Three Waste-Derived Composts Compared in Container Substrates©

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Organic wastes and composts are increasingly being advocated for use in potting mixes (Chong, 1999; Hoitink, 1999). Before these materials can become widely accepted by commercial producers, it is important to demonstrate efficacy in a wider assortment of usage and mix ratios.

This study compared the response of dogwood (*Cornus alba* 'Sibirica'), forsythia (*Forsythia* ×*intermedia* 'Lynwood'), and weigela (*Weigela* 'Nana Variegata') grown for one season in #2 containers filled with one of 18 waste-derived substrates. The substrates were formulated from spent mushroom compost (SMC), turkey litter compost (TLC), and municipal waste compost (MWC), each at rates of 25%, 33%, and 50% (by volume) mixed respectively with 50%, 33%, and 25% paper mill sludge (PMS), plus 25%, 33%, and 25% of a supplemental ingredient [bark (B) or sand (S)]. There were also two control mixes: 100% bark and 80 bark : 15 peat : 5 topsoil (by volume), a proven nursery mix. Nutricote 16-10-10 T140 controlled-release fertilizer with micronutrients was pre-incorporated into each substrate (7.1 $k \cdot gm^{-3}$). Plants of each species were arranged in a separate randomized complete block design with four replications and four plants per plot. Each container received 2 L of hand-applied water immediately after potting, and 1-L trickle-applied twice daily thereafter.

Analysis of variance with treatments in factorial combinations (3 compost sources × 3 rates × 2 supplemental ingredients) indicated variable species response. Dogwood (no treatment interactions; Fig. 1) grew best with the SMC-amended substrates, providing equal but less growth with TLC and MWC. This species also grew better with bark as supplement than with sand and showed no response to compost rates. Corresponding results for the other species (Fig. 1) were: weigela, MWC > SMC = TLC, and increasing growth with increasing rates of all composts when supplemented with sand but not bark; and forsythia, SMC = MWC > TLC, and increasing growth with increasing rate of SMC with sand, or of MWC with bark. Despite these variations, all plants were at least of marketable size at harvest (Fig. 1). Plants were considered to be of minimum marketable size if growth was at least comparable to that in 100% bark, or larger if growth was at least comparable to that in the nursery mix.

Before mixing, electrical conductivity [EC, a measure of the soluble salts concentration expressed as $dS \cdot m^{-1}$ using 1 substrate : 2 water (v/v) extracts] in the unamended composts were excessive (SMC, 4.0; TLC, 4.1; and MWC, 3.0), due primarily to elevated quantities ($mg \cdot L^{-1}$) of K (1166-2006), Cl (848-1656), Na (139-511), and/or SO_4 (29-894) (Table 1). Throughout the season, however, there was no sign of nutrient toxicity because the soluble salts in the substrates (initially ranging from 0.6-2.6 $dS \cdot m^{-1}$ at planting on 20 May just before first watering) declined rapidly after the first irrigation (0.2-1.0 $dS \cdot m^{-1}$) and remained low thereafter (≤0.6) (Table 2). The pH values of the two control substrates were within the recommended 5.5-7.0 range at planting (6.3, 100% bark; 5.5, nursery mix; Table 2) and remained near neutral during the season. In contrast, the pH values of the compost-amended substrates were high at planting (7.4-7.8, SMC; 7.7-8.1, TLC; and 7.7-8.0, MWC); values declined during the season but remained ≥ 7.1 (Table 2).

The similarity in bulk density and porosity characteristics of the three composts (Table 1), and the relatively narrow range in mix ratios (25% to 50% by vol), and

Table 1. Chemical and physical analysis of substrate materials before use[z].

Variable	Desirable nursery values mix[z]	Spent mushroom compost	Turkey litter compost	Municipal waste compost	Paper mill sludge	Bark	Sand	Nursery mix
				Chemical Analysis				
EC($dS\cdot m^{-1}$)[y]	≤1	4	4.1	3	1.2	0.1	0.1	0.2
NH_4-N[x]	≤10	15	103	4	37	0.02	0.5	0.5
$N0_3$-N	100-200	89	232	0.02	0.02	0.02	5	13
P	6-9	6	27	2	8	8	0.05	0
K	150-200	2066	2792	1166	89	42	6	18
Ca	200-300	871	100	165	409	34	30	73
Mg	70-200	220	153	50	83	12	16	18
Na	0-50	511	501	139	387	10	10	19
Cl	0-50	1328	1656	848	136	19	14	0
SO_4	<300	894	316	29	159	3	10	19
Fe	0.3-3.0	1.9	11.4	1.5	1.4	0.5	0.5	1.6
Mn	0.3-3.0	0.9	2	0.1	1.4	0.6	0.05	0.3
Zn	0.3-3.0	0.4	6.3	0.1	0.5	0.05	0.05	0.4
				Physical Analysis				
Bulkdensity ($g\cdot cm^{-3}$)	0.2-0.75	0.39	0.55	0.43	0.2	1.50	0.27	0.31
Total porosity (%)	>50	71	73	66	72	78	27	63
Aeration porosity (%)	15-30	40	45	32	40	46	14	30
Water retention porosity (%)	25-35	31	28	34	31	32	13	33

[x] Concentration of all nutrients expressed in terms of $mg\cdot L^{-1}$ using the saturated medium extraction (greenhouse) procedure.
[y] EC (electrical conductivity) measured in 1 substrate : 2 water (v/v) extracts.
[z] Average of three samples.

Table 2. Changes in EC and pH in the waste substrates during the growing season.

Substrate (% by vol)[z]						EC (dS·m^{-1})						pH					
SMC	TLC	MWC	PMS	B	S	20 May[y]	21 May[z]	30 May	20 June	23 July	27 Aug	20 May[y]	21 May[x]	30 May	20 June	23 July	27 Aug
SMC-amended																	
25			50	25		1.7	0.5	0.4	0.2	0.3	0.2	7.4	7.9	7.7	7.5	7.3	7.3
33			33	33		2.0	0.5	0.4	0.2	0.2	0.4	7.4	7.9	7.7	7.9	7.5	7.1
50			25	25		2.0	0.5	0.6	0.2	0.2	0.3	7.6	8.2	7.8	8.0	7.6	7.3
25			50		25	1.4	0.4	0.4	0.2	0.3	0.3	7.6	8.2	7.8	7.9	7.6	7.4
33			33		33	1.7	0.4	0.4	0.1	0.2	0.2	7.5	8.2	7.9	8.0	7.7	7.4
50			25		25	2.0	0.6	0.4	0.2	0.4	0.2	7.8	8.4	8.1	8.0	7.5	7.4
TLC-amended																	
	25		50	25		1.5	0.6	0.5	0.2	0.4	0.2	7.8	7.6	7.4	7.8	7.2	7.3
	33		33	33		1.8	0.6	0.5	0.1	0.4	0.3	7.7	7.7	7.4	7.8	7.2	7.2
	25		25	25		2.6	0.9	0.6	0.2	0.4	0.2	7.8	8.0	7.3	7.7	7.3	7.3
	50		50		25	1.8	0.6	0.3	0.2	0.6	0.4	8.0	8.0	7.6	8.0	7.5	7.3
	33		33		33	1.7	0.5	0.3	0.1	0.5	0.2	8.0	8.1	7.7	8.0	7.3	7.4
	50		25		25	2.4	1.0	0.3	0.2	0.4	0.2	8.1	8.2	7.6	7.6	7.2	7.4
MWC-amended																	
		25	50	25		1.3	0.2	0.2	0.1	0.4	0.2	7.7	8.1	7.9	8.0	7.3	7.4
		33	33	33		0.7	0.2	0.3	0.1	0.4	0.3	7.7	8.2	7.7	8.1	7.4	7.4
		50	25	25		1.7	0.3	0.3	0.1	0.3	0.1	7.9	8.4	8.0	8.1	7.6	7.5
		25	50		25	0.6	0.3	0.4	0.2	0.2	0.1	7.8	8.3	7.8	8.1	7.7	7.6
		33	33		33	0.7	0.2	0.2	0.1	0.5	0.2	7.9	8.5	8.0	8.2	7.5	7.5
		50	25		25	0.9	0.3	0.3	0.1	0.3		8.0	8.4	8.0	8.3	7.8	7.5
Control substrates:																	
100% bark						0.4	0.1	0.1	0.1	0.3	0.1	6.3	7.0	6.8	7.2	6.9	7.2
Nursery mix						0.4	0.1	0.1	0.1	0.2	0.2	5.5	6.4	6.9	7.1	6.8	7.0
LSD[w] ($P \leq 0.05$)						0.6	0.5	0.3	0.2	0.4	0.2	0.2	0.2	0.3	0.2	0.4	0.2

[w]Least Significant Difference test.
[x]One day after planting just before start of drip irrigation.
[y]Date of planting; containers immediately hand-watered after planting.
[z]SMC = spent mushroom substrate; TLC = turkey litter compost; MWC = municipal waste compost; PMS = paper mill sludge; B = bark; and S = sand.

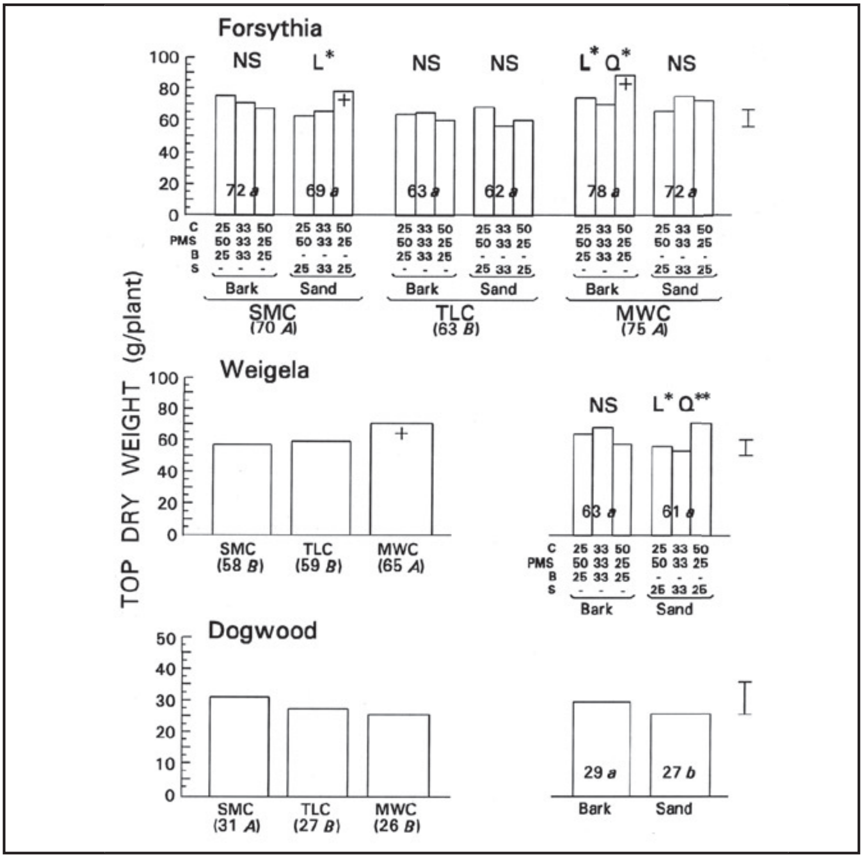

Figure 1. Response of three container-grown species to waste substrates formulated using three compost (C) sources (spent mushroom compost, SMC; turkey litter compost, TLC; and municipal waste compost, MWC). Each source was present at rates of 25%, 33%, and 50% (by volume) mixed respectively with 50%, 33%, and 25% paper mill sludge (PMS), and 25%, 33%, and 25% of supplemental ingredient [bark (B) or sand (S)]. The main effect of compost sources were separated (*A* - *B* in brackets outside the bars) by contrast analysis at $P \leq 0.05$, as also the main effects of supplements (*a* - *b* inside the bars). With weigela and forsythia, trends between increasing compost rates were either not significant (NS) or significant [linear (L) and/or quadratic (Q) responses at $P \leq 0.05$ (*) or $P \leq 0.01$ (**)]; the + near the top within bar indicates significantly more growth than with the nursery mix using contrast analysis. The lower and upper limits (horizontal lines to the right of histograms) represent growth in 100% bark and the nursery mix, respectively.

lack of excess salts during the growing season (Table 2), may explain the good to excellent responses of all the substrates investigated and re-confirms earlier results with a wide assortment of composts and waste-derived substrates (Chong, 1999).

LITERATURE CITED

Chong, C. 1999. Experiences with the utilization of wastes in nursery potting mixes and as field soil amendment. Can. J. Plant Sci. 79:139-148.

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