Evaluation of Windrow Versus In-Vessel Digester Poultry Litter Compost for Greenhouse Use©

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Windrow composting was compared to in-vessel digester composting using poultry litter as the compost media. In order to compare the two compost methods, temperature, moisture, C:N ratio, and bacteria were monitored during production of the compost. Once the compost from each method was considered stable, a greenhouse growth study was initiated using *Impatiens walleriana* Trailing Fanfare™ 'Blush'. The greenhouse study lasted a total of seven weeks, at which time the plants were harvested and dry weights were recorded. Data from the test was analyzed using SAS 9.1 Tukey's Studentized Range Test. Analysis of data revealed windrow- compost significantly out performed in-vessel digester compost when the ratio of in-vessel compost within the media was greater than 7:1 pine bark: in-vessel compost. Both methods produced weed free compost material with satisfactory physical properties for use as a container substrate component.

INTRODUCTION

Poultry production is a rapidly growing industry in the United States. As a nation, the U.S. produces 8.9 billion birds annually with Alabama currently third in production producing 11.9% (1.1 billion birds) of U.S. totals (AAS, 2007). Typically, on a commercial broiler farm, bedding material is used for six or more consecutive grow-outs. Each grow-out generally lasts 6+ weeks; which means that bedding material is generally being utilized for at least one year (Macklin,

2008) before removal as litter. Currently around 419.12 million metric tons of litter is produced in the United States each year (Kaplan et al., 2004). Therefore, around 49.8 million metric tons of poultry litter (PL) is produced in Alabama alone.

In poultry production, the bedding material in poultry operations is used to render the floor more manageable. After use, the bedding material is referred to as litter and consists primarily of poultry manure, but also contains the original bedding material (generally pine shavings, peanut hulls, or sawdust), feathers, and spilled feed (Freeman and Cawthon, 1999). In recent years there has been concern with land disposal of this agricultural waste in the United States and elsewhere in the world. Scientists and the poultry industry have an increased awareness of compost as a beneficial byproduct; in particular poultry litter compost.

Poultry litter can be used by many industries. Studies evaluating fresh, non-composted poultry litter as a fuel source, cattle feed, container media in nurseries, erosion control, and as a fertilizer have been conducted (Atkinson et al., 1996; Guertal et al., 1997; Lopez et al., 1998; Tyler et al., 1993). However, nursery crop growers are looking for substrates that are consistent, reproducible, available, easy to handle and mix, cost effective, and have the appropriate physical and chemical properties for the crop they are growing (Klock-Moore et al., 2000). Composts meet many of these requirements and therefore can be considered a suitable component of a potting media (Freeman and Cawthon, 1999). Evaluation of various composting methods is necessary because of potential differences in final material. Although there are numerous ways in which to compost poultry litter; for the purpose of our study two methods were evaluated: windrow composting and in-vessel digester composting. Generally, windrow widths are determined by the equipment used to turn them, formed in heights of 3-4 feet, with length limited to available space (Misra and Roy, 2002). An in-vessel-digester system however, is a rotating drum system which allows for breakdown in a few days compared to weeks in the windrow system (Dougherty, 1999). These drums can measure from 3 feet in diameter and 12 feet long all the way to 16 feet in diameter and 230 feet long (Spencer, 2007).

MATERIALS AND METHODS

On July 25, 2007 we began the composting process for a windrow comprised of about 60 cubic yards of fresh poultry litter and 100 cubic yards of carbon feedstock (sawdust) with the moisture adjusted to 40% through irrigation of the windrow. The windrow was divided into two sections - one considered west, the other east. Two temperature data loggers were placed into the windrow at each end which recorded temperatures every hour. On the same date approximately 9 yards of fresh poultry litter was added to an in-vessel digester to begin composting. After eight days in the in-vessel digester the litter volume was reduced to about 6 cubic yards of compost, removed and placed outdoors in a pile beside the windrow with two temperature data loggers inserted to record at the same interval as the windrow. Therefore, virtually the same atmospheric conditions occurred for both treatments. In addition to temperature data, moisture content, carbon to nitrogen ratios, and bacterial samples were collected and monitored for each method.

Plant materials for the greenhouse growth test (Paterson Greenhouse Complex, Auburn University) consisted of *Impatiens walleriana* Trailing Fanfare™ 'Blush'. Substrates were blended consisting of varying ratios of pine bark: compost with the control being pine bark: peat moss for a total of 9 treatment blends with ten repetitions per treatment. Treatments were as follows: 1.) 2:1 pine bark (PB): peat moss (PM), 2.) 4:1 PB: PM, 3.) 7:1 PB: PM, 4.) 2:1 PB: windrow (W), 5.) 4:1 PB: W, 6.) 7:1 PB: W, 7.) 2:1 PB: in-vessel (IV), 8.) 4:1 PB: IV, and 9.) 7:1 PB: IV. All substrates were prepared and then four inch cups (Dillen Manufacturing, Middlefield, Ohio) were filled then placed in a completely randomized block design in a temperature controlled greenhouse. Once the cups were placed on the bench, plugs of *Impatiens walleriana* Trailing Fanfare™ 'Blush' were inserted into the pots and watered in. Data collection at the first day of planting consisted of shrinkage, growth indices, and leachates (for the determination of pH and EC values). The test was installed on 3/18/2008 and terminated on 5/6/08. During the test plants were watered by hand using a Dosatron® with 200ppm N fertilizer. At termination of the test plants were cut off at the soil line and placed in an oven dryer at 155°F for 48 hours in order to obtain dry weights. In addition to dry weights, final leachates along with shrinkage and growth indices were recorded.

RESULTS

Results of the study revealed no significant differences between the substrates for comparison of shrinkage data (Table 1), which was an additional confirmation of the compost stability. However, comparison of substrate pH and EC over the course of the study revealed interesting results (Table 2). Substrate pH and electrical conductivity showed that there were significant differences among blends (Table 2) for substrate pH. Over time there were significant differences between recorded means. Analysis of substrate electrical conductivity revealed that at the start of the study, containers with 2:1 and 4:1 pine bark: in-vessel compost had a significantly higher EC measurement. However, by the end of the study, the EC had dropped significantly enough to be grouped with all other treatment means.

Once the dry weights were recorded and analyzed there were a few significant differences between treatments (Table 3). Windrow composting compared well to the control treatments of PB:PM and in some cases out performed the control. As for the growth indices, 2:1 pine bark: windrow compost out performed 2:1 pine bark: in-vessel compost and 4:1 pine bark: in-vessel compost (Table 4).

DISCUSSION

The *Impatiens walleriana* Trailing Fanfare™ 'Blush' growth test revealed that windrow composting out-performs in-vessel digester composting as long as the ratio of compost from in-vessel is at a greater rate than 7:1 pine bark: in-vessel. The significance of these results points out the importance for a grower to know how the compost that is added to a potting media is produced. It is also advised that the grower know for certain what stage of maturity the compost is in. The more the grower knows about how the compost is produced and the methods the compost producer is using to quantify maturity, the better informed the grower can be on making a decision on how to use these composts.

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Table 1. Substrate shrinkage for substrates comprised of poultry litter by two different methods[Z].

Treatment[Y]	Shrinkage
	F-I[X]
2:1 PB:PM	.250a[V]
4:1 PB:PM	.255a
7:1 PB:PM	.405a
2:1 PB:W	.405a
4:1 PB:W	.225a
7:1 PB:W	.425a
2:1 PB:IV	.765a
4:1 PB:IV	.330a
7:1 PB:IV	.270a

[Z]Substrate shrinkage reported in centimeters.

[Y] Treatments (on a Vol:Vol ratio) were PB = Pine Bark; PM = Peat Moss; W = Windrow; IV = In-Vessel Digester.

[X]F = Final Measurement; I = Initial Measurement.

[V]values in columns followed by different letters are significant according to Tukey's Studentized Range Test (α = 0.05).

Table 2. Substrate chemical properties for substrates comprised of poultry litter composted by two different methods[Z].

Treatment[Y]	pH			EC[X]		
	0 DAP[W]	21 DAP	42 DAP	0 DAP	21 DAP	42 DAP
2:1 PB:PM	3.38e[V]	3.64d	3.89c	.971cd	1.86b	1.93a
4:1 PB:PM	6.14bc	5.80ab	5.70b	.901cd	1.37b	1.60a
7:1 PB:PM	6.88a	6.70a	6.50a	6.19a	2.79a	2.24a
2:1 PB:W	3.35e	4.96cd	4.17c	.991cd	1.65b	1.98a
4:1 PB:W	5.86dc	5.81ab	5.98b	.578d	1.29b	1.23a
7:1 PB:W	6.51ab	6.88a	6.28a	4.38b	1.74b	1.88a
2:1 PB:IV	3.56e	3.82cd	4.05c	.855cd	1.58b	1.83a
4:1 PB:IV	5.60d	5.38abc	5.92b	.510d	1.50b	1.18a
7:1 PB:IV	6.49ab	6.57ab	6.31a	1.85c	1.34b	1.56a

[Z] Substrate chemical properties were measured using the Virginia Tech pour through method.

[Y] Treatments (on a Vol:Vol ratio) were: PB = Pine Bark; PM = Peat Moss; W = Windrow; IV= In-Vessel Digester.

[X] EC = electrical conductivity reported in mS/CM (milliSiemens per centimeter).

[W] DAP = Days After Planting.

[V] Values in columns followed by different letters are significant according to Tukey's Studentized Range Test (α = 0.05).

Table 3. Plant dry weights for substrates comprised of poultry litter composted by two different methods[Z].

Treatment[Y]	Dry Weight[X]
	Grams
2:1 PB:PM	.422abc[V]
4:1 PB:PM	.793a
7:1 PB:PM	.018d
2:1 PB:W	.599ab
4:1 PB:W	.455abc
7:1 PB:W	.072cd
2:1 PB:IV	.478ab
4:1 PB:IV	.545ab
7:1 PB:IV	.373bcd

[Z] Dry weights are oven dried at 300°F.

[Y] Treatments (on a Vol:Vol ratio) were PB = Pine Bark; PM = Peat Moss; W = Windrow; IV = In-Vessel Digester.

[X] Dry weights in grams.

[V]values in columns followed by different letters are significant according to Tukey's Studentized Range Test (α = 0.05).

Table 4. Growth indices for substrates comprised of poultry litter composted by two different methods[Z].

Treatment[Y]	GI[X]
	Centimeters
2:1 PB:PM	64.17ab[V]
4:1 PB:PM	79.97a
7:1 PB:PM	3.67c
2:1 PB:W	73.50ab
4:1 PB:W	52.83ab
7:1 PB:W	7.50c
2:1 PB:IV	49.33ab
4:1 PB:IV	55.33ab
7:1 PB:IV	44.00b

[Z] Growth indices taken height x width[1] x width[2].
[Y] Treatments (on a Vol:Vol ratio) were PB = Pine Bark; PM = Peat Moss; W = Windrow; IV = In-Vessel Digester.

[X] GI = Growth Indices
[V]values in columns followed by different letters are significant according to Tukey's Studentized Range Test (α = 0.05).