# Evaluation of Various Industrial, Construction, and Municipal Wastes as Pine Bark Amendments in Container Nursery Plant Production

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**Nature of Work**: Pressures to properly dispose of wastes is increasing in all areas of society. Application of these wastes to land as fertilizers is technically feasible, but transportation increases costs 2 to 3 fold, limiting economic feasibility. Currently, poultry manure cost about $8/ton at the source, yet transportation costs may add $17-22 to each ton making it uneconomical for most nurseries as a fertilizer. Development of new technologies and value-added products from wastes could potentially reduce environmental concerns while generating economic returns.

Composting and combining various waste residues provides an opportunity for development of useful products in the multi-billion dollar horticultural and floriculture industries as substrates, top-soils, mulches, fertilizers, soil conditioners, and biofilters. Research is needed to determine suitable/optimal combinations of poultry wastes and processing residues, industrial and forestry byproducts, residential trimmer trash, and biosolids from sewage effluent for use as substrate components. Interest in the use of various composted waste materials for container substrates has increased over the last 20 years as a way to utilize and recycle material that would otherwise be disposed of in landfills. Lawn clippings, leaves, vegetable refuse, etc. represent approximately 150 million tons of municipal solid wastes (MSW) produced in the U.S. annually. Nationally, about 70 % of the daily waste total is organic matter. In excess of 75% of MSW in the U.S. consists of recyclable materials, about 40% of which is paper and paper products much of which could be extracted from the MSW and composted for nursery substrates.

Peat moss and softwood bark have provided the primary components for most greenhouse and nursery substrates over the last 30 years. However, availability of softwood bark of consistent quality is often a problem due to the variety of methods used to harvest, process, and store bark. In addition, potential movement of the lumber and paper industries to other countries or the practice of burning bark for energy will likely limit future bark supplies. Many studies have investigated the use of various wastes as substitutes for bark and peat moss including animal wastes, cotton gin waste, wood by-products, municipal leaf and sewage sludge and rice hulls. While suitable for plant growth, regional availability and a limited supply of uniform and consistent quality product reduces widespread use of most alternative substrate components. For successful container nursery crop production, growers require substrates that are readily available, easy to mix and handle, economical, and have consistent and appropriate physical and chemical properties. Therefore, there continues to be a need to identify readily available, low-cost and renewable substrate components with consistent quality.

Research with composted MSW (MSWC) was conducted in multiple locations with a wide range of nursery crops in 2003 and 2004 (see Table 1 for blend ratios and other details). Studies at

Auburn University and CANR evaluated 5 MSWC and PB blends in 6 species (Table 1). No attempt was made to standardize the species, irrigation, fertilizer, or other cultural practices. Plant growth measurements were determined by a growth index (GI) ((height + width at widest point + width perpendicular to width at widest point)/3) measured initially through the end of the growing season. Leachates were collected by the Virginia Tech Extraction Method for analysis. Results from one additional field trial at Greene Hill Nursery in Waverly, Ala. are also presented in Table 1.

The objective of the 2005 research was to evaluate processed municipal solid waste in both composted (MSWC) and non-composted (MSW) stages as an amendment to composted pine bark for use as a growing substrate in container plant production (Tables 2-3). All processed MSW (referred to as "Fluff") was obtained from the WastAway Sciences Co., in McMinnville, TN. The MSW studies presented here were conducted at CANR. Five treatments using 96 plants of four species were separated into four replications for the study and grown outdoors under standard overhead irrigation. Species evaluated and data collected in the MSW studies for 2005 appear in Tables 2 and 3.

Additional studies in Auburn, Alabama evaluated potential substrate components of composted poultry litter (Ala. Agric. Expt. Stat., Crossville, AL), or municipal biosolid saturated newsprint crumbles (Tascon Inc., Houston, TX) blended with either ground pine chips or composted pine bark. The pine chips were originally generated for use as fuel or for paper pulp production but were ground in a hammer mill to pass a 3/8 inch screen for this study. Ten plants per treatment for each of three species were grown in trade gallon containers in a standard double-poly greenhouse and irrigated with overhead irrigation at 0.3 inches per day. Each substrate blend was pre-plant incorporated with 23 lbs/yd$^3$ 13-13-13 Polyon control release fertilizer; 5 lbs/yd$^3$ dolomitic limestone and 1.5 lbs/yd$^3$ Micromax. Pour-through extractions were conducted at 2, 4, 6, and 8 weeks after planting to determine pH and soluble salts (EC). At the end of the growing season plant quality was assessed using a SPAD-502 Leaf Greenness Meter (Minolta, Inc.), as well as measurements for size and dry weight. Treatments (see Table 4) were arranged on elevated tables in a completely randomized design by species.

**Results and Significance to the Industry:** Understandably, everything that goes in the kitchen trash cannot be sorted and removed at garbage processing centers. When household garbage is processed with a hammer mill or similar equipment, composted, and flushed with abundant water, many of the potential hazards from handling these materials are minimized. In the MSWC studies of 2003 and 2004, physical properties were comparable to pine bark and with the exception of 'initial' EC fell within the recommended desirable range for substrates. Studies concluded in 2004 suggested that replacing about one-third of pine bark with MSWC could be effectively used to grow a wide variety of container plants or flowers. Grower opinions of "Fluff" were generally positive at the rates used. A concern with the initial versions of MSWC were C:N ratios ranging from 16:1 to 57:1, a variable that has become more consistent and now ranges from 25:1 to 35:1. "Fluff" is a substrate component that is compatible with automated production systems and common methods of container plant production.

In 2005, there were few differences in growth across all blends for all species. Where different, the best growth occurred for the standard pinebark:sand mix and the blend containing 75% bark with 25% composted MSWC – results similar to those found in the two previous years. Likewise, pH levels were of no concern in any of the blends. Also, similar to previous years EC values were initially high in blends containing non-composted MSW but fell quickly following about two weeks at standard overhead irrigation. However, with the composted MSW (MSWC) blends the initial EC were within acceptable ranges and remained similar to the standard pinebark:sand mix through the growing season.

For the Auburn studies, as a general observation, for all species, the largest plants across all treatments were those in which poultry litter was a component of the substrate. Also, as a general rule, plants grown in substrate blends containing pinebark as the primary component were larger than those grown with ground pine chips as the primary component. In many cases, dry weight of plants from pinebark based substrates was more than double the size of those from ground pine chips. However, plant quality, based on SPAD-502 values was not different among treatments for ageratum, and only one treatment difference was detectable for vinca.
The materials evaluated in the Auburn studies are plentiful nationwide and typically at a cost lower than that of pinebark. For example, poultry litter is sometimes available at the cost of hauling while ground pine chips destined for fuel or paper pulp use run about $\$5/yd^3$. Even with the added cost of additional grinding, chip-mill material may still be competitive with pine bark prices, and much lower in price than peat, which could lead to reduced production costs. Our studies indicate that ground pine chips may be have potential as a substrate component, but more work is needed on particle size and optimization of nutrition when combined with other materials. Also, additional attention to possible toxins in fresh wood from a variety of sources is needed.

**Table 1. Growth[z] of container plants in blends of Composted Municipal Solid Waste (MSWC) and pinebark (PB) in 2004 at three locations.**

| Location | Species | 100% MSWC | 75:25 MSWC:PB | 50:50 MSWC:PB | 25:75 MSWC:PB | 100% PB |
|---|---|---|---|---|---|---|
| Auburn | 'Renee Mitchell' Azalea | 49.4 ab [y] | 47.6 b | 50.6 ab | 50.1 ab | 53.9 a |
| | 'Compacta' Holly | 61.4 b | 63.9 b | 65.9 ab | 66.0 ab | 68.9 a |
| | 'Firepower' Dwarf Nandina | 53.9 a | 51.6 a | 52.9 a | 55.5 a | 53.5 a |
| Center for Applied Nursery Research | 'Pink Ruffle' Azalea | 19.6 ab | 20.9 a | 17.9 b | 21.1 a | 21.4 a |
| | Dwarf Yaupon Holly | 17.7 ab | 19.5 a | 14.8 b | 17.7 ab | 18.0 ab |
| | Ternstroemia gymnanthera | 26.4 ab | 30.2 a | 24.1 b | 30.2 a | 31.0 a |
| Greene Hill Nursery | 'Cameo' Quince | NA | NA | NA | 63.3 a | 57.6 b |
| | Common sweetshrub | NA | NA | NA | 54.2 a | 49.5 b |
| | 'Snow White' Indian hawthorn | NA | NA | NA | 39.5 a | 40.4 a |

[z] Growth index (GI) determined by (height + width at widest point + width perpendicular to width at widest point/3).

[y] Means within rows followed by a different letter are different according to Tukey's Studentized Range (HSD) Test ($p = 0.05$).

**Table 2. Growth[z] of container plants in blends of Non-Composted Municipal Solid Waste (MSW) and pinebark (PB) at CANR in 2005.**

| Location | Species | 100% MSW | 75:25 MSW:PB | 50:50 MSW:PB | 25:75 MSW:PB | 100% PB |
|---|---|---|---|---|---|---|
| Center for Applied Nursery Research | Azalea 'Pink Gumpo' | 16.5 | 16.7 | 16.4 | 17.1 | 16.8 |
| | 'Compacta' Holly | 20.1 | 21.1 | 24.2 | 25.5 | 27.4 |
| | Cleyera (*Ternstroemia*) | 25.9 | 28.7 | 26.6 | 29.1 | 27.5 |
| | Ligustrum | 22.3 | 22.9 | 25.0 | 24.7 | 27.5 |

[z] Growth index (GI) determined by (height + width at widest point + width perpendicular to width at widest point/3).

**Table 3. Leachate analysis of container plants in blends of Composted Municipal Solid Waste (MSWC) and pinebark (PB) at CANR in 2005.**

| Location | Species | 100% MSWC | 75:25 MSWC:PB | 50:50 MSWC:PB | 25:75 MSWC:PB | 100% PB |
|---|---|---|---|---|---|---|
| Center for Applied Nursery Research Initial/One-Month pH[Z] | Azalea 'Pink Gumpo' | 6.6 / 6.4 | 6.4 / 6.1 | 6.3 / 6.1 | 6.1 / 5.9 | 5. / 4.9 |
| | 'Compacta' Holly | 6.4 / 5.9 | 6.3 / 5.8 | 6.1 / 5.8 | 6.0 / 5.7 | 5.6 / 4.5 |
| | Cleyera (*Ternstroemia*) | 6.5 / 6.2 | 6.3 / 6.0 | 6.1 / 5.8 | 6.0 / 5.5 | 5.4 / 4.4 |
| | Ligustrum | 6.3 / 5.8 | 6.3 / 5.7 | 6.2 / 5.7 | 5.9 / 5.6 | 5.7 / 4.9 |
| Center for Applied Nursery Research Initial/One-Month EC[Y] | Azalea 'Pink Gumpo' | 0.20 / 0.16 | 0.40 / 0.13 | 0.32 / 0.23 | 0.31 / 0.20 | 0.59 / |
| | 'Compacta' Holly | 0.17 / 0.12 | 0.12 / 0.18 | 0.24 / 0.25 | 0.52 / 0.28 | 0.38 / |
| | Cleyera (*Ternstroemia*) | 0.39 / 0.23 | 0.43 / 0.22 | 0.37 / 0.21 | 0.40 / 0.21 | 0.62 / |
| | Ligustrum | 0.21 / 0.13 | 0.15 / 0.12 | 0.29 / 0.18 | 0.95 / 0.22 | 0.25 / |

[Z] Within each column and row, the first value represents initial pH following potting and the second value represents pH one-month after potting.
[Y] EC (electrical conductivity measured in milli-Siemens per centimeter). EC for leachates collected from plants grown in all blends containing composted MSW (MSWC) fell to 0.8 within 1 month under conventional overhead irrigation.

**Table 4. Evaluation of various substrate component blends for container production of summer annuals.**

| | Ageratum 'Hawaii Blue' | | Salvia 'Vista Red' | | Vinca 'Rose Cooler' | |
|---|---|---|---|---|---|---|
| Treatment[Z] | Dry weight (g)[Y] | SPAD-502 | Dry weight (g) | SPAD-502 | Dry weight (g) | SPAD-502 |
| 100 GW: 0 PL | 3.6 e | 33.5 a | 8.0 d | 53.4 cd | 2.0 e | 43.7 ab |
| 87.5 GW:12.5 PL | 6.9 cd | 34.5 a | 14.9 b | 54.9 bcd | 2.8 cde | 46.7 a |
| 75 GW:25 PL | 10.7 a | 34.1 a | 12.3 bc | 52.2 cd | 2.1 e | 40.0 ab |
| 87.5 GW:12.5 BIO | 5.8 cde | 33.2 a | 7.3 d | 51.7 d | 1.8 e | 42.5 ab |
| 75 GW:25 BIO | 4.5 de | 33.1 a | 9.7 cd | 51.2 d | 2.0 e | 37.6 b |
| 100 PB: 0 PL | 6.0 cde | 33.0 a | 7.9 d | 53.7 cd | 2.6 de | 42.9 ab |
| 87.5 PB: 12.5 PL | 10.2 ab | 32.0 a | 20.4 a | 57.5 abc | 4.9 a | 44.0 ab |
| 75 PB:25 PL | 10.3 ab | 31.3 a | 19.2 a | 60.0 ab | 4.6 ab | 44.5 ab |
| 87.5 PB:12.5 BIO | 7.9 bc | 33.0 a | 13.8 b | 59.6 ab | 3.4 bcd | 43.2 ab |
| 75 PB:25 BIO | 9.5 ab | 35.8 a | 15.3 b | 61.4 a | 4.0 abc | 44.6 ab |

[Z] Treatments were percentage of substrate component where GW = pine chips ground to pass a 3/8 inch screen; PL = poultry litter; PB = Pine bark; and BIO = Municipal biosolid saturated newsprint crumbles.
[Y] Means within **rows** followed by a different letter are different according to Tukey's Studentized Range (HSD) Test ($p$ = 0.05).