Getting Physical with Fluff®: Effects of amending a pine bark substrate with Garbage

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Pine bark has been a major component of nursery container substrates since the 1960's. In recent years with the continuous rise in energy prices, bark has been used as a clean fuel resource by many industries. In addition, the quantity of timber harvested in the United States has decreased since 1986. Concurrently, rapid growth in the nursery industry over the past two decades has increased demand for pine bark. A recent study on future pine bark supplies projected a short fall in pine bark during the next decade. We believe identifying alternative components that can be used as a bark supplement to extend bark supplies is the best solution as this would require minimal changes in current nursery production practices. Many studies have investigated the use of industrial and agriculture wastes as substitutes for bark including animal, cotton gin, wood by-products, municipal leaf and sewage sludge, rice hulls, rubber tire chips, spent mushroom compost, and coconut coir dust. Many of these alternative substrate components show promise, in that, they are non-toxic to plants and can be successfully used to amend conventional substrates. However, cost, regional availability, and a limited supply of uniform and consistent quality reduce their widespread use.

The average American produces over four pounds of solid waste per day with the production of garbage estimated to increase by 5% per year. The use of recycled waste as a container substrate component could provide the nursery industry with a reproducible, consistent substrate amendment of unlimited supply. It is not incumbent on the nursery industry to solve the world's waste disposal problems. However, if recycled waste is a valuable substrate amendment then it becomes a win/win situation.

Boulin Corporation, Composite Products of America, and Wastaway Services (McMinnville, TN) are focusing efforts on converting processed garbage into a value added component called Fluff® for horticultural crop production. Research examining the suitability of Fluff® as a substrate amendment is limited.

At the NCSU Horticulture Substrates Lab, we specialize in evaluating physical and chemical characteristics of potting materials. We engineer substrates by manipulating ratio's of each component to optimize air and water relationships. When lab work looks promising, we grow plants in selected substrates and evaluate growth, plant nutrient uptake, and substrate nutrient loss. We also evaluate physical properties of substrates at the initiation of a study and at harvest to determine stability and interaction of components in the substrate.

Our primary interests in Fluff® were related to physical and chemical characteristics of processed garbage and their effects on plant growth. Consequently, our objective for this research was to evaluate the physical, chemical, and growth effects of Fluff® added in incremental ratios to pine bark in a nursery container environment. To accomplish this objective we added Fluff® to pine bark at 0, 15, 30, and 45% (by volume) and grew Skogholm cotoneaster for 5 months in 1 gallon containers. No other amendments (such as micronutrients and limestone) were added. In addition, we grew cotoneaster in a 8 pine bark : 1 sand substrate amended with micronutrients and limestone. All containers were topdressed with 5 g N per container with a commercial controlled release fertilizer (Harrell's 17-5-10, 6 month controlled release fertilizer). .

All of the physical properties except bulk density were unaffected by rate of Fluff® (Table 1). However, total porosity, container capacity, air space, and unavailable water of the Fluff® amended substrates were significantly greater than the control substrate, whereas available water and bulk density of the Fluff® amended substrates were significantly less than the control. During the study, air space in 0% Fluff® (100% pine bark) and the pine bark:sand substrates decreased. This is typical of most organic substrates, as the material decomposes air space usually decreases which can lead to problems by the end of the growing cycle. In contrast, air space in the 15% and 45% Fluff® substrates were essentially unchanged during the experimental period. Thus, Fluff® provided stability to the substrate throughout the entire production cycle. Apparently there is enough inorganic material in Fluff® to provide significant stability to organic components contained in potting substrates. The 45% Fluff® had the most consistent physical properties. Even though substrates amended with Fluff® had lower available water than pine bark:sand, it did not take more water to produce an equivalent size plant. Water required to produce a plant during the study (2.7 liters/container) was unaffected by rate of Fluff® nor was it different from the pine bark:sand substrate.

Plant growth was unaffected by any of the treatments except 0% Fluff® (100% pine bark) so an equivalent plant was produced in all substrates. We incorporated 2 lbs/cubic yard of dolomitic limestone to the pine bark:sand substrate but we did not add dolomitic limestone to substrates containing Fluff®. Even though, foliar calcium (Ca) and magnesium (Mg) concentrations of cotoneaster grown in 15%, 30%, and 45% Fluff® were greater than Ca and Mg concentrations of cotoneaster grown in the pine bark:sand control, indicating that Fluff® has a liming equivalent. Similarly, no micronutrients were added to the Fluff® substrates, although the pine bark:sand control was amended with 1.5 lbs/cubic yard MicroMax minor element supplement. Here again, Fluff® provided adequate quantities of all micronutrients throughout the study. Considering these results, it appears that Fluff® contains enough Ca and Mg and has an adequate minor element content to make addition of dolomitic lime and minor element packages unnecessary.

Human-kind cannot continue throwing all resources away; eventually we will exhaust or contaminate all remaining supplies. Recycling and re-using cast-off but not fully utilized wastes will be necessary in the future. Civilization will need to use these resources to have enough or because we no longer will have a place to put them when discarded. The nursery industry could solve two problems by utilizing household wastes. First, the bark supply could be extended with a unlimited and widely available material. Second, a societal problem of disposing of household waste would be solved.

Table 1. Effect of pine bark substrates amended with Fluff® on physical properties at 63 and 135 days after treatment initiation.

Treatments	Total Porosity		Air Space		Container Capacity		Available Water		Unavailable Water		Bulk Density	
	Days after treatment initiation											
	63	135	63	135	63	135	63	135	63	135	63	135
% by vol.	% vol										$g \bullet cm^{-3}$	
0	84*[z]	85*	33*	23*	52	55	22*	22*	29*	33*	0.26*	0.24*
15	84*	86*	**31***	**32***	54	54*	24*	21*	30*	33*	0.27*	0.25*
30	84*	85*	33*	30*	51	55	21*	23*	30*	32*	0.27*	0.27*
45	84*	85*	**32***	**32***	51	52*	20*	22*	31*	31	0.29*	0.28*
8:1[y]	77	80	23	21	54	59	28	29	26	29	0.43	0.44
Significance[x]												
Linear	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	***	***
Quadratic	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	***	***

[Z]*Significantly different from the control substrate [8:1 pine bark:sand (by vol.)] based on mean separation by Dunnett's test, $P = 0.05$.

[y]8:1 pine bark:sand substrate by vol. The control substrate data not included in regression analysis.

[x]NS, *** nonsignificant or $P \leq 0.001$ respectively.

Suggest Ranges for Physical Properties: Total Porosity - 50-85% ; Air Space - 10-30% ;

Container Capacity - 45-65%; Available / Unavailable Water Content - 25-30%

Bulk Density- (oven dry weight) 0.19 to 0.52 g/cc (12 to 32 lbs/ft^3)