Growth and Mineral Nutrient Status of Containerized Woody Species in Media Amended with Spent Mushroom Compost

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Abstract. 'Eight deciduous ornamental shrubs—deutzia (*Deutzia gracilis* Siebold & Zucc.), dogwood (*Cornus alba* L. 'Argenteo-marginata'), forsythia (*Forsythia* × *intermedia* Zab. 'Lynwood Gold'), ninebark [*Physocarpus opulifolius* (L.) Maxim.], potentilla (*Potentilla fruticosa* L. 'Red Ace'), privet (*Ligustrum vulgare* L.), rose (*Rosa* L. 'John Frank. lin'), and weigela [*Weigela florida* (Bunge) A. DC. 'Variegata Nana'] —were grown in trickle-irrigated containers with 100% bark (control) or with bark and 33%, 67%, and 100% (by volume) of each of three sources of spent mushroom compost (unweathered, weathered, and unweathered compost leached with water). Despite large variation in species growth response to sources and levels of compost, most grew equally well or better in the compost-amended regimes than in 100% bark and were influenced little, or not at all, by initial or prevailing salt levels in the media. Shoot and root dry weight of dogwood, forsythia, ninebark, rose, and weigela (all sources), and shoot dry weight of deutzia and potentilla (weathered source only), increased linearly or curvilinearly with increasing compost levels. The reverse relationship occurred (all sources) in shoot and root dry weight of privet and root dry weight of weigela and potentilla. Leaf nutrients (N, P, K, Ca, Mg, Fe, Mn, and Zn) tended to increase with increasing compost levels, but not all species showed this response with all nutrients. Regardless of compost source or level, all shrubs were of marketable quality when harvested, except privet, which showed leaf chlorosis in all compost-amended regimes.

The availability of large quantities of spent mushroom compost in southern Ontario at little or no cost makes this organic waste product attractive for use as an inexpensive growing medium additive in nursery container culture. Studies have reported use of spent mushroom compost as soil amendment for field-grown fruits (Robbins et al., 1986), vegetables (Kaddous and Morgans, 1986; Male, 1981; Wang et al., 1984a, 1984b), and greenhouse-grown crops (Dallon, 1987; Rathier, 1982; Wang et al., 1984 b), but there is little or no definitive information on response of woody nursery crops to such growing regimes (Eames, 1977; Lemaire et al., 1985; Smith, 1982).

High soluble salt concentrations and toxicities or deficiencies due to specific nutrients in spent mushroom compost are major potential problems with restricted medium volume in container culture (Lemaire et al., 1985; Male, 1981). Eames (1977) observed unfavorable media characteristics and reduced growth of containerized shrubs in 25% or 50% spent mushroom compost medium and concluded that there was little potential for use of mushroom compost in container culture. Chong et al. (1987) reported that dogwood and forsythia grew well in container media amended with 25% to 100% by volume of unweathered or weathered spent mushroom composts.

The objective of this study was to evaluate the desirability of various spent mushroom composts as medium components in container culture of a wide assortment of woody species.

Materials and Methods

Plant material. Eight deciduous woody species were evaluated: deutzia; dogwood ('Argenteo-marginata'); forsythia ('Lynwood Gold'); ninebark; potentilla ('Red Ace'); privet; rose ('John Franklin'); and weigela ('Variegata Nana'). Stem cuttings (10 to 12 cm long) of all shrubs were rooted during Summer 1987 in Multipot #3 plastic plug trays (99 cm³; Ropak Capilano Ltd., Mississauga, Ont.), and overwintered in a minimum-heated (– 5C) polyethylene-covered greenhouse.

Compost sources and levels. On 19 May 1988, rooted cuttings (liners) of all species were potted in 6-liter (21 cm diam. × 21 cm deep) nursery containers filled with a control medium of 100% composted bark (equal parts of white and red pine bark screened through a 2-cm mesh) or with bark amended with 33%, 67%, and 100% (by volume) of each of three sources of spent mushroom compost (unweathered, weathered, and leached).

Table 1. Physical properties of the three basic media components, bark, weathered compost, and unweathered compost.

Variable	Bark	Mushroom compost	
		Weathered	Unweathered
Bulk density (g·liter ⁻¹)	221 ± 8.9 ^z	433 ± 28.7	148 ± 14.1
Total porosity (%)	69 ± 2.5	66 ± 2.1	82 ± 1.5
Aeration porosity (%)	35 ± 3.5	23 ± 4.9	61 ± 3.2
Moisture retention (%)	34 ± 2.6	41 ± 2.9	20 ± 3.5

^zEach datum represents an average of three determinations ± standard deviation.

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Table 2. pH, soluble salts, nutrient composition, and shrinkage of media amended with weathered, unweathered, or leached mushroom compost.

		Mushroom compost (%) ^x									
Variable ^z	Exam. (no.) ^y	Bark (Control)	Weathered			Unweathered			Leached		
		0	33	67	100	33	67	100	33	67	100
pH	1	6.1	6.7	7.1	7.4	7.0	7.4	7.3	7.4	7.5	7.5
	2	6.4	6.9	7.1	7.3	7.3	7.3	7.0	7.2	7.3	7.3
	3	6.3	6.8	6.9	7.0	7.6	7.3	7.0	6.9	6.9	6.9
Soluble salts (mS/cm) ^w	1	0.4	2.2	3.7	5.5	3.9	6.3	8.7	0.4	0.5	0.8
	2	0.4	1.4	2.0	3.0	1.3	2.0	2.3	0.6	0.8	1.1
	3	0.4	0.7	1.0	1.5	0.5	1.0	1.7	0.5	0.7	1.5
NO ₃ ⁻ -N	1	6	66	138	257	16	53	121	4	5	6
	2	7	35	60	111	27	48	50	12	50	69
	3	6	21	46	87	17	74	155	23	55	156
P	1	3	4	4	3	3	4	3	3	3	2
	2	2	4	4	3	4	3	3	2	4	3
	3	11	8	7	6	11	9	7	11	9	10
K	1	40	247	465	929	724	>999	>999	13	7	23
	2	47	140	214	318	185	296	348	34	35	38
	3	43	55	63	70	58	71	59	31	33	40
Ca	1	30	209	341	441	279	385	423	55	71	118
	2	33	149	220	379	104	171	220	59	112	144
	3	30	76	137	200	59	126	238	53	91	221
Mg	1	10	54	91	138	70	115	153	13	16	27
	2	12	35	50	88	26	45	59	17	25	28
	3	10	16	33	56	20	44	43	12	24	40
Fe	1	0.9	1.1	1.0	1.1	0.9	3.6	3.1	0.8	1.5	1.7
	2	0.6	0.7	0.7	1.0	0.7	0.7	1.0	0.4	0.5	0.5
	3	1.4	2.1	1.5	1.4	1.0	0.7	0.5	0.8	0.8	0.5
Mn	1	0.03	0.07	0.06	0.06	0.28	0.58	0.53	0.06	0.11	0.17
	2	0.03	0.06	0.06	0.07	0.10	0.19	0.24	0.19	0.15	0.12
	3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Zn	1	0.05	0.08	0.10	0.14	0.18	0.25	0.36	0.05	0.07	0.11
	2	0.12	0.24	0.20	0.25	0.22	0.20	0.18	0.29	0.22	0.18
	3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SO ₄ ^v	1	---	---	700	750	750	800	800	---	---	---
Cl ^v	1	---	---	251	433	536	860	985	---	---	---
Shrinkage (cm) ^u	---	2.1	2.2	2.7	3.3	2.8	3.6	4.7	2.8	3.1	4.3

^zConcentration of all nutrients is expressed in terms of mg-liter⁻¹.^yDate of planting; 1 = 19 May; 2 = 29 May; 3 = 27 Aug.^xEach datum represents an average over four replications.^wLow 0-0.75, acceptable 0.76-2.0, optimum 2.1-3.5, high 3.6-5.0, very high, 5.0+ according to Warncke (1980).^vSO₄ and Cl were analyzed only when soluble salts content was >3.0 mS/cm.^uDepth from container rim at harvest, 4-6 Oct.

Composts were derived primarily from wheat straw-bedded horse manure, amended with gypsum, poultry litter, brewer's grain, soya bean meal, urea, or ammonium nitrate to increase the initial N value to 1.670 to 1.8%. After controlled aerobic composting, pasteurization, and conditioning, composts were inoculated with the vegetative mycelium of *Agaricus bisporus* (Lange) Imbach and, after 2 weeks of colonization, were top-dressed with sphagnum peat amended with CaCO₃. Mushrooms began to be harvested 3 weeks later; cropping continued for up to 5 more weeks. At the termination of cropping, the compost temperature was raised to 70°C for 8 hr. Compost immediately removed from the production area was the *unweathered* spent mushroom compost. The *weathered* compost also produced a crop of mushrooms but, after heat treatment at the end of the cropping period, this material was placed in a pile to weather and compost naturally for 2 years. The *leached* compost was obtained as follows: before planting, containers amended with unweathered compost were leached by applying water (10 mm-hr⁻¹) from oscillating sprinklers for 18 hr (three consecu-

tive daily 6-hr periods). Selected physical properties of each of the basic media components (Table 1) were determined in triplicate air-dried samples according to Davidson and Mecklenburg (1981).

Two hundred plants of each species were arranged separately in a randomized complete-block design with four replications of all 10 treatments and five plants per treatment in each replicate. Deutzia, potentilla, rose, and weigela were spaced 45 × 45 cm, and the others 45 × 60 cm. Plants were trickle-irrigated through turbulent flow emitters (Wade Manufacturing, Fresno, Calif.) at the rate of 2 liters of water per container per day applied during two one-half-hour periods. Liquid fertilizer concentrate (20.0N-8.7P-16.6K with micro-nutrients; Plant Products, Brampton, Ont.), injected through the trickle system each Monday, Wednesday, and Friday (2 liters of fertilizer per day in conjunction with the irrigation schedule described above), provided the following nutrients (mg-liter⁻¹): N, 200; P, 87; K, 166; Fe, 1.0; Mn, 0.5; Zn, 0.5; Cu, 0.5; and Mo, 0.005.

Medium samples were collected (7- to 12-cm depth) from

Fig. 1. Shoot dry weight of eight woody species in response to increasing levels of spent mushroom compost in the container medium. The regression for each compost source is represented by Y_W (weathered), Y_U (unweathered), and Y_L (leached). Y_{WUL} indicates no significant difference at $P \leq 0.05$ between the regressions for the three sources of compost. NS indicates that slope was nonsignificant at $P \leq 0.05$.

each treatment within replicate and pooled across species on 19 May (date of planting), 29 May, and 27 Aug. The electrical conductivity, a measure of soluble salts content, and pH (Table 2) were determined in each sample from the saturated media extract (Warncke, 1980). Nitrate-nitrogen (NO_3-N) was determined in the extract with a nitrate electrode, P by calorimetry,

Fig. 2. Root dry weight of eight woody species in response to increasing levels of spent mushroom compost in the container medium. The regression for each compost source is represented by Y_W (weathered), Y_U (unweathered), and Y_L (leached). Y_{WUL} indicates no significant difference at $P \leq 0.05$ between the regressions for the three sources of compost. NS indicates that slope was nonsignificant at $P \leq 0.05$.

and K, Ca, Mg, Fe, Mn, and Zn by flame emission or atomic absorption spectrophotometry. Sulphate (SO_4) and Cl were determined by a turbidimetric procedure and by chloride electrode,

Table 3. Regressions of height of various ornamental shrubs and of number of rose blooms on increasing levels of spent mushroom compost in the container media.

Variable	Species	Equation ^z	Partial R ²
Ht (cm)	Dogwood	$Y_{WUL} = 78.1 + 0.095x$	0.18
	Rose	$Y_{WUL} = 53.6 + 0.17x$	0.47
	Weigela	$Y_{WUL} = 49.3 + 0.047x$	0.11
Blooms (no.)	Rose (July)	$Y_{WUL} = 21.0 + 0.67x - 0.0047x^2$	0.38
	(August)	$Y_{WUL} = 84.3 + 0.97x - 0.0052x^2$	0.29

^zSubscripts W, U, and L refer to weathered, unweathered, and leached composts, respectively. Y_{WUL} indicates no significant difference at $P \leq 0.05$ between the regressions for the three sources of compost.

respectively, only when salt contents of soil extracts were >3.0 mS/cm [Table 2).

In mid-July and mid-August, the total number of opened and unopened blooms' was counted on each rose plant. In mid-August, samples of newly matured leaves were taken from each species, except privet, which showed high mortality in all compost treatments. Leaf samples were dried at 70C and ground to pass through a 40-mesh screen. Total N was determined by the Kjeldahl method, and P, K, Ca, Mg, Fe, Mn, and Zn as in media samples after dry-ashing at 550C.

In early October, height (all species) or width (potentilla) of each plant, and the medium in each pot, expressed by depth from the container rim (Table 2), were recorded. Shoots and roots (recovered after repeated washing) were dried at 70C and weighed.

Statistical analysis. Data for each species were analyzed separately. Each response was regressed on percent mushroom compost, separately for each source. Graphically, the model represents a series of curves, one for each source, radiating from a common intercept. Quadratic polynomials were fitted when necessary to account for a curved relationship. Preliminary tests to determine whether or not to use the quadratic relationship were done at $P \leq 0.15$. When an initial test revealed that the three regressions were not significantly different at $P \leq 0.05$, a common regression was fitted to the three sources of compost. The initial model fitted was: $Y_{ijk} = \mu + r_k + \beta x_j + \alpha x_j + e_{ijk}$, where Y_{ijk} is the response to compost from source i ($i = 1,2,3$) at level j ($j = 0,1,2,3$) in the k -th replicate, r_k is the replicate effect, $\beta x_j + \alpha x_j$ is the quadratic polynomial regression on level of compost ($x_0 = 0$, $x_1 = 33$, $x_3 = 100$) from source i , and e_{ijk} is the residual error. The coefficient of determination for each response was expressed in terms of 'partial R^2 ', which measured the strength of the relationship between the response and the compost treatments, after removing replication effects (Deveau et al., 1987).

Results and Discussion

Growth. Shoot and root growth (Figs. 1 and 2) of most species responded to sources and (or) levels of spent mushroom compost in a manner that was not related to salt levels in the media (Table 2).

Shoot dry weight (Fig. 1) of dogwood, forsythia, ninebark, and rose increased markedly in response to increasing amounts of weathered (Y_w), unweathered (Y_u), or leached (Y_l) mushroom compost in the growing medium. Similar results were observed for root dry weight (Fig. 2) of these shrubs, except that regressions for ninebark and rose were not significant in the unweathered and leached regimes, respectively.

There were moderate curvilinear increases in shoot dry weight

of weigela with increasing levels of all composts (Fig. 1). Small but significant linear increases in shoot dry weight of deutzia and potentially occurred only in the weathered compost. In contrast, shoot dry weight of privet decreased with increasing levels of compost with no difference between compost sources (Y_{WUL}) (Fig. 1). Root dry weight of privet showed a similar negative response as did weigela and potentilla (Fig. 2). Root dry weight of deutzia was not significantly influenced by any compost treatment.

Height of dogwood, rose, and weigela and number of rose blooms (both July and August), represented by equations for Y_{WUL} (Table 3), responded positively to increasing amounts of mushroom compost in the medium but sources of compost had no significant influence. Most species produced the largest shoot dry weight in the weathered compost, but differences between this and other sources were small (Fig. 1).

Leaf and medium analysis. There were large differences in leaf macro- and micro-elemental composition of the seven shrubs analyzed. Six of these (dogwood, forsythia, ninebark, rose, deutzia, and weigela) (Table 4) exhibited consistent curvilinear increases in leaf Mn contents with increasing levels of all compost sources. Manganese accumulated less in plants grown in weathered than in unweathered or leached composts. Leaf Mn content in potentilla (data not shown) was variable and apparently not related to treatments.

Except for forsythia and potentilla, in which contents of K and Fe, respectively, decreased with increasing levels of composts (Table 4), there were also significant increases in other leaf nutrients but not all shrubs showed this response for all nutrients. The range in partial R^2 values for regressions with leaf Mn (Table 4) were notably higher (0.59 to 0.86) than those for other nutrients (0.12 to 0.69).

Analysis of the medium extracts (Table 2) indicated that elevated salt levels in the composts at the start of the experiment were due primarily to high concentrations of K, Ca, SO_4 , and Cl. Concentrations of all micro-elements, including Mn, were very low with all media. Manganese never exceeded $0.6 \text{ mg} \cdot \text{liter}^{-1}$ in medium extracts at the start of the experiment and remained low thereafter. Robbins et al. (1986) reported that mushroom compost applied to field plots increased fruit yield (doubled), yield efficiency, and leaf N, Ca, Mn, and Fe in *Prunus domestica*. Even after 3 years, mushroom compost produced the highest leaf K content compared to other treatments applied to the soil to increase K. This result likely was due to better soil air-water relations since actual K content of the compost was not greater than that of the other soil-applied treatments (Robbins et al., 1986).

Except for privet, all species grew vigorously and were of marketable quality when harvested in early October, irrespective of medium. Throughout the growing season, there were no

Table 4. Regressions of leaf nutrient content of various ornamental shrubs in response to increasing levels of spent mushroom compost in the container media.

Nutrient	Species	Equation ²	Partial R ²	
Macro-elements (% dry wt)				
N	Dogwood	Y _{wUL} = 2.24 + 0.0029x	0.12	
	Forsythia	Y _{wUL} = 2.20 + 0.0032x	0.25	
	Ninebark	Y _w = 3.25 - 0.023x + 0.00019x ²	0.22	
		Y _U = 3.25 - 0.015x + 0.00019x ²		
		Y _L = 3.25 - 0.022x + 0.00019x ²		
		Y _w = 1.79 + 0.0100x		
	Rose	Y _U = 1.79 + 0.0046x	0.32	
		Y _L = 1.79 + 0.0051x		
		Y _w = 1.91 + 0.0060x - 0.000032x ²		
	Weigela	Y _U = 1.91 + 0.0073x - 0.000032x ²	0.55	
		Y _L = 1.91 + 0.0070x - 0.000032x ²		
		Y _w = 0.38 + 0.000019x		
P	Deutzia	Y _U = 0.38 + 0.000520x	0.30	
		Y _L = 0.38 + 0.000300x		
		Y _{wUL} = 0.25 + 0.00066x		
	Ninebark	Y _w = 0.29 + 0.00060x	0.47	
		Y _U = 0.29 + 0.00091x		
		Y _L = 0.29 + 0.00073x		
	K	Forsythia	Y _w = 1.94 - 0.0016x	0.69
			Y _U = 1.94 - 0.0047x	
Y _L = 1.94 - 0.0054x				
Rose		Y _w = 1.67 + 0.0015x - 0.0000074x ²	0.26	
		Y _U = 1.67 + 0.0018x - 0.0000080x ²		
		Y _L = 1.67 + 0.0096x - 0.0001250x ²		
Ca		Potentilla	Y _{wUL} = 1.83 + 0.0013x	0.19
		Dogwood	Y _{wUL} = 2.22 + 0.0068x	0.44
	Forsythia	Y _w = 0.34 + 0.00081x	0.36	
		Y _U = 0.34 + 0.00160x		
		Y _L = 0.34 + 0.00170x		
	Ninebark	Y _{wUL} = 0.90 + 0.0015x	0.25	
	Weigela	Y _{wUL} = 1.33 + 0.0018x	0.19	
Mg	Dogwood	Y _{wUL} = 0.37 + 0.00047x	0.16	
	Forsythia	Y _w = 0.12 - 0.00100x + 0.000012x ²	0.51	
		Y _U = 0.12 - 0.00064x + 0.000012x ²		
		Y _L = 0.12 - 0.00045x + 0.000012x ²		
	Ninebark	Y _w = 0.25 + 0.00034x	0.47	
		Y _U = 0.25 + 0.00056x		
		Y _L = 0.25 + 0.00039x		
Micro-elements (mg·kg ⁻¹)				
Fe	Potentilla	Y _{wUL} = 180 - 3.88x + 0.028x ²	0.42	
Mn	Dogwood	Y _w = 19.8 + 0.12x	0.74	
		Y _U = 19.8 + 0.23x		
		Y _L = 19.8 + 0.23x		
		Y _w = 39.4 + 0.23x		
	Forsythia	Y _U = 39.4 + 0.53x	0.59	
		Y _L = 39.4 + 0.61x		
		Y _w = 25.4 - 0.02x + 0.0013x ²		
	Ninebark	Y _U = 25.4 - 0.31x + 0.0076x ²	0.81	
		Y _L = 25.4 - 0.11x + 0.0042x ²		
		Y _w = 30.3 + 0.18x + 0.00008x ²		
	Rose	Y _U = 30.3 - 0.40x + 0.011x ²	0.82	
		Y _L = 30.3 + 0.35x + 0.002x ²		
		Y _w = 42.9 - 0.30x + 0.0035x ²		
	Deutzia	Y _U = 42.9 - 0.21x + 0.0035x ²	0.70	
		Y _L = 42.9 - 0.24x + 0.0035x ²		
		Y _w = 40.5 + 0.13x + 0.003x ²		
	Weigela	Y _U = 40.5 - 0.26x + 0.011x ²	0.86	
		Y _L = 40.5 + 0.02x + 0.008x ²		
		Y _{wUL} = 52.5 + 0.195x		
Zn	Weigela	Y _{wUL} = 52.5 + 0.195x	0.21	

²Subscripts W, U, and L refer to weathered, unweathered, and leached composts, respectively. Y_{wUL} indicates no significant difference at $P \leq 0.05$ between the regressions for the three sources of compost.

symptoms of specific nutrient toxicity or deficiency in the foliage of most species. However, early season (3 weeks after planting) chlorosis developed in leaves of privet grown in all compost-amended media, regardless of source, and 30% of the plants died subsequently, indicating that the spent mushroom compost was phytotoxic to privet. Slight yellowing of potentilla foliage, which developed during mid- to late season in all compost-amended media, was no longer evident before plants were harvested in October, and appeared to be related to decreased leaf Fe content of compost-grown (62 to 71 mg·kg⁻¹) compared to bark-grown (197 mg·kg⁻¹) plants. As noted in other studies (Chong et al., 1987; Wang et al., 1984a, 1984b), the increased pH with increasing compost levels (Table 2) did not seem to impair adequate uptake of the micro-nutrients, except perhaps for Fe in potentilla (Table 4).

Previous recommendation to flower growers allowed no more than 15% of fresh, (unweathered) spent mushroom compost in the growing medium (Greenhouse Manager, 1985). Rathier (1982) recommended up to 33% decomposed (but not fresh) mushroom compost in media for greenhouse production of chrysanthemums, bedding plants, and tomatoes. Wang et al. (1984b) reported increased growth of various vegetable crops after additions of up to 30% to 50% spent mushroom compost. Smith (1982) recommended only 15% to 20% of spent mushroom compost for use in the nursery-landscape industry. The present study indicates that growth of most deciduous woody plants tested increased or was unchanged in media amended with up to 100% of unweathered, weathered, or leached mushroom compost.

Eames (1977) reported problems with plant stability and excessive shrinkage in spent mushroom compost media amended with peat and pulverized bark but not in compost media amended with peat and sand. In our study, plants remained well-anchored in all compost-amended treatments, regardless of source or level. However, due to increasing shrinkage of all compost-amended media as the proportion of compost increased (Table 2; Chong et al., 1987), media amended with > 67% of mushroom compost may not be desirable from a practical standpoint. The weathered corn-post shrank less than the unweathered or the leached compost and, in this regard, would be more useful.

The fact that roots of weigela, potentilla, and privet responded similarly to all compost sources, including those with high salinity, and that shoot growth of most species increased or was unchanged in all compost media, showed that plant response bore little relationship to initial salt levels or to the physical and chemical characteristics of the compost sources. However, increased salinity at planting, or soon thereafter, may have played a minor role in retardation of growth or adverse reaction in some plants. For example, the curvilinear regressions in weigela indicate reduction of shoot growth with increasing levels of compost, especially the unweathered source (Fig. 1). Reduced root weights were measured for weigela, potentilla, and privet as the levels of compost increased in the media (Fig. 2). Elevated salt levels found only in the 100% weathered compost (5.5 mS/cm) and in the 67% and 100% unweathered compost (6.3 and 8.8 mS/cm, respectively) decreased rapidly within the first 10 days after planting and remained relatively low throughout, the remainder of the season (Table 2). Related investigations under similar experimental conditions at more frequent and progressively increasing intervals (2 to 7 days within 2 weeks after

planting, 1 to 4 weeks thereafter) confirmed this trend in salt levels (C. C., unpublished data). Thus, any injury to roots likely occurred during a relatively short, critical period (days) after planting. Privet, the only species exhibiting reduction in both tops and roots, markedly recovered from early season injury, but the degree of initial damage was such that these plants were unmarketable.

According to Wang et al. (1984b), the factor limiting use of spent mushroom compost as a fertilizer or soil amendment was high salts content under conditions with little or no provision for adequate drainage. Under the conditions of the present study, adaptation of container-grown plants to compost-amended media was likely attributable to rapid elimination of high salinity by the constant and adequate supply of water through trickle irrigation to well-drained media.

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