll (Spad units)	Stem length (cm)	Flowers (no.)	Leaf DW[z] (g)	Stem DW (g)	Shoot DW (g)	Root DW (g)
				Peat			
0	51.8	60.9	26.8	12.4	15.3	27.7	9.54
25	48.9	60.6	24.8	11.6	14.4	26.0	9.03
50	49.4	60.5	27.4	9.4	14.0	23.4	6.87
75	46.6	48.9	18.8	7.5	7.9	15.4	6.30
100	43.5	52.0	24.6	9.5	9.9	19.4	7.80
Significance[y]	L*	L*	NS	L**	L**	L**	NS
				Coir			
0	50.7	58.3	21.8	11.2	11.2	22.4	7.58
25	49.7	60.5	24.4	11.2	14.5	25.7	11.5
50	47.7	58.5	20.2	10.0	10.6	20.7	7.71
75	42.9	53.5	14.4	8.4	8.8	17.2	6.46
100	37.8	55.0	16.6	8.7	8.4	17.1	5.33
Significance[y]	L**	NS	L*	L**	C*	L**	C*

[z]DW = dry weight

[y]Significant linear (L), quadratic (Q), or cubic (C) response at P < 0.05 (*) or 0.01 (**).

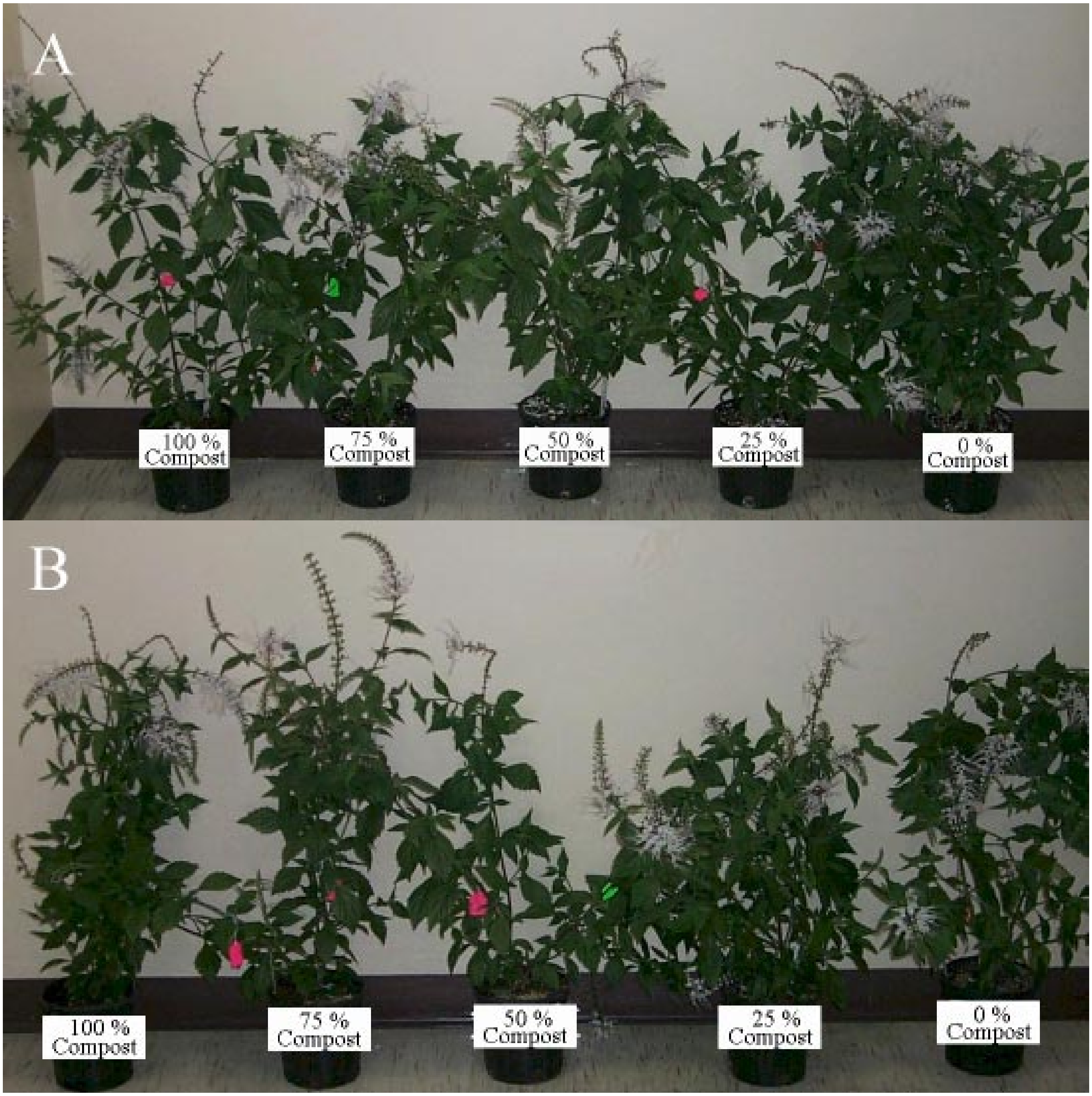

Fig. 1. Effects of media composition on growth of *Orthosiphon stamineus* after 8 weeks. Commercial peat-based (A) or coir-based (B) media was amended with 0, 25, 50, 75, or 100% (by vol) compost.

Erba NA-1500; BICO, Burbank, CA). Compost samples were oven dried for 2 days (60C (140F)) and ground to a powder with a ball grinder before combustion.

Plant growth and development. Final shoot characteristics (primary stem length, dry weight, and flower number) were measured 8 weeks after transplanting. Stem length was measured from the shoot apex of the primary stem to the crown. Shoots were severed at the crown and roots were hand-washed thoroughly. Leaves, stems and roots of *Orthosiphon* were separately dried for 1 week in a 50C (122F) oven before weighing. Chlorophyll content was measured from leaves on the 4th, 5th, and 6th branch from the apex of each plant using a Spad-502 meter (Spectrum Technologies Inc., Plainfield, IL). For *Angelonia*, primary stem length was recorded and shoots were severed at the crown for dry weight measurements. Flower number of both species was determined by counting the number of spiked inflorescences per plant.

Statistical analysis. A randomized complete block design was used for the peat- and coir-based media experiments.

Each treatment was replicated five times. All data were subjected to an analysis of variance (ANOVA) and main effects of treatments were partitioned into orthogonal contrasts.

Results and Discussion

Physical characteristics and nutrient composition of media. Compost alone had an initial pH of 7.0. Fitzpatrick et al. (9) reported that commercially produced compost has a pH range of 6.7 to 7.7. Maximum nutrient availability in organic media occurs at a lower pH than in mineral soils (17). Initial pH values increased linearly as % compost increased in both peat- and coir-based media (Table 1). Bugbee (4) reported media pH affects plant growth of certain plant species (*Rhododendron ponticum* L. and *Thuja occidentalis* L.) more than the % compost added to the media. Growth of *Rudbeckia hirta* L., however, was not affected by media pH or % compost. Electrical conductivity (EC) values increased linearly as compost composition increased in both the peat- and coir-based media (Table 1). Yard waste/biosolids compost has been reported to have a high salt content (19, 20, 22). Bernstein (2) indicated that high salinity (>3.5 dS × m^{-1}) typically has adverse effects on the success and rate of seed germination and on the growth and development of seedlings. Although initial EC values of the compost alone or at a high (75%) composition rate were higher than 3.5 dS × m^{-1} (Table 1), Raymond et al. (18) reported a rapid leaching of soluble salts from containerized compost media within days after planting, thereby minimizing any adverse effects on container grown woody ornamentals. *Orthosiphon* has been reported to be salt intolerant (www.floridagardener.com). Therefore, media with high compost volumes (75% or 100%) may adversely effect plant growth.

Moisture content of 100% compost was approximately 36% (Table 1). As compost content increased, the moisture content decreased cubically or quadratically in either the peat or coir-based media, respectively. Jarvis et al. (13) also reported reduced moisture content in peat-based media amended with yard waste or municipal solid waste (MSW) composts.

As % compost proportion in peat or coir-based media increased, % N increased quadratically or cubically, respectively (Table 1). Compost alone had approximately 2.3% N. Composts can be an excellent source of N (21) and micronutrients (11). The low carbon/nitrogen (C/N) ratio of the compost (100%) indicated that the compost was stable and mature (Table 1). Davidson et al. (6) reported that composts with C/N ratios less than 20 are optimal for plant production. C/N ratios greater than 30 may result in phytotoxicity symptoms and possible plant death (24). Addition of compost dramatically decreased the C/N ratios as compared to peat and coir-based media (Table 1).

Orthosiphon growth. SPAD readings (an indirect measurement of chlorophyll) decreased linearly with increasing compost content in both peat and coir-based media (Table 2). Although the compost was considered stable and mature (C/N ratio = 12), an eight-week period may not have been sufficient time for substantial nutrient mineralization to occur. Therefore, media with amended compost, particularly at higher rates, may have had an insufficient supply of available nutrients for plant uptake, resulting in lower SPAD readings.

Most shoot characteristics (except number of flowers for peat-based media, and stem length for coir-based media) decreased linearly or cubically as % compost content increased in either media (Table 2). Much of the reduction in shoot variables occurred with plants in the higher (75 and 100%) compost-amended media. Root weight was not significantly affected by amended compost in peat-based media but reduced cubically as % compost increased in coir-based media (Table 2). Shoot:root ratios were not affected regardless of % compost added to either media (data not presented). High media water holding capacity has been associated with greater root fresh weight of geranium (*Pelargonium* x *hortorum* L.H. Bailey) and greater fresh weights of petunia (*Petunia* x *hybrida* Vilm.-Andr.) and marigold (*Tagetes patula* L.) (8). *Orthosiphon* plant growth was reduced when grown in media amended with compost, particularly at higher rates. However, all plants, regardless of compost treatment or media base, had comparable visual quality by subjective observations (Fig. 1).

Angelonia growth. Plants grown in compost amended peat-based media did not differ significantly in stem length, number of flowers, and shoot dry weight (Table 3). However, as more compost was added to the coir-based media, stem length, flower number, and shoot dry weight decreased linearly (Table 3). Similarly, Bragg et al. (3) reported a growth reduction of several bedding plants grown in peat, coir or wood fiber media amended with composted biosolids, or fresh, partial composted, or fully composted domestic refuse. Regardless of the % compost added to the media, all plants had comparable visual quality, with the exception of plants grown in 100% compost (visual observation, Fig. 2).

Novel approaches to utilization of composted waste products are continuously being developed and commercial private or municipal composting facilities are increasing throughout the United States (10). Clearly, physical, chemical, and biological properties of containerized media are important considerations for developing compost-amended

Table 3. Stem length, flower number, and dry weight of *Angelonia angustifolia* plants grown for 8 weeks in peat- or coir-based media amended with 0, 25, 50, 75, or 100% compost.

Compost (% by vol)	Stem length (cm)	Flowers (no.)	Shoot dry weight (g)
		Peat	
0	56.68	2.4	8.17
25	51.98	1.6	7.02
50	44.83	0.8	5.32
75	51.52	1.6	7.38
100	41.48	1.0	5.08
Significance[z]	NS	NS	NS
		Coir	
0	54.66	2.2	8.77
25	39.51	1.2	6.28
50	45.01	0.8	5.06
75	42.99	0.8	5.07
100	35.79	0.4	4.34
Significance[z]	L*	L*	L**

[z]Significant linear (L), quadratic (Q), or cubic (C) response at $P < 0.05$ (*) or 0.01 (**).

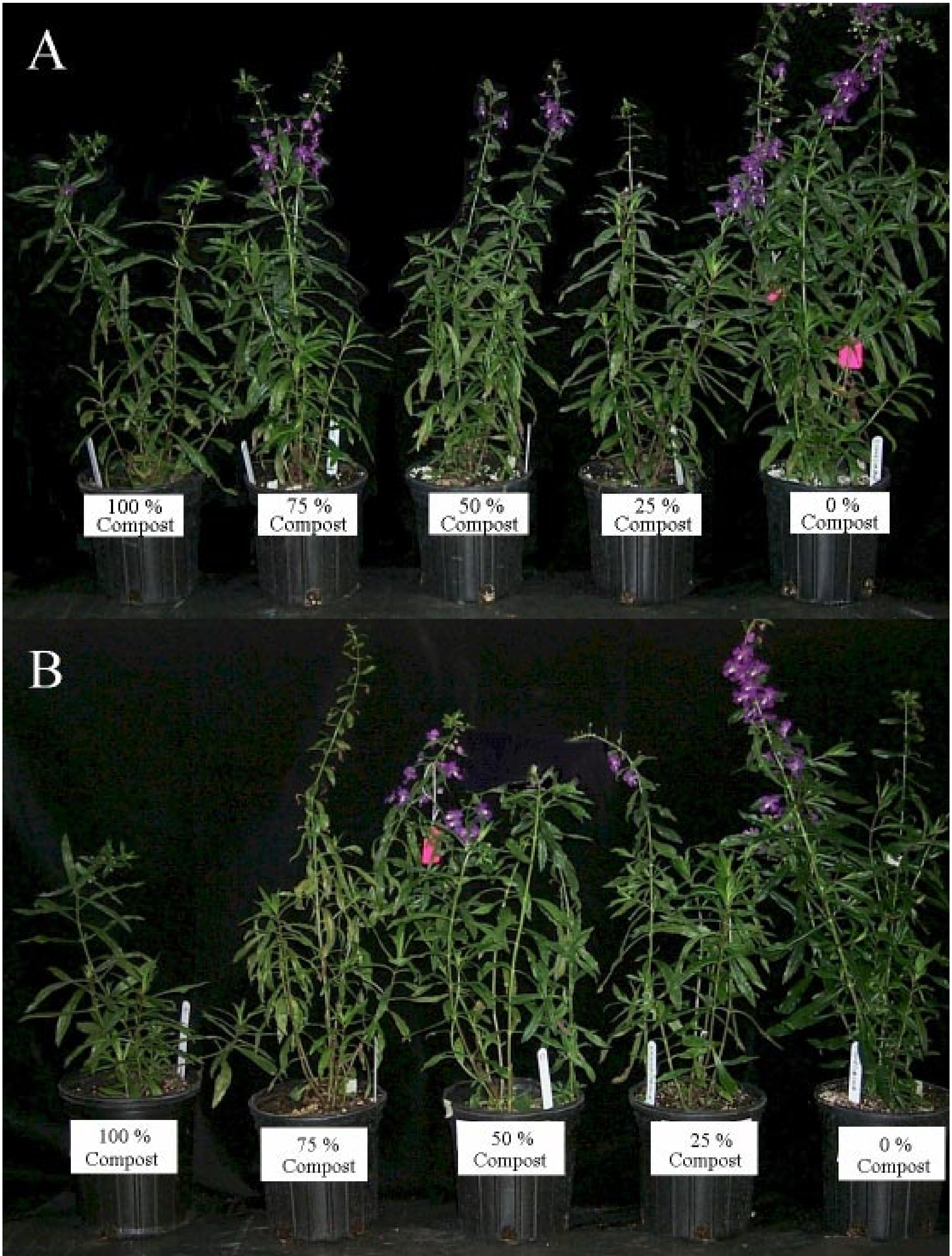

Fig. 2. Effects of media composition on growth of *Angelonia* after 8 weeks. Commercial peat-based (A) or coir-based (B) media was amended with 0, 25, 50, 75, or 100% (by vol) compost.

substrates (12). In this study, shoot characteristics of perennials grown in compost-amended media were either reduced or similar to plants grown in peat (commercial standard) or coir-based media. Media amended with 50% compost (v:v) provided plants of similar appearance to unamended media. A higher compost amendment (75 or 100%) reduced *Orthosiphon* plant growth but still produced high quality plants. *Angelonia* plants grown in 100% compost were considered unmarketable. Partially amending peat- or coir-based media with compost may have positive economic consequences for commercial perennial production due to the rising costs of peat. Further investigations on improvement of physical properties (porosity, and water infiltration rates) of media are needed if more than 50% compost is amended in peat or coir-based media.

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