Bedding Plant Growth in Greenhouse Waste and Biosolid Compost

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ADDITIONAL INDEX WORDS. begonia, impatiens, sewage sludge, biosolids, yard trimmings, recycling, used greenhouse growing substrate, *Begonia ×semperflorens-cultorum*, *Impatiens wallerana*

SUMMARY. Growth of 'Oasis Scarlet' begonia (*Begonia ×semperflorens-cultorum* Hort.) and 'Super Elfin Violet' impatiens (*Impatiens wallerana* Hook. f.) was compared in substrates containing compost made from used greenhouse substrates and yard trimmings (GHC) and in compost made from biosolids and yard trimmings (SYT). Treatments consisted of 100% compost (GHC or SYT) or compost combined with control substrate components at 60%, 30%, or 0%. Substrates containing SYT compost produced significantly larger begonia and impatiens plants than substrates containing GHC compost. Higher initial substrate nutrient concentrations in substrates containing SYT probably prompted increased begonia and impatiens growth because substrates containing SYT compost had significantly higher initial soluble salt, nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) concentrations than substrates containing GHC compost. Begonia and impatiens shoot dry mass and size linearly increased as the percentage of SYT compost in the substrate increased from 0% to 100%. However, no difference in begonia or impatiens growth was observed among the different percentages of GHC compost. Initial soluble salt, N, P, K, Ca, and Mg concentrations also linearly increased as the percentage of SYT increased while only initial P, K, and Ca concentrations linearly increased as the percentage of GHC increased.

The greenhouse industry generates used greenhouse growing substrates that may be reused. However, concerns with disease problems when reusing substrates have limited its general use. Because composting generates considerable heat [43–66 °C (109–151 °F)] during the active composting phase (Rynk et al., 1992), composting used greenhouse substrates with yard trimmings would generate temperatures high enough to kill most disease-causing organisms.

Before recommending the use of any compost amended substrate for the growth of bedding plants, identifying substrate physical and chemical properties associated with superior bedding plant growth is important. For example, the physical and chemical properties of substrates containing composted biosolids have been described and successfully used to grow marigold (*Tagetes erecta* L.) (Chaney et al., 1980; Wootton et al., 1981), zinnia (*Zinnia elegans* Jacq.) (Wootton et al., 1981), petunia (*Petunia hybrida* Hort.) (Klock, 1997a; Wootton et al., 1981), .) snapdragon (*Antirrhinum majus* L.) (Klock, 1997b; Sanderson, 1980), geranium (*Pelargonium ×hortorum* L.H. Bailey) (Sanderson, 1980), dianthus (*Dianthus chinensis*

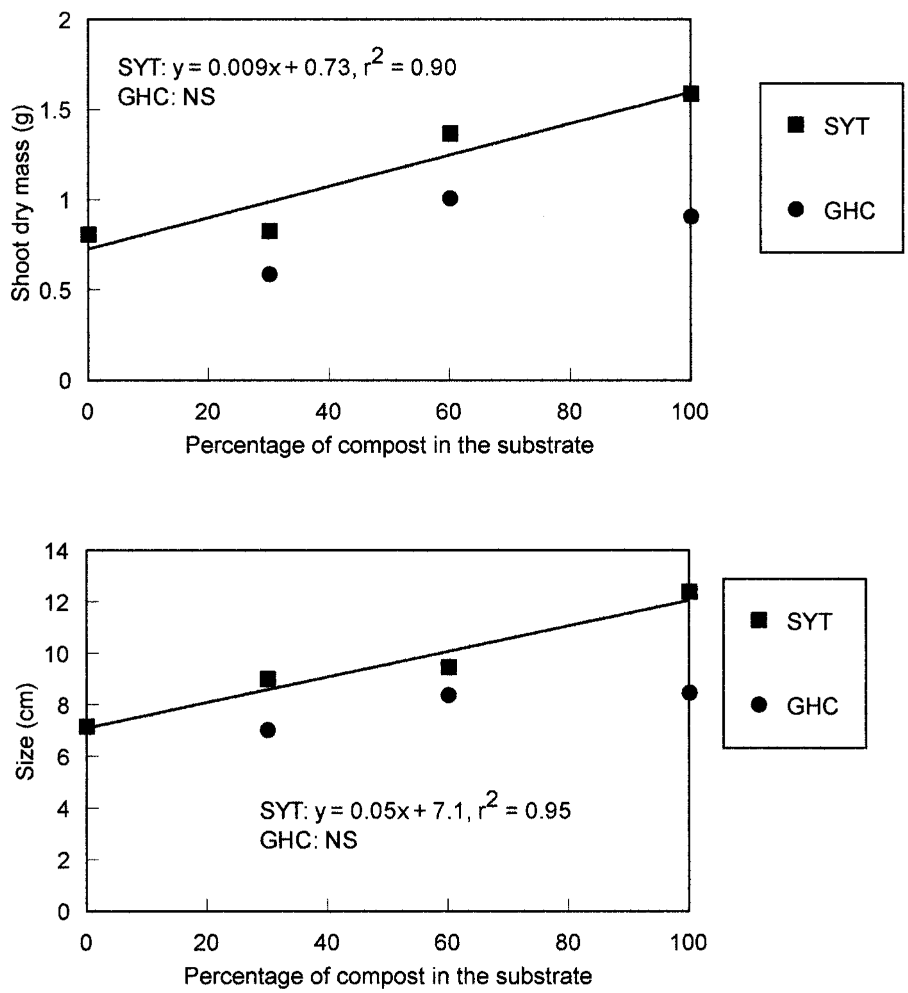

Fig. 1. Final 'Oasis Scarlet' begonia shoot dry mass and size (average of height and width) of plants grown in substrates containing compost made from a used greenhouse growing substrate and yard trimmings (GHC) and in substrates containing compost made from biosolids and yard trimmings (SYT) (1 oz = 28.4 g; 1 inch = 2.54 cm).

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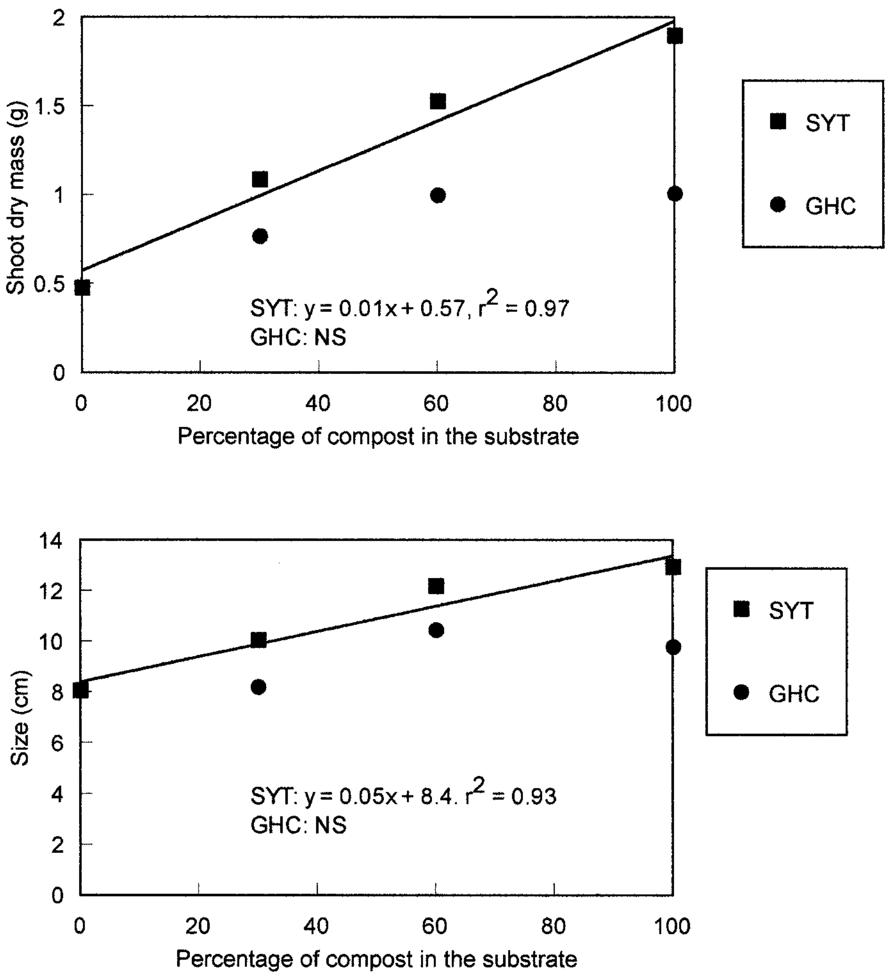

Fig. 2. Final 'Super Elfin Violet' impatiens shoot dry mass and size (average of height and width) of plants grown in substrates containing compost made from a used greenhouse growing substrate and yard trimmings (GHC) and in substrates containing compost made from biosolids and yard trimmings (SYT) (1 oz = 28.4 g; 1 inch = 2.54 cm).

L.) (Klock, 1997a), and impatiens (Klock, 1997b). The objective of this experiment was to compare the growth of 'Oasis Scarlet' begonia and 'Super Elfin Violet' impatiens plants in substrates containing compost made from used greenhouse substrates and yard trimmings and in substrates containing compost made from biosolids and yard trimmings.

Materials and methods

Two compost products were evaluated by combining them at four different percentages with control substrate components. The control substrate was based on a standard substrate used in the greenhouse industry. In March 1997, plugs of begonia and impatiens from 392-plug trays were transplanted into 400-mL (13.5-fl oz) (9.5 cm tall × 10.2 cm diameter; 3.7 × 4 inches) round pots filled (by volume) with 1) 100% compost; 2) 60% compost : 25% vermiculite : 15% perlite; 3) 30% compost : 30% sphagnum peat : 25% vermiculite : 15% perlite; or 4) 0% compost : 60% sphagnum peat : 25% vermiculite : 15% perlite (control). The first compost evaluated (GHC) consisted of (by volume) 20% used greenhouse substrate layered with 80% yard trimmings. The used greenhouse substrate (obtained from Lovell Farms, Miami) was 60% sphagnum peat : 25% shredded bark : 15% polystyrene (by volume) combined with the remains of bedding and pot plants. The yard trimmings used in the layers were chipped wood waste [no larger than 7.6 cm (3 inches)] received from a commercial arborist. Materials were layered and composted for 4 months, cured for 6 months, and the resulting compost product was not screened before use in this project. The second compost (SYT) was a 1:1 by mass mixture of biosolids and yard trimmings obtained from the Solid Waste Authority (SWA) of Palm Beach County, Fla. Biosolids used by SWA were polymer dewatered wastewater residuals (14% dry solids) obtained from two local utilities. The yard trimmings used were mainly woody waste ground and screened to 1.2- to 3.0-cm (0.5- to 1.2-inch) mulch. The SYT compost was made using a rectangular agitated bed system. Materials were mixed and composted for 21 d, cured for 3 months, and screened to pass a 19-mm (0.75-inch) screen.

All pots were topdressed with a standard rate of 3 g (0.11 oz) of 14N–6.2P–11.6K Osmocote (Scotts Co., Marysville, Ohio) 6 d after transplanting. Plants were watered twice daily at 0800 and 1300 HR for 10 min using 0.15-cm (0.06-inch) inside diameter leader tubes (Stuppy's, Kansas City, Mo.). Plant height and width were recorded 32 d after transplanting, and plant size was calculated as the average of final height and width. Shoots were cut at the surface of the growing substrate, dried at 93 °C (199 °F) for 48 h, and weighed. Whole shoot nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) were determined by A&L Southern Agricultural Laboratories Inc. (Pompano Beach, Fla.) who determined N and P using a spectrophotometer and determined K, Ca, and Mg using an atomic absorption spectrophotometer.

Initial moisture content, porosity, air-filled porosity (APS), water-holding capacity (WHC), and initial and final pH and soluble salt, N, P, K, Ca, and Mg concentrations were determined on all substrates. Percent moisture, porosity, APS, and WHC were determined on five replicate samples of each substrate in 9.5 cm tall × 10.2 cm diameter (3.7 × 4 inch) [400-mL (13.5-fl oz)] round pots by volume displacement methods (Niedziela and Nelson, 1992). Initial and final substrate pH and soluble salt, N, P, K, Ca, and Mg concentrations were determined on five replicate samples of each substrate by A&L Southern Agricultural Laboratories who used a Morgan extract (Soil and Plant Analysis Council, Inc., Athens, Ga.).

The experiment was conducted at the University of Florida, Fort Lauderdale Research and Education Center in a 30% shade house. Plants were exposed to ambient air temperatures

Table 1. Physical properties of substrates containing compost made from a used greenhouse growing substrate and yard trimmings (GHC) or compost made from biosolids and yard trimmings (SYT).

Substrate	Moisture content (%)	Total pore space (%)	Water-holding capacity (%)	Air-filled porosity (%)
0% GHC	75	72	49	23
30% GHC	65	57	30	27
60% GHC	63	54	29	25
100% GHC	42	49	19	30
Significance	L	L	L	NS
0% SYT	75	76	52	24
30% SYT	63	60	36	24
60% SYT	60	54	32	22
100% SYT	39	45	21	24
Significance	L	L	L	NS
Suggested range[z]	10–80	35–88	20–60	5–30
Significance				
Substrate	NS	NS	*	NS

[z]Suggested range based on recommendations from Poole et al. (1981) and Fonteno (1996).
NS,*Nonsignificant or significant at $P \geq 0.05$; L = linear.

[30/21 °C day/night (86/70 °F)]. Pots were arranged in a completely randomized design with five single pot replications per substrate. All data were analyzed using analysis of variance and regression procedures (SAS Institute, Cary, N.C.).

Results and discussion

Average begonia shoot dry mass and size were 1.4× and 1.2× significantly larger, respectively, in substrates containing SYT compost than in substrates containing GHC compost (Fig. 1). Similarly, average impatiens shoot dry mass and size were 1.5× and 1.2× significantly larger, respectively, in substrates containing SYT compost than in substrates containing GHC (Fig. 2). Wootton et al. (1981) speculated that decreased marigold growth in unsieved compost made from sewage sludge and yard trimmings was due to water stress. They observed that as compost particle size increased, the percentage of available water decreased (Wootton et al., 1981). Substrates containing SYT compost, on average, had a significantly smaller particle size and a slightly higher WHC than substrates containing GHC compost (Table 1). However, no difference existed in moisture content, pore space, or APS between the two composts (Table 1).

Differences in begonia and impatiens growth between the two composts were most likely due to differences in substrate nutrient concentrations. Composts that are composed largely of woody waste tend to be high in carbon (C) and can block the availability of N due to high C:N ratios while composts made from biosolids, a very N-rich material, are less likely to cause N deficiencies (Rynk et al., 1992). Average initial substrate soluble salt, N, P, K, Ca, and Mg concentrations and final P, Ca, and Mg concentrations were higher in substrates containing SYT than in substrates containing GHC or 0% compost (Table 2). For example, substrates containing GHC compost or 0% compost had very low to low initial soluble salt and N concentrations while substrates containing SYT compost had high to very high initial soluble salt and N concentrations (Table 2).

Both begonia and impatiens shoot dry mass and size also linearly increased as the percentage of SYT compost in the substrate increased from 0 to 100% while begonia and impatiens growth was similar in all percentages of GHC compost (Figs. 1 and 2). Initial substrate pH and soluble salt, N, P, K, Ca, and Mg concentrations linearly increased

Table 2. Initial and final substrate pH and soluble salt and nutrient concentrations of substrates containing compost made from a used greenhouse growing substrate and yard trimmings (GHC) or compost made from biosolids and yard trimmings (SYT) (1 μg·g^{-1} = 1 ppm).

	pH		Soluble salts (ds·m^{-1})		N (μg·g^{-1})		P (μg·g^{-1})		K (μg·g^{-1})		Ca (μg·g^{-1})		Mg (μg·g^{-1})	
Substrate	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
0% GHC	5.0	6.3	0.03	0.24	14	24	5	12	61	47	130	998	113	137
30% GHC	6.1	6.5	0.03	0.37	15	46	16	20	120	76	290	998	102	123
60% GHC	7.1	6.8	0.12	0.31	14	60	17	30	275	89	640	893	109	113
100% GHC	7.4	6.6	0.13	0.44	15	83	19	48	301	131	790	1060	111	134
Significance	L	NS	NS	NS	NS	L	L	L	L	L	L	NS	NS	NS
0% SYT	5.0	6.3	0.03	0.24	14	25	6	11	56	50	115	998	130	137
30% SYT	5.7	6.4	0.34	0.51	69	87	31	43	160	75	570	1468	136	175
60% SYT	6.4	6.7	0.50	0.59	134	89	63	68	272	97	1170	1638	198	176
100% SYT	6.5	6.5	0.83	0.68	152	97	80	80	444	111	1795	2108	314	228
Significance	L	NS	L	L	L	L	L	L	L	L	L	L	L	L
Suggested range[z]	5.5–6.5		0.2–1.0		25–150		12–60		50–250		500–5000		50–500	
Significance														
Substrate	***	NS	***	NS	***	NS	***	***	***	NS	***	***	***	***

[z]Suggested range based on recommendations from A&L Southern Laboratories, Pompano Beach, Fla., who used a Morgan extract.
NS,***Nonsignificant at $P \geq 0.05$ or significant at $P \geq 0.001$; L = linear.

as the percentage of SYT compost in the substrate increased, while only initial pH, P, K, and Ca linearly increased as the percentage of GHC increased (Table 2). No symptoms of nutrient deficiency or toxicity were evident on any of the plants. Furthermore, no significant differences in begonia or impatiens shoot N, P, K, Ca, or Mg concentrations were reported among plants grown in either compost product at any of the percentages (data not shown).

Although begonia and impatiens plants were larger in substrates containing SYT compost, substrates containing GHC compost also produced commercially acceptable plants. With appropriate nutrient management, substrates containing either SYT or GHC compost similar to the ones described will produce acceptable begonia and impatiens plants.

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