Composted Yard Waste as a Component of Container Substrates[1]

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Abstract

Rhododendron indicum (L.) Sweet 'Duc du Rohan' and *Pittosporum tobira variegata* Ait. were produced in 10.2 liter (#3) containers in substrates consisting of 20, 40, 60, and 80% (v/v) composted yard waste mixed with pine bark and coarse sand. Plant growth, substrate physical properties, and N and P leachate were compared with a control substrate of pine bark fines:sledge peat:sand (3:1:1 by vol). Shoot growth of plants in compost substrates was similar or better than control plants and greater with daily irrigation compared to alternate day irrigation. Root growth and percent air porosity declined as compost composition and waterholding capacity increased. Total porosity was generally consistent throughout the study. Irrigation regime had no effect on root growth nor substrate physical properties. Ammonium, NO_3-N, and P concentrations in leachates varied with substrate and time following topdressing with controlled release fertilizer. Both species grew best in the 40% compost, 50% pine bark, and 10% sand substrate.

Index words: container production, azalea, pittosporum, potting media, nitrate, ammonium, phosphorus, leachate, substrate properties.

Species used in this study: 'Duc du Rohan' azalea (*Rhododendron indicum* (L.) Sweet 'Duc du Rohan') and variegated pittosporum (*Pittosporum tobira variegata* Ait.).

Significance to the Nursery Industry

Composted yard waste consisting of leaves, grass, and ground tree components produced plants of equal or better quality than the control substrate consisting of pine bark:sledge peat:sand (3:1:1 by vol). Nitrate leaching from substrates composed of up to 40% compost was significantly less than that measured from substrates with higher percentages of compost or the control substrate. Root system development declined as compost percentages increased above 40% due to decreases in air space within the substrate. Minimum air porosity to insure good root development for container substrates in the humid regions appears to be 15%. With daily irrigation, substrates composed of 40% yard waste compost, 50% pine bark, and 10% sand produced marketable plants more rapidly with less nitrogen leachate than the control substrate.

Introduction

Composition of potting substrates for container-grown landscape plants varies widely. Substrates usually consist of a bulking agent, principally pine bark in the Southeastern United States, and a mixture of other organic or inorganic components. Since the mid-1970s, potting substrates have been suggested as an outlet for waste stream compost, such as those generated from biosolids (7), municipal solid waste (14), and wood waste (12). Mandated reductions in waste being landfilled has resulted in yard waste compost being included in the list of potential components for container substrates. Unlike other waste compost, only recently has yard waste compost been produced in commercial quantities, thus, research is limited (1).

The study reported here was initiated to provide information on the use of yard waste compost in container substrates. Objectives considered were: 1) determine optimum proportion of yard waste compost in a container substrate which produced plants of equal or superior quality to those grown in a representative standard substrate; 2) characterize substrate physical properties and relate these to plant growth; and 3) characterize nitrate, ammonium, and phosphorus leaching as a function of substrate composition and safety.

Material and Methods

In March 1993, four container substrates were blended from components of pine bark fines, commercially available yard waste compost (Enviro-Comp, Inc., Jacksonville, FL) and coarse sand. Substrates consisted of 7:2:1, 5:4:1, 3:6:1, and 2:8:0 (pine bark fines:compost:sand, by vol). Sand was not added to the 2:8:0 substrate because sufficient sand was supplied in the compost (Table 1). Compost feedstock was grass clippings, leaves, branches and trunks of principally oak, with some pine and palm trees included. All woody material was ground in a tub grinder then mixed with leaves and grass clippings and windrow composted on sand soils. Windrows were thoroughly mixed periodically. After 9 months, several windrows were combined and screened through a 19 mm (0.75 in) screen. A control substrate consisted of pine bark fine:Florida sledge peat:sand (3:1:1 by vol). All substrates were amended with 0.89 kg m^{-3} (1.5 lb yd^{-3}) micronutrients (Peter's Fritted Trace Minerals, Scotts Co., Marysville, OH). Small (5100 cm^3, 310 in^3) samples of each compost substrate were blended and sampled for initial pH using a 2:1 water:soil extraction method. Based on initial pH values, elemental sulfur (S) was added to compost substrates to lower the pH to near 5.5 using the equation:

$$\textbf{144.5 g sulfur} \times \textbf{0.7 pH unit}^{-1} \textbf{ reduction} \times \textbf{m}^{-3} \textbf{ (0.25 lbs yd}^{-3}\textbf{)}$$

(R. Poole, CFREC—pers. comm.) applied at 75% (D. McConnell, Univ. of Fla., pers. comm.). Actual S applied was 0, 62.3, 147.5, and 170.4 g m^{-3} (0, 1.7, 4.1, and 4.8 oz. yd^{-3}) for the 20, 40, 60, and 80% compost substrates, respectively. The control substrate was a commercial blend and amended with 2.3 kg m^{-3} (4 lb yd^{-3}) dolomite limestone to raise the pH to near 5.5.

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Table 1. **Mineral analysis and physical properties typical of yard waste compost from Enviro-Comp, Inc. Analyses were provided by compost producer for compost of similar age and composition to that used in this study.**

Mineral analysis[z] (ppm)									
N	**P**	**K**	**Ca**	**Mg**	**Fe**	**Mn**	**Zn**	**Cu**	**B**
1	66	529	780	124	1.3	3.6	6.5	0.1	1.3

Physical properties[y]	
Compost pH	7.3
Soluble salts	0.66 mmhos/cm
Bulk density	0.38 g/cc
% Organic by ignition	49% dry weight
% Total sand by weight	36.1%
% Large pore space	42.9%
% Capillary pore space	41.5%
Waterholding capacity at 0.4 kpa	41.5 (by vol)

[z] Analysis by A & L Southern Agricultural Laboratories, Pompano Beach, FL.

[y] Analysis by Agro Services International, Inc., Orange City, FL.

Eighty *Rhododendron indicum* (L.) Sweet. 'Duc du Rohan' (azalea) and 80 *Pittosporum tobira variegata* Ait. (variegated pittosporum) rooted liners were potted into 3.8 liter (#1) containers of each substrate. Each container was topdressed with 14 g (0.5 oz) of 18N–2.6P–10.0K (18–6–12) Osmocote at potting. Plants were topdressed again in August 1993 with 12 g (0.4 oz) 14N–6.1P–11.7K (14–14–14) Osmocote. Forty containers of each species and substrate treatment were irrigated daily (high regime) or on alternating days (low regime) from late March until mid-December 1993. Irrigation frequency was reduced to alternating days and every third day during the winter for the high and low regimes, respectively. Initially irrigation rates were 7 mm (0.28 in) and 14 mm (0.56 in) per irrigation event (high and low regime, respectively), but were gradually increased to 19 (0.75 in) and 38 mm (1.5 in) per event for the high and low regimes, respectively by late April 1994. In January 1994, all plants were transplanted in 10.2 liter (#3) black polypropylene containers using substrates stored for 10 months in galvanized tubs under black polyethylene sheets. Plants were topdressed with 70 g (2.5 oz) of 18N–2.6P–10.0K (18–6–12) Osmocote. Azaleas were pruned to commercial standards. Irrigation returned to daily and alternating day regimes in mid-March 1994. Azaleas were re-topdressed with 70 g (2.5 oz) 14N–6.1P–11.7K (14–14–14) in June 1994.

At initial potting and at 4-month intervals thereafter, five plants from each treatment and species were randomly selected for measurements of canopy height and spread (widest width and width perpendicular). Canopy dimensions were used to estimate canopy volume (growth index = height × width 1 × width 2). Shoots of these plants were severed at the soil line and dried at 65C (149F) until constant dry weight was obtained.

Pittosporum grown in the control substrate under the high irrigation regime obtained marketable size in late May (draft version—Florida Nursery Grades and Standards; Dept. of Agric., Tallahassee, FL). Final growth measurements were recorded on five plants of each substrate and irrigation regime. Azaleas were grown until August 1994 when most canopies had exceeded median marketable size and final measurements were recorded. Final measurements were delayed until August so that roots in the control substrate encompassed the entire substrate volume.

Growth parameters were analyzed separately for each species and harvest by analysis of variance using a split-plot design, with irrigation regime as the main plot and substrate as the subplot with five blocks of single plant replicates. Where appropriate, means were separated using Fisher's Protected LSD (15).

At potting and bimonthly thereafter, nitrate (NO_3-N), ammonium (NH_4-N), and phosphorus (P) concentrations in leachates were measured from the same 3 plants in each irrigation and substrate treatment. Leachates were collected using the VPI Pour-through Method. After irrigation, distilled water was applied to substrate surfaces to collect 25 to 300 ml (0.9 to 10.6 oz) of leachate. This was filtered and nutrient concentrations of NH_4-N and NO_3-N determined by the University of Florida Soil Analysis Laboratory using an automated spectrophotometer, with P concentrations determined by Inductively Coupled Plasma Spectroscopy. Concentrations were normalized to 100 ml (3.5 oz) of leachate. Areas under leachate curves for each plant were integrated to estimate quantities of a nutrient leached. Areas were divided to encompass periods between fertilizations and the total area under the curve summed to estimate total nutrient leaching. Integrated areas were subjected to the same analysis of variance as the growth parameters except 3 blocks of single plant replicates were used.

At potting, extra 3.8 liter (#1) and 10.2 liter (#3) containers were filled with each substrate and placed under the irrigation regimes. These containers were treated identically to containers with plants. Shrinkage, the decrease in substrate depth, was measured in three 10.2 liter (#3) containers of each irrigation and substrate treatment about every 4 months. Substrates in the 3.8 liter (#1) containers were used to measure physical changes in substrate properties.

Substrate physical properties were measured using the Australian Standard Method (16). Substrate within a container was homogenized and used to fill three 76 mm (3 in) diameter by 150 mm (6 in) tall polyvinyl chloride cylinders capped on one end. Five holes were drilled in the caps for drainage. Filled cylinders were allowed to soak vertically in water for 3 h, then drained and re-soaked for 30 min three more times. Cylinders were then carefully removed with fingers covering drainage holes and placed in a saucer. Volumes draining from cylinders after 15 min were recorded. Drained weight of a substrate was recorded as was weight after drying at 70C (158F) for 48 hr. Bulk density (g cc^{-3}) was measured by weighing a known volume of the homogenized oven-dried substrate. Physical properties of air porosity, total porosity, and waterholding capacity (based on oven dried weight) of each substrate were calculated. Physical properties were measured in conjunction with field shrinkage. Linear regression equations were calculated for each irrigation and substrate combination for each physical property. Slopes of the regression lines were compared using single-degree-of-contrast (15). When irrigation was not significant, data was combined within substrates and regression analysis repeated. Initial and final measurements of each physical property were analyzed by analysis of variance as a split plot; with irrigation as the main plot and substrates as the subplot.

Results and Discussion

Shoot growth of 'Duc du Rohan' azaleas. Prior to 36 weeks after potting (WAP), there were no differences in shoot dry mass among irrigation regimes or substrate treatments. Interactions of irrigation regime and substrate for shoot dry mass were not significant ($\alpha = 0.05$) at either 36 or 75 WAP. By 36 WAP plants irrigated with the high regime had greater shoot dry mass than those under the low regime, and remained larger through to final harvest at 75 WAP (Fig. 1a). Interactions of irrigation regime and substrate composition for shoot dry mass were only significant ($\alpha = 0.05$) at 53 WAP (data not shown). Significantly higher shoot dry masses were obtained with 20 and 40% compost substrates under the high irrigation regime compared to other irrigation and substrate combinations. High irrigation also resulted in larger plant canopies (growth index, GI) than low irrigation by 18 WAP and thereafter (Fig. 1b).

Azaleas grown in 20% compost substrate had more shoot dry mass than those grown in the control substrate at 36 WAP (Fig 2a). By 75 WAP plants grown in 20 or 40% compost substrates were more massive than the control plants (Fig. 2a). Substrate effects were not significant at 18 or 53 WAP.

Growth indices were significantly different ($\alpha = 0.05$) among substrate treatments only at 36 WAP, when plants in 20% compost substrates were larger than all other plants (data not shown). Interactions of irrigation and substrate composition were significant ($\alpha = 0.05$) only at the final harvest (75 WAP; Fig 2b). At that time, the largest plants had been grown under high irrigation in the 40% compost substrate. Under low irrigation, no significant differences in GI occurred among substrates treatments (Fig. 2b). Growth indices of plants in the control substrate were similar between irrigation regimes.

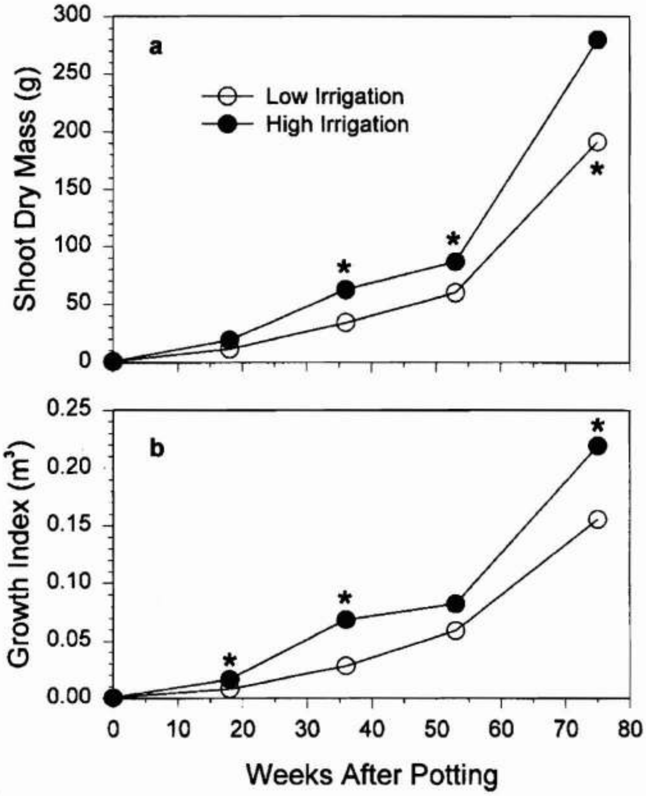

Fig. 1. **Mean shoot dry mass (a) and growth indices (b) for azaleas with substrate treatments combined within high (daily) and low (alternate day) irrigation regimes. Means are representative of 25 single plant replicates. An * indicates significant ($\alpha = 0.05$) differences between means within each date.**

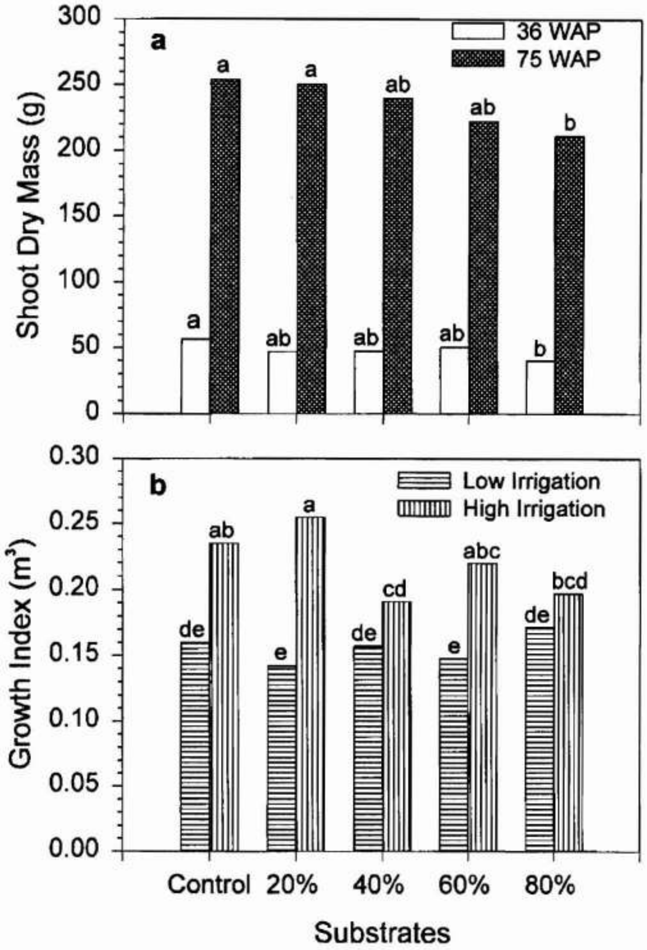

Fig. 2. **Mean shoot dry masses (a) of substrate treatments of azaleas at 36 and 75 weeks after potting (WAP). Data from irrigation regimes were combined within each substrate, with means representative of 10 single plant replicates. Interaction of irrigation regime and substrate treatment for growth indices (b) of azaleas at 75 WAP. Each mean is representative of 5 single plant replicates. Means with the same letters are not significantly different ($\alpha = 0.05$) as separated by Fisher's Protected LSD.**

Shoot growth of variegated pittosporum. Significant differences ($\alpha = 0.05$) in shoot mass and GI were measured only at 36 and 53 WAP, when high irrigation resulted in larger plants than low irrigation (Table 2). There were no significant ($\alpha = 0.05$) differences among irrigation regimes at final harvest (61 WAP). Substrate composition generally affected neither shoot dry mass nor growth index within a harvest. Interactions between irrigation regime and substrate composition were significant ($\alpha = 0.05$) only at 53 WAP for GI, where the largest plants were growing in 20 or 40% compost substrates under high irrigation (data not shown). Growth indices of all other irrigation and substrate combinations were similar.

Table 2. Shoot dry mass and growth indices (GI) of harvested pittosporum with substrate treatments combined within an irrigation regime. Low irrigation was generally an alternate day frequency while high irrigation was generally a daily frequency.

Weeks after potting	Shoot dry mass (g) Low	Shoot dry mass (g) High	Significance[z]
0	4.68[y]	4.68	NS
18	15.32	17.89	NS
36	33.08	54.69	*
53	82.77	110.17	***
61	192.30	239.20	NS
	Growth index (m^3)[x]		
0	0.0013	0.0013	NS
18	0.0089	0.0104	NS
36	0.0271	0.0445	*
53	0.0824	0.1179	**
61	0.1351	0.1871	NS

[z]NS, *, **, *** indicate no significance and significant differences at the 5, 1, and 0.1% levels, respectively.

[y]Means are representative of 15 single plant replicates.

[x]Calculated as widest width x width perpendicular to widest width x height.

Nitrogen leachate. Concentrations of ammonium (NH$_4$-N) and nitrate (NO$_3$-N) in leachates were not significantly different (α = 0.05) between irrigation regimes, thus data from irrigation regimes were combined. Mean NH$_4$-N concentrations ranged from 0 to 115 mg liter^{-1} for azaleas and 0 to 50 mg liter^{-1} for pittosporum while mean NO$_3$-N concentrations ranged from near 0 to 1150 mg liter^{-1} for both species. Concentrations on NH$_4$-N measured from 3.8 liter (#1) containers of either species were generally about one-half that measured by Ingram and Yeager (10), although fertilizer and growing conditions were similar. Concentrations of both NO$_3$-N and NH$_4$-N peaked about 2 to 5 weeks after fertilization with Osmocote 14N–6.1P–11.7K (14–14–14) and after about 5 to 8 weeks with Osmocote 18N–2.6P–10.0K (18–6–12) for both species (Fig. 3).

Prior to transplanting into 10.2 liter (#3) containers at 43 WAP, NO$_3$-N in leachates were less than 200 mg liter^{-1}, but increased up to 9-fold after upgrading when fertilizer application was increased 5-fold (Fig. 3b). Ammonium leachate concentrations were also elevated in both species after upgrading (Fig 3a). NO$_3$-N concentrations leached from 3.8 liter (#1) containers tended to be at or below the 100 mg N liter^{-1} suggested as optimum for most woody species (11,

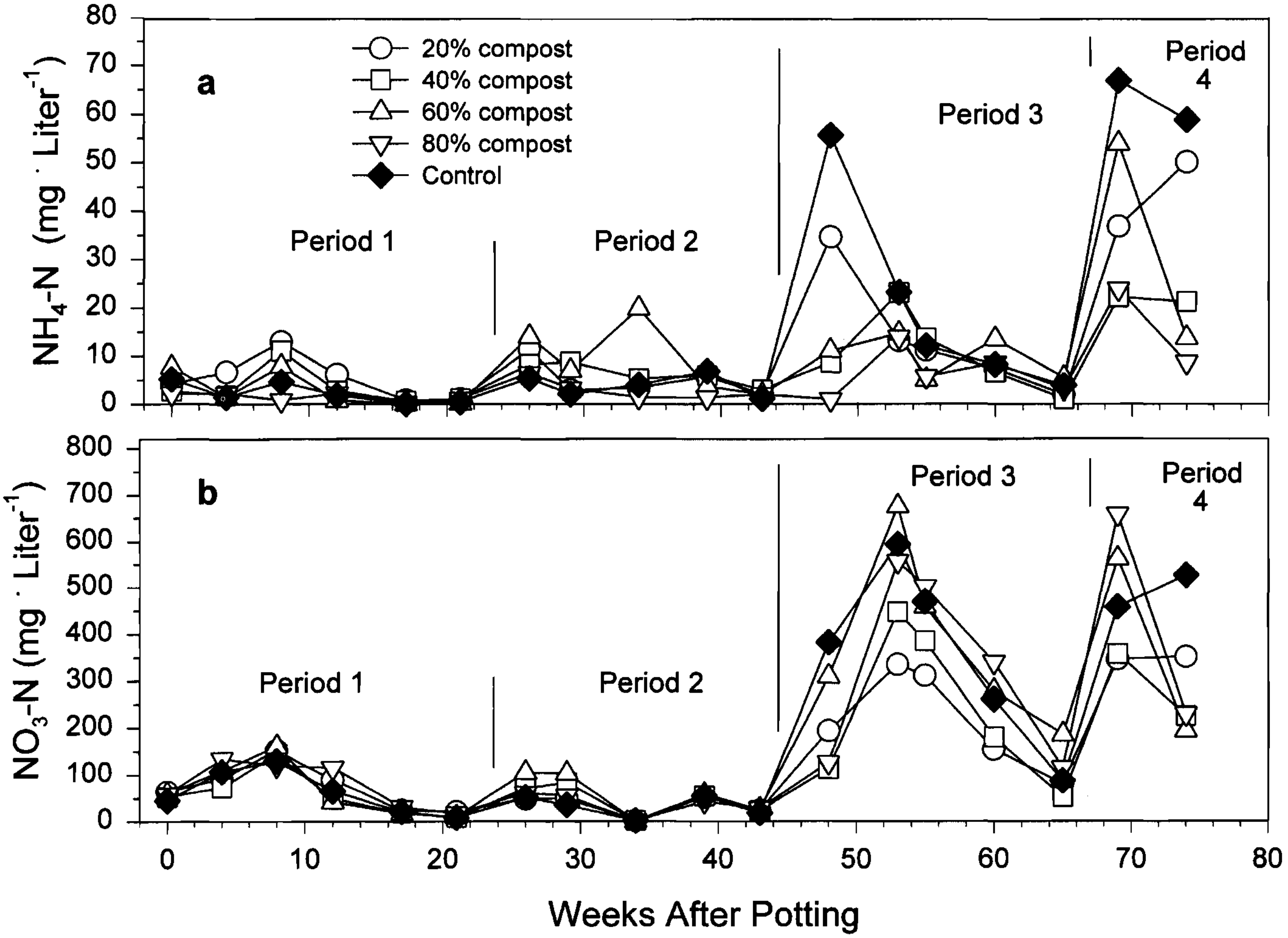

Fig. 3. Mean ammonium (NH$_4$-N) (a) and nitrate (NO$_3$-N) (b) concentrations measured in leachates recovered from azaleas. Substrate treatments consisted of 20%, 40%, 60%, and 80% composted yard waste by volume with the reminder being pine bark and sand. The control substrate consisted of pine bark, sledge peat and sand (3:1:1 by vol). Means are based on 6 replications with concentrations measured from the high and low irrigations combined. Periods relate to the time between fertilizations.

Table 3. **Integrated ammonium (NH_4-N) and nitrate (NO_3-N) leachate concentrations calculated for each substrate for azalea. Data from irrigation regimes were combined within each substrate. Only integration periods were differences were significant are included.**

	Substrate treatment[z]				
	20%	**40%**	**60%**	**80%**	**Control**
NH_4-N					
Period 1[y]	824a[x]	510b	383bc	201c	296bc
NO_3-N					
Period 4	22,018b	19,736b	31,329a	33,816a	30,558a
Total integration	64,133b	63,287b	93,612a	88,657a	89,010a

[z] Percentage of a substrate consisting of yard waste compost with the remainder being pine bark and sand. The control substrate consisted of pine bark, sledge peat and sand (3:1:1 by vol).

[y] Time between fertilizer applications. Total consisted of the time between initial potting and final measurement.

[x] mg liter^{-1} period^{-1}. Means within rows with the same letter are not significantly different ($\alpha = 0.05$) as determined using Fisher's Protected LSD. Each mean is representation of 6 plant replicates.

13, 19), but similar to that reported for Osmocote 18N–2.6P–10.0K (18–6–12) in 3.8 liter (#1) containers (10). High NO_3-N and NH_4-N leachate concentrations after transplanting are likely due to limited root growth into a substrate immediately thereafter and random placement of fertilizer. Fertilizer rates were based on manufacture recommendations and in agreement with recommendations for woody plants produced outdoors (6, 18).

Irrigation regime had no effect on cumulative NH_4-N leachate concentrations calculated over any integration period for either species. Substrate composition had no significant ($\alpha = 0.05$) effect on total integrated NH_4-N leachate concentrations for either species and no effect over any integrated period for pittosporum. However, total integrated NH_4-N concentrations tended to be highest from control substrates and lowest from 40 and 80% compost substrates in both species (data not shown). During the first period after potting, integrated NH_4-N concentrations in leachates of azaleas were significantly ($\alpha = 0.05$) higher from 20% compost substrate than from other substrates (Table 3); thereafter concentrations were similar (data not shown).

Integrated NO_3-N concentrations leached from pittosporum containers were not significantly ($\alpha = 0.05$) affected by irrigation regime or substrate composition. However, for azaleas, low irrigation resulted in significantly higher integrated NO_3-N concentrations during the first and fourth periods (12,138 and 33,433 mg NO_3-N liter^{-1} period^{-1}, respectively), than those calculated from the high regime (8,950 and 21,549 mg NO_3-N liter^{-1} period^{-1}, respectively). Among substrates, significant differences in integrated NO_3-N concentrations leached from azaleas occurred during the last (fourth) fertilizer period and when compared over the entire production period (Total; Table 3). For both, higher concentrations were calculated from 60 and 80% compost and control substrates than substrates composed of 40% compost or less (Table 3). Total integrated NO_3-N leachate concentrations from substrates of 20% or 40% compost were 72% or less of those found in other substrates. For pittosporum, a similar trend for lower total integrated concentrations in 20 and 40% compost substrates was observed.

Phosphorus (P) leachate. Neither irrigation frequency nor substrate composition influenced P leachate concentrations over the production period for either species. Mean P concentrations ranged from near 0 to 40 mg liter^{-1} through the first 60 weeks of production for both species, reaching highs of 90 mg liter^{-1} near the end of production for azaleas (data not shown). Phosphorus concentrations were above the 10 mg P liter^{-1} suggested as the minimum optimum level for woody plants (19, 20) and similar to that found by Ingram and Yeager (10).

Differences in integrated P leachate concentrations among substrates occurred only during the first period for both species. For pittosporum, P concentrations were significantly ($\alpha = 0.05$) higher from 80 and 60% compost substrates than the rest, with those from the control being significantly the lowest (data not shown). For azaleas, leachates from substrates with compost had similar integrated P concentrations and were significantly ($\alpha = 0.05$) higher than those from the control substrate. Thirty percent more P was calculated to have been leached from containers of azaleas the first period under high irrigation compared to low irrigation (data not shown). Differences in other integration periods between irrigation regimes for either species were not significant ($\alpha = 0.05$).

Substrate physical properties. Irrigation regime had no effect on the substrate physical properties measured. Thus, irrigation regime data were combined within substrates with significant differences ($\alpha = 0.05$) among substrates observed.

Substrate shrinkage. Shrinkage of the control substrate was small and not significant ($\alpha = 0.05$; Fig. 4). Shrinkage of 20% compost substrates was statistically significant ($y = -0.14 - 0.011 \times WAP$; $r^2 = 0.452$); yet minimum and of little commercial importance. Substrates with 40% ($y = -0.085 - 0.031 \times WAP$; $r^2 = 0.578$) or more compost had comparable rates of shrinkage, about 3 times greater than that of 20% compost. Yet, over the 75-week production period, decreases in depth of substrates with 40% or more compost was about 25 mm (1 in) or 12% of a 10.2 liter (#3) container.

Bulk density. Bulk densities of control and 60% compost substrates were highest at 0.62 g/cc while 20% compost substrate was lightest at 0.48 g/cc. Bulk densities of the other two compost substrates (0.50 and 0.54 g/cc) were in between. Bulk density of the control substrate was much higher than the 0.388 g/cc reported for the same substrate by Fonteno et al. (5) and perhaps due to use of newly composted pine bark.

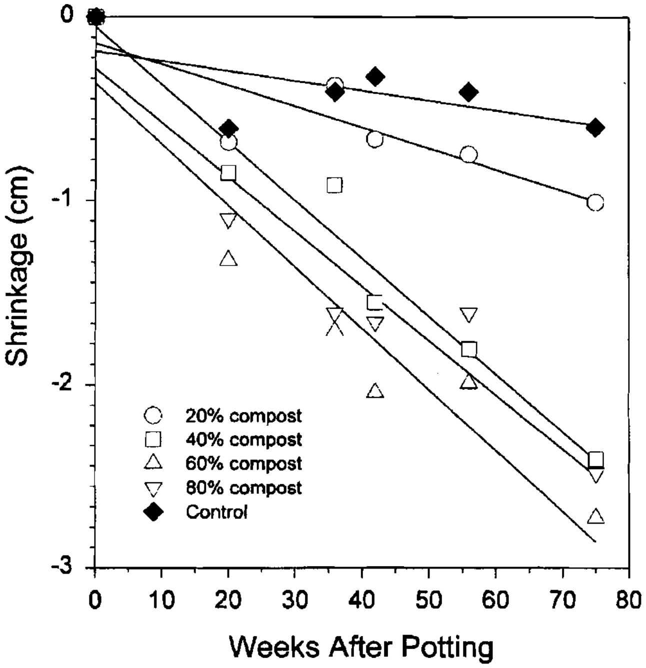

Fig. 4. Mean shrinkage of substrates over the 75 week production period. Substrate treatments consisted of 20%, 40%, 60%, and 80% composted yard waste by volume with the reminder being pine bark and sand. The control substrate consisted of pine bark, sledge peat and sand (3:1:1 by vol). Means are representative of 6 single pot replications with high and low irrigation regimes combined.

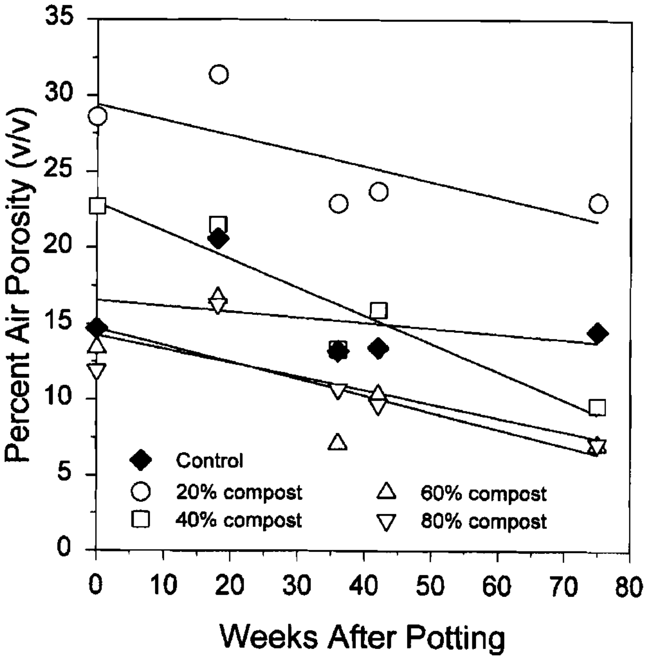

Fig. 5. Mean percent air porosity (%Air) of combined irrigation regimes. Substrate treatments consisted of 20%, 40%, 60%, and 80% composted yard waste by volume with the reminder being pine bark and sand. The control substrate consisted of pine bark, sledge peat and sand (3:1:1 by vol). Means are representative of 6 replications.

Air porosity. Percent air porosity (%Air) is the percent by volume of air-filled macropores in a saturated substrate. Initially, 20% compost substrates had the highest %Air (28.6%) with that of 40% compost substrates also acceptable at 22.7% (Fig 5). The %Air of other substrates were statistically similar, ranging from 14.8% for the control substrate to 11.9% for 80% compost substrates. The %Air of the control was half that reported for this substrate by Fonteno et al. (5) and may be partially due to differences in technique. Initial %Air for 60 and 80% compost substrates were marginal for sufficient aeration (8, 9), but below the ideal range proposed by DeBoodt and Verdonck (4).

Air porosity generally declined after potting for all substrates except the control (Fig. 5). Air porosities after 75 weeks were 14.5% for the control substrate and 22.4, 9.9, 6.5, and 7.3% (20, 40, 60, and 80% compost substrates, respectively). Air porosities less than 10% are considered unacceptable for greenhouse substrates (3). Minimum acceptable %Air should be higher in outdoor production since container moisture levels are more difficult to control.

Waterholding capacity. Percent waterholding capacity (%WHC) is the percentage by volume of micropores that remain filled with water after a saturated substrate has drained. Initial %WHC was lowest for 20% compost substrates (33.4%) and increased with increasing rates of compost, with 80% compost (53.8%) and the control (52.4%) substrates being similar (Fig 6). The %WHC of the control substrate did not change after potting and was consistent with reported values (5). For compost substrates, %WHC

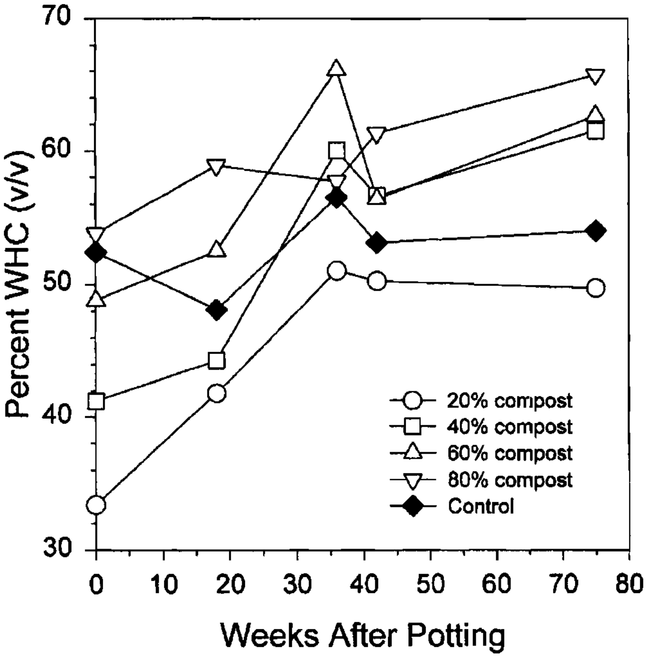

Fig. 6. Mean percent waterholding capacity (%WHC) of combined irrigation regimes. Substrate treatments consisted of 20%, 40%, 60%, and 80% composted yard waste by volume with the reminder being pine bark and sand. The control substrate consisted of pine bark, sledge peat and sand (3:1:1 by vol). Means are representative of 6 replications.

increased with time (Fig. 6). The slowest increase in %WHC occurred with 80% compost substrates (%WHC = 55.0 + 0.14 × WAP; $r^2 = 0.510$). Rates of increase for other compost substrates were significantly higher and similar among substrates composed of 60% compost (%WHC = 51.5 + 0.18 × WAP; $r^2 = 0.604$) or less. After 75 weeks, %WHC was near or above 50% for all substrates, with highest %WHC in 60% (64.1%) and 80% (65.7%) compost substrates. All final values for %WHC were near the ideal range of 55 to 65% suggested by DeBoodt and Verdonck (4).

Total porosity. Percent total porosity (%TP) is the sum of air-filled macropores and water-filled micropores in a saturated substrate. Initial %TP ranged from 62% for 20% compost substrates to 67% for the control substrate (data not shown). Final %TP values 75 WAP were 74.4, 71.8, 70.6, 72.9, and 68.5% for 20, 40, 60, and 80% compost and the control substrates, respectively. The %TP of the control substrate was lower than reported by Fonteno et al. (5), but is the result of a higher bulk density (8).

Larger plant growth under the high irrigation regime agrees with similar reports of growth increases with daily versus alternate day irrigation (17). Azalea canopy growth indices are very sensitive to mild water stress (2). This effect of this sensitivity was magnified by alternate day compared to daily irrigation.

Under low irrigation in full sun, compost substrates did not increase canopy growth compared to the control. Yet, with high irrigation frequencies, azaleas grown in 20 or 40% compost substrates were larger than control plants. This suggests water conservation benefits were not obtained by incorporating yard waste compost, but conflicts with the wide range of initial %WHC measured. Differences in air porosities and observed differences in root system development may explain this conflict. At transplanting to 10.2 liter (#3) containers and final harvest, root ball development generally declined as percentage of compost increased. Substrates containing 40% compost or less produced a full root ball at upgrading and final harvest. Root balls of both species grown in 60 and 80% compost, however, were less developed. High air porosities would have promoted rapid root growth, especially when water was not limited, such as under high irrigation. More rapid root growth would explain lower overall N concentrations in leachates from 40% or less compost substrates. Lower leachate concentrations suggest more efficient use of N and may lower risk of water contamination. Rapid root growth would also have supported more extensive canopy growth during the production period. Less N in the leachate was associated with larger plant canopies.

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