Waste is a Terrible Thing to Mind©

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INTRODUCTION

Selection of substrates for horticultural use is often based on cost, availability, ease of handling, and consistency. Peat and pine or other types of bark are common substrate components for nursery growers in the United States. Availability and cost of peat and pinebark is greatly affected by the timber industry, transportation, and/or environmental conditions such that the supply can be inconsistent or unpredictable. Future supply of pinebark is predicted to be further constricted as papermills relocate outside of the United States or to regions of the country where freight costs will prohibit nursery use of the material. Additionally, pinebark use as a biofuel is increasing as EPA regulations requiring reduction in fossil fuels hit full stride early next year (Lu et al., 2004).

The phrase "One man's waste is another man's treasure" certainly applies to materials we find useful for various horticultural applications. Alternative products as substrate blending components for horticultural use are evermore urgent. Factors such as transportation costs, consistency of product, disease and insect infestation, and availability of alternative materials have been the primary concerns for growers. As the landscape industry continues to expand, new opportunities have developed for use of a variety of alternative materials. For example, in recent years use of bark chips or recycled rubber products as the bedding or floor of playgrounds has become commonplace.

Many substrate components such as sand, vermiculite, perlite, rockwool, Styrofoam beads, and peat are intended for horticultural use with little, if any further processing needed. However, most industrial, municipal, agricultural and manufacturing byproducts (Table 1) must be composted and/or further processed before use as a container substrate. Further processing may include hammer milling, pelleting, sizing and sorting, addition of nitrogen, or grinding.

Potential uses of composts and other organic materials in the horticultural industry are frequently evaluated. Benefits of composts are often overlooked due to a lack of scientific literature on which to base beneficial claims. However, some positive features of compost which are generally accepted include its organic content, improvement of soil structure, and water holding capacity. Most materials are considered free of weed seed and pathogenic diseases when properly composted (Davidson et al., 2000).

Some of the more common organic byproducts marketed to the green plant industry include animal wastes such as poultry litter, stable cleanings, and dairy solids. For many years these products have found additional distribution as animal feeds. However, the Food and Drug Administration announced Jan. 26, 2004 (www.alfafarmers.org/headlines/headline.phtml?id=4368, Helms, 2004) it will ban the use of animal blood and poultry litter in cattle feed at some future date, a policy already in effect for the dairy industry. For a number of years some beef cattle operations have supplemented feed rations with up to 80% composted poultry litter as a protein supplement. But now, after the discovery of the first U.S. case of bovine spongiform encephalopathy (BSE), poultry operators or designated waste contractors will once again be searching for alternative routes of disposal for poultry litter. It is likely that the green plant industry will receive renewed focus as one avenue of poultry litter use.

Cotton gin waste (CGW) is a term used to describe the byproducts of the cotton ginning process that typically include leaves, stems, burrs, and some fiber. The end result of composting CGW is a fine, dark topsoil-like product. Cotton gin compost (CGC) is a prospective substrate component for production of ornamental crops (Jackson et al., 2004). CGC is readily available in the Southeast and may hold potential as a substrate component substitute (for example, peat: Cole et.al., 2002) or extender suitable for nursery use (Table 1). There is a current dilemma of cost effective and legal disposal of this cotton byproduct. Cotton gins throughout the South are located in close proximity to nurseries. With CGC, the burden of disposal costs can be decreased from cotton ginning operations while at the same time possibly decreasing production costs for nearby nurseries.

Regardless of the region of the country, inexpensive alternatives to current substrate components are certain to be available (Cole and Sibley, 2004; Davidson et al., 2000). If evaluated carefully and handled properly many organic or inorganic alternatives can be added to a traditional pine-bark mix at 10 to 15 percent volume:volume without adverse effects on plant growth and quality. Keep in mind that physical and chemical properties of substrate components are not sums of the parts. In other words, components may behave quite differently if used alone than when blended with other materials. Simple chemical and physical properties (Table 1) of potential substrate blends can be easily determined (Wright, 1994).

A few hours spent on a rainy day investigating streams of municipal and agricultural wastes, looking into the dumpsters of local industrial parks, or tracking down the origin of bulk waste quantities at the local dump could lead to decreased substrate costs for growers. Many companies across the country contract to haul industrial and construction debris away from the source, then run the materials through tub grinders before selling the materials as manufactured topsoils.

A few industrial and municipal byproducts appear to be suitable for growing plants but have yet to be evaluated extensively. In some cases, additional research is needed to verify their safety to workers handling the material. Examples of byproducts in use that need additional evaluations include **1.)** Tub-ground pallets and construction debris intended for use as mulch. The wood content of such material is a concern due to the potential impact of wood preservatives in pressure treated lumber and also from the standpoint of setting a banquet table for termites. Until proven otherwise, it seems sensible to avoid using these materials around buildings and structures – reserving use for bank stabilization, beds in large open areas, or along highways; **2.)** Municipal biosolids. Treated biosolids designated as Class A materials are generally considered free of pathogens and safe for horticultural use. However, concerns such as BSE are not eliminated by heat treatment, and other concerns include the potential densifying or concentrating of heavy metals or carcinogenic compounds; **3.)** Processed municipal solid wastes (MSW). Understandably, everything that goes in the kitchen trash cannot be sorted and removed at garbage processing centers. When MSW are 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. However, these materials can differ batch by batch and need further research to characterize the range of expected components in the final products. The most promising work in this area is underway in McMinnville, TN, where Floyd Bouldin’s WastAway Sciences has developed sophisticated municipal solid waste handling equipment and procedures to produce a composted material referred to as “Fluff” (Rodda, 2004).

During the past few years we have evaluated several waste materials as potential bark substitutes. Research with earlier versions of "Fluff" were promising (Kahtz and Gawel, 2004) leading to a much better product. With "Fluff", our objective was to evaluate various blends of municipal solid waste compost (MSWC) as a horticultural substrate in growth of (a) weeping figs (*Ficus benjamina*) (Croxton et al., 2004); (b) three bedding plant selections (Croxton et al., 2004); and (c) nursery crops at several nurseries. All MSWC was obtained from the WastAway Sciences Co., in McMinnville, TN following indoor composting at WastAway. All CGC was obtained from the E.V.S. Research Center, Shorter, AL.

This paper presents general information from studies with CGC and MSWC conducted in multiple locations with a wide range of nursery crops in 2003 and 2004. Studies in Auburn, AL and at the Center for Applied Nursery Research (CANR, Dearing, GA) evaluated 5 MSWC and PB blends in 9 species (see Tables 2 and 3 for blend ratios and other details). Nursery trials used 25-30% MSWC with 70-75% PB. No attempt was made to standardize the species, irrigation, fertilizer, or other cultural practices. The growers in 2004 were Martin's Nursery, Semmes, AL (3 gal 'Formosa' Azalea); PDSI, Loxley, AL (3 gal Encore Azalea® Autumn Royalty™ PP#10580; *Agarista populifolia* Leprechaun™ PP#10580; *Rosa* 'Radrazz' Knockout Rose™ PP#11836, *Rhaphiolepis indica* Spring Sonata™ PPAF; and *Wisteria frutescens* 'Amethyst Falls'); S & S Nurseries, Athens, AL (45 and 65 gal 'Red Sunset' and 'October Glory' red maples, 25 gal 'Little Red' and 'Robin' red hollies, and 7 gal redbud, willow oak, and sawtooth oak) (data not shown); and Greenhill Nursery, Waverly, AL (Table 2).

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 (Wright, 1994) for analysis.

Results and Discussion: In the weeping fig study, we found MSWC can be used as a partial substitute for PB or PM. There were no significant differences on the final GI (12 weeks after transplant). Analysis also indicated a greater increase over initial GI of plants in 3:1 PB:MSWC than plants in 3:1 PB:PM one week after transplanting. There was no difference in the increases over initial GI 6 or 12 weeks after transplanting. Fresh weights of weeping figs grown in 3:1 MSWC:PB were greater than plants in 3:1

PB:PM, but there was no difference in dry weights of plants across all four blends (Croxton et al., 2004).

The New Guinea impatiens grown in the blend containing 40% MSWC had the best growth and color development compared with the three commercial blends used in this study. Less than 20% of the petunias survived in 100% MSWC, about 50% of the petunias survived and grew well in the 2:1 MSWC:PLR blend and almost all petunias in 1:1:1 PB:MSWC:PLR survived and grew well. Dusty miller grew well in all three blends. Analysis of the harvest shoot weight indicated no significant differences in the fresh weights among different blends, but dusty miller in the 2:1 MSWC:PB had a greater dry weight than those from 100% MSWC (Table 3). Leachate analysis indicated a very high initial EC reading in the 100% MSWC which may have contributed to the low survival of petunias in 100% MSWC. Some bedding plants, like petunias, may not perform well in 100% MSWC, but MSWC can be used to replace at least one-third of the pine bark or peat as a substrate component for both petunias and dusty miller.

Our studies suggest that replacing about one-third of pine bark with MSWC can be effectively used to grow a wide variety of container plants or flowers. Grower opinions of "Fluff" were generally positive at the rates used. Determinations of product safety, quality control, and transportation costs will likely dictate wholesale acceptance in the future. In current form, the volume of "Fluff" screened to a one-inch maximum particle size is reduced by about 15%. Most of what is screened out are large pieces of plastic or other non-organic material. A concern with the initial versions of "Fluff" 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 (Table 4).

Several factors will continue to drive green industry professionals to consider the potential of various materials for landscape and production use. Recognizing the value in byproducts from other industries (Table 5) will be a direct benefit to the green industry in years to come. Across the nation, some companies have already tapped into this market with established, reputable, consistent products for a number of horticultural applications. For example, Rose Acres Farms, Seymour, IN with poultry manure; Tascon in Houston, TX with recycled newsprint products; Milorganite in Milwaukee, WI with processed biosolids; and Sims Bark and Soil in Tuscumbia, AL. In the future, waste management problems in other industries will continue to pose opportunities as solutions to current and future green industry needs.

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Table 1. Physical and chemical properties of various substrate blends.

Substrate [z]	AS [y]	WHC [y]	TP [y]	BD [x]	pH	EC [w]
100% PB	41.0	35.9	79.6	0.12	3.9	0.96
1:1 PB:PRL	41.6	21.0	62.6	0.13	4.4	0.11
100% CGC	14.5	55.1	69.6	0.44	6.6	6.62
1:1 PB:CGC	20.4	55.8	76.2	0.20	6.1	1.94
1:1 CGC:PRL	16.0	50.8	66.8	0.23	5.7	2.83
100% MSWC	21.0	47.2	68.2	0.31	6.4	14.08
Desirable Range [v]	10-30	45-65	50-85	0.19-0.70	5.0-6.0	0.8-1.0

[z] PM=Peat; PRL=Perlite; PB=Pine bark; CGC=Cotton gin compost.
[y] AS (air space), WHC (water holding capacity), and TP (total porosity) are on a percent volume basis.
[x] BD (bulk density) was measured in grams per cubic centimeter.
[w] EC (electrical conductivity) was measured in milli-Siemens per centimeter. EC for leachates collected from plants in 100% CGC = 1.06 and MSWC = 0.8 after 1 month of conventional overhead irrigation.
[v] Recommended ranges for substrates used in general nursery production (Yeager et al., 2000).

Table 2. Growth[z] of container plants in blends of Municipal Solid Waste Compost (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 3. Leachate analysis and effect of substrate blends on growth of dusty miller.[z]

Treatment[y]	Fresh weight[x]	Dry weight	Initial pH	Final pH	Initial EC[w]	Final EC[w]
100% MSWC	12.29 a[v]	1.81b	7.06	6.85	14.08	0.31
1:1:1 PB:MSWC:PLR	15.49 a	2.49ab	7.02	6.88	9.32	0.23
2:1 MSWC:PLR	15.24 a	2.68a	6.34	6.86	8.42	0.37

[z] Study conducted in a climate-controlled double-poly greenhouse in Auburn, Alabama in 2004.
[y] PB = pine bark, PM = peat moss, MSWC = municipal solid waste compost (Fluff) from household garbage.
[x] Fresh and dry weight measured in grams.
[w] Initial and final electrical conductivity measured in milli-Siemens per centimeter.
[v] Means within columns followed by a different letter are different according to Duncan's Multiple Range Test ($p = 0.05$).

Table 4. Element and soil analysis of Municipal Solid Waste Compost (MSWC) passing through a one-inch screen.[z]

Ca	K	Ma	P	Al	B	Ba	Cd	Co	Cr	Cu	Fe	Mn
	ppm											
88.9	580.9	18.4	9.2	7.5	3.8	0.1	<0.1	<0.1	0.6	20.9	15.4	0.8

Na	Ni	Pb	Zn	NO_3-N	EC	SS	pH	% N	% C	C:N ratio	% S
ppm					mmhos/cm	ppm					
1154.3	0.7	0.9	4.1	38.7	9.5	6650	7.86	1.22	31.55	26:1	0.292

[z] Analysis was conducted by Auburn University Soil Testing Laboratory using the saturated paste extract method, February, 2004.

Table 5. Byproducts or residuals from industrial, municipal, agricultural, and manufacturing industries with current or potential horticultural use in landscapes or production.

Products	Current or potential use area	Known or speculative concerns
Pine and other barks	Substrates, bagged products, mulch [Z]	Availability
Animal wastes such as poultry litter, stable cleanings, dairy solids, feather and bone meals	Substrates, fertilizer supplements, turf applications, bagged products	Odors, freight cost to value ratio, ease of handling, pathogenicity, availability
Newsprint pellets and crumbles	Substrate component, nutrient filters, mulch	Availability, durability
Cotton gin compost, rice hulls, sugar cane bagasse, cottonseed meal, soybean meal	Substrates, fertilizer supplements, bagged products	Regional availability
Coconut coir, cocoa bean hulls, peanut hulls	Substrate components, mulch, bagged products	Regional supply, fresh, non-composted peanut hulls may carry nematodes
Shavings, sawdust, tree chipper trash, ground pallets and construction debris	Mulch, slope stabilization, substrate components, bare-root bedding and bagging materials	Erratic supply, high cellulose levels may attract pests, nutritional imbalances when materials are not fully composted
Processed biosolids, municipal solid waste compost, fly-ash	Substrate components, turf application, bagged products	Odor, pathogenicity, public perception, heavy metals, soluble salts, weight
Channel dredging soils, kaolin or calcined clays, sheetrock/gypsum remnants, mine land spoils	Direct land application, bed formation, substrate components, turf application, bagged products	Weight, regional availability, ease of handling, weeds
Sea shells, brick fragments, shale, smelting slags	Mulch, nursery production floors, substrate components, slope stabilization, spillways	Regional availability, low cation exchange capacity (if any), weight
Residuals from manufacturing of floor tile and other flooring, ground tires or other rubber materials	Mulch, walkways, substrate components	Availability, weight, volatiles, leachable toxins, ease of handling
Textile remnants (carpet mills, spun polypropylene culls, etc.)	Substrate components, nursery production floors, shipping padding	Regional availability, weight and handling

[Z]Mulch is a general term describing materials used to dress beds, create the floor of pathways, provide insulation or moisture retention to landscape beds, surface playgrounds, etc.