Use of Composts in Nursery Potting Substrates

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Cultural practices in container nurseries in the Southeastern United States have evolved to frequent irrigation, porous substrates, and slow-release fertilizers. This combination results in rapid plant growth with few problems. However, water quality, solid waste, and fire ants may soon bring changes in irrigation and potting-substrate practices. Substrates such as pine bark and sand have low anion and cation exchange capacities, and nutrients available for plant absorption are primarily held in solution between particles. Overhead irrigation pushes water and nutrients in solution out of the pot; therefore, irrigation can affect water quality in the environment.

Solid waste management of urban yard wastes and agricultural animal wastes have become environmental concerns in the United States, and composted wastes are being targeted for use in the nursery industry as potting components. The usefulness of these composts to the nursery industry needs to be evaluated.

Most recently the amount of Talstar required for fire ant suppression is based on the weight of the substrate. Southeastern growers who must use Talstar may use less sand in order to reduce bulk density, which determines the weight of the substrate. Water quality control and solid waste management may also create widespread changes in potting substrate in the Southeastern United States.

Table 1. Percent solids, drainage and bulk density of pine bark and pine bark : sand substrates.

Substrates	Solids[x] (%vol)	Drainage[y] (ml)	Bulk density[z] (g/cc)
PB[w]	16.22	70.4 a	0.19 c
9PB:1S	24.84	39.2 b	0.38 b
5PB:1S	33.77	12.2 c	0.69 a

[x] Solids = The total % volume of solids in each medium.
[y] Drainage = Amount (ml) water drained from each cylinder after saturation.
[z] Grams per cubic centimeter after drying samples in a forced-air drying oven at 110°C for 24 hours.
[w] PB = pine bark, S = sand.

The addition of sand (S) to pine bark (PB) adds weight which, growers appreciate because larger plants blow over less when potted in a heavier potting substrate (Table 1). Sand also fills in between bark particles which reduces total pore space, but mostly affects the air space of potting substrates (Table 2). However, unsaturated (lateral) flow and infiltration rate are not often measured in potting substrates. Sand drastically affects these physical properties. For example in Table 1, drainage values for three substrates are shown. As the volume of sand is increased from 0% to 10% and 17% by volume, drainage values 15 min after saturation decreased nearly two and six times. In a nursery, decreased or slower drainage would allow irrigation water to wet the substrate rather than channel rapidly through the container. Vertical water movement is fast but horizontal movement is slow in 100% pine bark. The addition of sand slows capillary water movement downward and, therefore, increases water movement across the container. If nurserymen reduce the amount of sand to reduce weight, then either irrigation practices need to be adjusted or other components added to enhance lateral water flow in pine bark. Ultimately, these new components will substitute water retention for the weight of the sand. The number of possible available components is almost unlimited. However, many are unstable, inconsistent, and hard to reproduce. Often supplies are limited, shipping and handling costs are high. Other than peat moss, which is familiar to most nurserymen, potential components need to be locally available to reduce shipping costs.

Table 2. Physical properties of substrates.

Media[x]	TP[w]	AS[v] (% Volume)	CC[u]	UAW[t]	AWC[s]	BD[r]
PB	83.70 c[z]	18.45 a	65.22 ab	31.92 b	33.30 c	0.19 c
PB+CYW (90 : 10)	81.42 c	20.60 a	60.82 c	30.18 c	30.64 c	0.23 bc
PB+TBL (90 : 10)	85.28 ab	18.24 a	67.04 a	33.97 a	33.07 c	0.20 c
PB+RW+CYW (70 : 20 : 10)	84.78 bc	16.98 a	67.80 a	27.35 d	40.45 a	0.24 b
PB+RW+TBL (70 : 20 : 10)	86.08 a	18.07 a	68.00 a	28.42 d	39.58 b	0.22 bc
PB+S (80 : 20)	76.62 d	10.94 b	65.68 b	24.58 e	41.10 a	0.45 a

[z] Mean separation in columns by Waller-Duncan k-ratio t-test (k-ratio=100), P=0.05. Analyses performed using aluminum soil-sampling cylinders (7.6 cm i.d., 7.6 cm h).
[x] PB = pine bark, CYW = composted yard waste, TBL = turkey broiler litter, RW = granulated rockwool, S = sand.
[w] Total porosity is equal to container capacity + air space.
[v] Air space equals water drained from the sample divided by volume of the sample.
[u] Container capacity was (wet weight-dry weight) divided by volume.
[t] Percent volume at 1.5 MPa.
[s] Calculated as the difference between container capacity and unavailable water.
[r] Grams per cubic centimeter after drying samples in a forced-air drying oven at 110°C for 24 h.

EPA has mandated solid waste reduction in landfills. As a result composts made up of a broad group of components will be available in most communities of the

United States. This paper will review results of studies conducted with turkey broiler litter (TBL) and yard-waste composts (CYW) as components in container potting substrates.

Bilderback and Warren (1992) reported increased bulk density, total porosity, and air space with incremental addition of a two-year-old TBL compost to pine bark. A 15% by volume compost amendment increased available water capacity, but additional TBL compost decreased the available water held in the substrate. Electrical conductivity (soluble salts), nutrient leachate concentration, and foliar nutrient content increased with incremental TBL compost addition. *Cotoneaster dammeri* 'Skogholm' top dry weight and root dry weight increased with 15% and 30% volume additions of compost but decreased with higher rates. 'Sunglow' azalea top dry weight decreased with incremental compost addition. However, data indicated that 15% by volume addition of TBL compost to pine bark resulted in physical and chemical properties that produced the best growth of cotoneaster.

Granulated horticultural rockwool (RW) appears to have properties that can increase air space when added to coarse pine bark substrates amended with composts (Bilderback and Fonteno, 1990).

TBL compost was added at 15%, 25%, and 33% by volume to pine bark or pine bark and horticultural rockwool substrates. The results of the study indicated that TBL compost blended with pine bark maintained higher phosphate and other nutrient levels during the growing season in substrates and plant tissue than pine bark alone, while rockwool increased air space when compost was used. Use of both components with pine bark produced growth equal to the pine bark control substrate for *Cotoneaster dammeri* 'Skogholm' and suggested that these materials could be beneficial in commercial nursery potting substrates.

However, negative effects of TBL included reduced air space and available water and excessive initial soluble salts. Further studies are needed to establish component ratios that will help solve these problems.

Work with a third source of TBL compost incorporated at 10% by volume produced physical and chemical properties similar to pine bark except that total porosity (TP) was increased and unavailable water content (UAW) was highest of the five substrates compared (Table 2). The addition of CYW 10% by volume to pine bark changed only container capacity (CC), which was least in the pine bark : CYW substrate. An 8 pine bark : 2 sand (v/v) substrate had the lowest total porosity, air space, and lowest unavailable water content and highest available water capacity (AWC) of the substrates compared. Addition of horticultural rockwool decreased unavailable water content in three-component substrates compared to two-component or pine bark alone. Of the physical properties tested, the three-component substrates appeared to have the most consistent favorable physical properties.

Electrical conductivity (soluble salts) and all nutrient leachate levels were measured by VTEM water-extraction procedure (Wright, 1986). All nutrient capacity factors were high on day 1 after potting in substrates containing TBL compost (data not presented). The PB : RW : TBL medium had an EC value of 4.5 dS•m-1 which was higher than all other treatments. High EC levels were apparently due to high leachate concentrations of NH_4-N, P, and K. Electrical conductivity was not significantly different on any other sampling dates. Leachate pH initially ranged from 4.9 to 6.1. During the study pH increased and all substrates ranged from 5.2 to 5.8.

Leachate phosphorus (P) level in substrates containing TBL compost were very high initially, generally 3 to 4 times greater than other substrates; however, the TBL substrates also maintained leachate P within suggested solution levels (Wright, 1986) through Day 42 (Table 3). Substrates without TBL were well below suggested levels by Day 42.

Table 3. Container leachate phosphate levels from 6 substrates on 5 sampling dates[z].

Substrate[y]	Sampling dates (days after potting)				
	1	22	42	63	84
Suggested leachate levels =10-15 mg/l	Phosphate leachate concentration (mg/l)				
PB	86.0 b[x]	11.8 c	2.3 c	0.7 c	1.2 c
PB+CYW (90 : 10)	66.3 b	7.5 c	1.9 c	0.97 c	1.5 c
PB+TBL (90 : 10)	330.3 a	78.5 a	16.8 a	8.9 a	8.9 a
PB+RW+CYW (70 : 20 : 10)	41.8 b	7.1 c	2.2 c	0.8 c	1.2 c
PB+RW+TBL (70 : 20 : 10)	376.5 a	43.1 b	9.3 b	2.2 bc	2.6 bc
PB+S	84.8 b	4.6 c	1.6 c	0.7 c	1.1 c

[z] Each value represents the mean of 6 containers.
[y] See Table 2 for abbreviations.
[x] See Table 2 for statistical methods.

TBL substrates had higher potassium (K) levels initially than other substrates with the PB : RW : TBL having 834 mg/l K while PB : TBL was 543 mg/l. However, all the substrates had relatively high K leachate concentrations with 201 mg/l K in the PB leachate. Leachate Ca levels were above 10 mg/l Ca throughout the growing season. Magnesium leachate values remained between 10 to 30 mg/l in VTEM leachate solution. After the first sampling date the PB : CYW substrates tended to be low in Mg.

Leachate Fe was similar for all treatments. A Zn : Fe interaction due to high Zn levels is sometimes a concern when composts are used in potting substrates. No problems were apparent in leachate or foliar data. Cadmium, lead, and nickel leachate levels were undetectable in all treatments of either species.

The greatest top dry weight of 'Skogholm' cotoneaster was greatest in the 7 PB : 2 RW : 1 TBL (by volume) substrate but this treatment was not significantly different from the 9 PB : 1 TBL (v/v) substrate (Table 4). The least growth occurred in the PB : S substrate. Root dry weights (not shown) were not significant among substrate treatments.

Cotoneaster tissue levels were from samples collected at the end the growing season. Most guidelines for foliar tissue nutrient levels are expressed as mid-season optimal levels as given in Table 4 (Jones, 1991). Substrates containing TBL had foliar P level that would have been considered deficient by the guidelines.

Table 4. Effect of substrates on *Cotoneaster dammeri* 'Skogholm' foliar nutrient levels and top dry weight[z].

Container substrate[y]	N	Percents foliar tissue dry weight P	K	Ca	Mg	Top dry weight
PB	2.1 a[x]	0.06 c	1.03 a	1.04 c	0.45 ab	65.7 cd
PB+CYW (90 : 10)	2.1 a	0.08 bc	1.06 a	1.23 c	0.30 c	64.4 cd
PB+TBL (90 : 10)	1.5 b	0.15 a	0.99 a	1.70 a	0.34 c	90.5 ab
PB+RW+CYW (70 : 20 : 10)	1.6 b	0.10 b	0.87 b	1.55 ab	0.48 a	84.4 bc
PB+S (80 : 20)	2.3 a	0.06 c	0.98 a	1.08 c	0.48 a	50.6 d
Acceptable levels (Mid-season)	2.8	0.34	1.1	1.1	0.27	(g)

[z] Each value represents the mean of six plants.
[y] See Table 2 for abbreviations.
[x] See Table 2 for statistical methods.

Tissue nitrogen levels tended to be lowest in substrates containing TBL, which corresponds with leachate data that indicated greater solubility earlier in the year. Potassium and Ca foliar levels were generally within acceptable ranges. Although Mg solution levels in the PB : CYW and PB : TBL treatments were low throughout much of the study, the plants still had adequate Mg absorption. The foliar Ca data indicated the addition of the CYW and TBL yielded approximately equivalent foliar values as the dolomitic lime addition in non-compost treatments. Foliar tissue levels for Zn and Mn were not excessive and were not antagonistic with Fe in any treatment. Cadmium, lead, and nickel levels were below detectable limits for all treatments.

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