Evaluation of Compost as a Viable Medium Amendment for Containerized Perennial Production

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Abstract

The physical and chemical characteristics of peat make it an excellent component of potting media for a variety of ornamental plants. In recent years, environmental concerns and the cost of peat have escalated. In addition, many states have mandated laws to reduce waste inputs, particularly organic wastes, of municipal landfills. To achieve this, efforts have primarily focused on recycling and use of commercial compost produced from yard trimmings and organic wastes including treated sewage sludge (biosolids). Growth of 24 perennials was evaluated using a commercially available peat-based soilless medium amended with 25%, 50%, or 75% organic compost generated from biosolids and yard trimmings. Use of 100% compost in the medium increased plant growth of 11 species, reduced plant growth of 6 species, and did not affect plant growth of the remaining 6 species tested as compared to the peat-based commercial control mix. Use of 50% compost in the medium increased plant growth of 8 species, reduced plant growth of 2 species, and did not affect plant growth of the remaining 14 species tested as compared to the peat-based commercial control mix. Regardless of the plant species tested, compost amendments did not affect flowering or visual quality, and plants were still considered marketable. Results suggest that compost can be a viable alternative to peat as a substrate for containerized perennial production.

INTRODUCTION

In the United States, the increase of both public and private composting facilities over the past decade (Glenn, 1999) has coincided with improved compost products that are acceptable in terms of quality, quantity, and economical feasibility to various horticultural enterprises. Beneficial properties of compost have been reported, such as nutrient enrichment (Hue and Sobieszczyk, 1999), suppression of soil-borne diseases (Hoitink et al., 1991), and improvement of physical properties (Inbar et al., 1993). In addition, Fitzpatrick (2001) has reviewed and cited numerous investigations illustrating the beneficial growth responses of compost utilization in ornamental and nursery crop production systems including temperate woody ornamentals, bedding plants, foliage plants, and subtropical or tropical trees. Few reports investigated the use of compost for herbaceous perennial production. Therefore, a series of experiments were conducted, each building upon the other and addressing a new aspect of compost utilization in container media for perennials. The methods and results presented herein summarize our database of 24 separate perennial species (grouped by experiments) that have been evaluated to date.

CHEMICAL AND PHYSICAL PROPERTIES OF MEDIA

Compost for all experiments was generated by the Solid Waste Authority of Palm Beach County, West Palm Beach, Florida using a 1:1 ratio (w:w) of biosolids and yard trimmings (screened to 0.64 cm). Materials were composted for 18 d in an agitated bed system, stockpiled, and then re-screened to 0.64 cm.

Physical and chemical properties of each medium are reported in Table 1. For experiment 1, a peat-based soilless media was used that consisted of 55%-65% peat, 25%-35% polystyrene beads, and 5%-15% vermiculite (Poly-mix; The Scotts Co., Marysville, Ohio). For experiments 2 and 3, a peat-based commercial mix was used that consisted of 70% peat, 20% perlite, and 10% vermiculite (Fafard mix #2, Apopka, FL). For experiment 4, a sedge peat-based native commercial mix was used that consisted of 50% pine bark, 40% Florida peat, and 10% coarse sand (Atlas 3000, Atlas Peat and Soil Inc., Boynton, FL). For electrical conductivity (EC) and pH measurements, a 1:2 medium:deionized H_2O extract was prepared for each mixture. To determine total porosity and bulk density, standard drying procedures were used after volume displacement methods.

Total C and N concentrations were determined by a CNS analyzer whereby samples of each medium were oven-dried for 2 d at 60 °C and ground to a powder with a ball mill prior to combustion. The US Environmental Protection Agency (EPA) method 200.7 (USEPA 1993) was used to determine total P, K, Ca, Mg. An acid digestion procedure (EPA method 3050) (USEPA 1995) was used to prepare the samples for analysis by ICP/ICPMS/CIROS (model FTCEAOOO, Spectro Analytical Instruments, Fitchburg, Mass.).

EXPERIMENT 1: USE OF COMPOST AS A MEDIA AMENDMENT FOR CONTAINERIZED PRODUCTION OF SUBTROPICAL PERENNIALS (Wilson et al., 2001a; Wilson et al., 2001b; Wilson et al., 2001c)

Growth of four perennials, cat whiskers (*Orthosiphon stamineus*), angelonia (*Angelonia angustifolia*), Mexican heather (*Cuphea hyssopifolia*) and golden shrimp plant (*Pachystachys lutea*) was evaluated using commercially available peat-based soilless media amended with 25%, 50%, or 75% organic compost generated from biosolids and yard trimmings. Incorporation of any compost into the medium (25%, 50%, or 75%), significantly reduced plant growth of Mexican heather (Table 2). For cat whiskers, reduction of plant growth was only observed when media was amended with higher levels of compost (75% or 100%). Use of 100% compost reduced plant growth of golden shrimp plant or angelonia compared to the commercial peat-based medium (Table 2). Regardless of the plant species tested, the higher compost amendments (75 or 100%) did not affect flowering or visual quality and plants were still considered marketable.

EXPERIMENT 2: DEVELOPMENT OF COMPOST-BASED MEDIA FOR CONTAINERIZED PERENNIALS (Wilson et al., 2002)

Based on previous findings from Experiment 1, a second series of experiments were conducted to improve the physical properties of compost-based media. Growth of Bolivian sunset (*Gloxinia sylvatica*), Brazilian plume (*Justicia carnea*), and golden globe (*Lysimachia congestiflora*) transplants was evaluated in a vermiculite/perlite (1:1) media containing 25%, 50%, or 75% compost (derived from biosolids and yard trimmings) as compared to commercial peat-based media. Again, the effects of media composition on plant growth and development varied with each species tested. Bolivian sunset plants were smaller with reduced flower development (but still of high visual color and quality) when grown in media amended with as little as 25% compost (Table 2). Golden globe plants could be grown in media with up to 75% compost without significantly reducing plant size (Table 2). Brazilian plume plants were similar in size when grown in compost-based media as compared to peat-based media and flower development was unaffected (Table 2). However, the visual color and quality of the plants suffered somewhat when plants were grown in compost alone (data not presented). Based on these findings, it appeared that improving the physical properties of the media was beneficial when growing plants in up to 75% compost but compost alone was still not an acceptable alternative to using commercial soilless mix.

EXPERIMENT 3: COMPOST AMENDED MEDIA AND IRRIGATION SYSTEM INFLUENCE CONTAINERIZED PERENNIAL *SALVIA* (Wilson et al., 2003)

When the root distribution was analyzed from plants grown in un-amended compost (Experiments 1 and 2), it was discovered that the roots abnormally grew close to the circumference of the pots. This suggested that the method of irrigation may improve growth of plants grown in high volumes of compost. Therefore, a third series of investigations were conducted comparing hand-watering, sub-irrigation, and drip irrigation of three salvia species [blue anise sage (*Salvia guaranitica* 'Black and Blue'), indigo spires salvia (*Salvia* x 'Indigo Spires'), and wine sage (*Salvia* spp. 'Van Houttei') grown in 50% or 100% compost as compared to commercial peat-based media. Plants irrigated by ebb and flow resulted in higher (wine sage) or similar (indigo spires salvia) dry stem weights than plants irrigated manually or with drip irrigation (data not presented). Results of the sub-irrigation experiment showed no difference in plant size when plants were grown in peat-based media or 100% compost for indigo spires salvia and wine sage (Table 2). However, blue anise sage was significantly reduced when grown in compost alone as compared to the peat-base medium. For this salvia species, a 50% soil amendment of compost is recommended if sub-irrigation is conducted.

EXPERIMENT 4: COMPOST UTILIZATION FOR CONTAINERIZED PRODUCTION OF ORNAMENTAL SPECIES NATIVE TO FLORIDA (Wilson et al., 2004)

While Canadian sphagnum peat is still one of the primary components of many substrate blends used by the nursery and landscape industry, up to 40% of Florida peat (sedge peat) is used by some native nurseries in Florida. As a product consisting mainly of sedges and grasses of wetland ecosystems, Florida peat is not considered by some as renewable at the level in which it is harvested (Barkham, 1993; Buckland, 1993). Florida ranks in the top five states nationally in the production of horticultural peat with an annual mining industry value estimated at $8.18 million in 1999 (National Mining Association, 2001). Although considered less expensive than sphagnum peat, Florida peat is reportedly inconsistent in pH and quality (Alexander, 2001). This inspired a fourth series of investigations to determine if peat could be replaced or eliminated in media commercially used for containerized production of native plants.

Selection of the species for this study (Table 2) was based on their native origin, and association to Florida's hammocks, wetlands, and flatwoods. Also, all of these species were available in the trade, were popular among consumers for their ornamental value, and had proven performance in Florida landscapes. Plants were transplanted in containers filled with a biosolids:yard waste compost, a commercial peat-based mix, or a formulated compost-based mix (4:5:1, compost:pinebark:sand, v:v:v). At 8 weeks after transplanting in 100% compost, shoot dry weights of butterfly sage, firebush, scorpions tail, tropical sage, climbing aster, narrowleaf sunflower, pineland lantana, spotted beebalm, blackeyed susan, and Carolina wild petunia were 1.5 to 8.0 times greater than that of plants grown in the peat-based medium. This was inconsistent with results from our previous experiments where media with more than 50% compost reduced the shoot weight of seven out of the ten non-native perennial species evaluated (Wilson et al., 2001a,b,c; Wilson et al., 2002; Wilson et al., 2003). Other native species evaluated including wild coffee, lemon bacopa, coastalplain tickseed, and cardinal flower showed no differences in shoot dry weight among media, thus re-emphasizing differential growth responses to media amended with compost. Still, media amended with compost can serve as a stable, viable, and inexpensive alternative to current commercial peat-based media for the production of ornamental native species.

CONCLUSION

Our data indicates that compost (biosolid/yard waste) offers a source of macro- and micronutrients with similar physical properties to that of a peat-based commercial mix. With increasing substrate cost, particularly peat, and increasing supplies of commercially available horticultural grade compost, amending media with compost could be an economical advantage to traditional peat-based media. These studies suggest that compost may serve as a viable alternative substrate for peat in the container production of perennial ornamentals, however the optimal amounts of compost used in the medium will vary by species.

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Tables

Table 1. Physical and chemical properties of three commercially available media and compost.

Medium	pH	EC ($dS \cdot m^{-1}$)	Total porosity (% by vol.)	Bulk density ($g \cdot cm^{3}$)	N	C	C/N (ratio)	P	K	Ca	Mg
					-------(%)-------			---------------($g \cdot kg^{-1}$)---------------			
Compost[1]	7.1	5.8	59.5	0.26	2.30	29.8	13.0	10.4	7.1	49.4	3.1
EXPERIMENT 1											
Scotts Sierra® poly mix[2]	5.3	2.2	61.0	0.08	0.71	31.8	45.4	0.8	11.8	29.3	33.4
EXPERIMENTS 2 AND 3											
Fafard mix No. 2[3]	6.3	1.4	61.0	0.09	0.69	27.3	40.9	0.5	6.9	15.9	22.4
EXPERIMENT 4											
Atlas 3000[4]	6.5	0.9	56.9	0.24	0.89	33.1	37.3	0.1	0.3	11.7	4.3

[1]Solid Waste Authority, Palm Beach Co., FL. 50% yard trimmings; 50% biosolids.
[2]55-65% Canadian peat; 25-35% polystyrene; 5-15% vermiculite.
[3]70% peat; 20% perlite; 10% vermiculite.
[4]50% pine bark; 40% Florida peat; 10% sand.

Table 2. Shoot dry weights (g) of perennial plants grown in a commercial peat-based mix amended with 0, 25, 50, 75, or 100% (by vol.) (1:1) yard trimmings:biosolids compost.

	Botanical name	Common name	Compost (%)				
			100	75	50	25	0
Experiment 1	*Angelonia angustifolia*[1]	Angelonia	5.1*[2]	7.0NS	5.3NS	7.4NS	8.2
	Cuphea hyssopifolia[1]	Mexican heather	10.1*	11.1*	14.1*	16.4*	19.6
	Orthosiphon stamineus[1]	Cat whiskers	19.4*	15.4*	23.3NS	26.0NS	27.7
	Pachystachys lutea[1]	Golden shrimp plant	11.8*	14.2NS	16.4NS	16.1NS	16.8
Experiment 2	*Gloxinia*[3]	Bolivian sunset	13.0*	13.3*	14.2*	13.7*	23.0
	Justicia carnea[3]	Brazilian plume	14.9NS	17.7NS	17.9NS	14.9NS	17.7
	Lysimachia[3]	Golden globe	17.3*	20.5NS	18.7NS	18.8NS	19.7
Experiment 3	*Salvia guaranitica*[4]	Blue anise sage	4.8**	___	9.1NS	___	10.8
	Salvia 'Van Houttei'[4]	Wine sage	11.1NS	___	12.3NS	___	11.9
	Salvia x 'Indigo Spires'[4]	Indigo spires salvia	14.5NS	___	17.1NS	___	16.7
Experiment 4	*Bacopa caroliniana*[5]	Lemon bacopa	5.9NS	___	7.5*	___	5.0
	Cordia globosa[5]	Butterfly sage	4.2**	___	4.1**	___	1.8
	Coreopsis gladiata[5]	Coastalplain tickseed	10.0NS	___	9.7NS	___	6.3
	Hamelia patens[5]	Firebush	7.4**	___	4.2**	___	1.8
	Helianthus angustifolius[5]	Narrowleaf sunflower	20.7*	___	17.6NS	___	14.4

Botanical name	Common name	Compost (%) 100	75	50	25	0
Heliotropium angiospermum[5]	Scorpions tail	12.0**	—	8.3**	—	1.5
Lantana depressa[5]	Pineland lantana	7.9*	—	5.0NS	—	1.9
Lobelia cardinalis[5]	Cardinal flower	2.6NS	—	2.2NS	—	2.5
Monarda punctata[5]	Spotted beebalm	14.8**	—	12.4*	—	7.6
Psychotria nervosa[5]	Wild coffee	1.5NS	—	1.3NS	—	0.9
Rudbeckia hirta[5]	Blackeyed susan	11.8**	—	7.8NS	—	5.8
Ruellia caroliniensis[5]	Carolina wild petunia	6.5**	—	4.4**	—	1.9
Salvia coccinea[5]	Tropical sage	12.0**	—	9.6**	—	3.3
Symphyotrichum carolinianum[5]	Climbing aster	15.3**	—	13.8**	—	5.7

[1]Plants were grown in a peat-based commercial soilless mix amended with 25, 50, 75, or 100% compost.

[2]Comparisons were established between peat-based mix (0% compost) and other individual treatments within each row (NS=nonsignificant, *= significant at $P \leq 0.05$, **= significant at $P \leq 0.001$).

[3]Plants were grown in a 1:1 ratio of perlite and vermiculite amended with 25, 50, 75 or 100 percent (%) compost; the 0 (%) compost treatment was a peat-based mix.

[4]Plants were grown in a peat-based commercial soilless mix amended with 0, 50 or 100% compost and sub-irrigated in an ebb and flow system.

[5]Plants were grown in a peat-based commercial soilless mix (5:4:1 pine bark: Florida peat: coarse sand) (0% compost treatment); a 40% compost-based medium formulated on site (5:4:1 pine bark: compost: coarse sand) (50% compost treatement); or 100% compost.