Use of Composted Dairy Cow Manure as a Peat Moss Substitute in a Greenhouse Growing Substrate

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ABSTRACT

Dairies and other confined animal feeding operations (CAFOs) produce large amounts of manure that, when not disposed of properly, can lead to contaminated runoff into creeks and rivers or leach into ground water. Geenhouse experiments were conducted to determine if composted dairy cow manure can replace peat moss in greenhouse substrates. Bedding plants were grown in four substrate mixes: 1) 100% peat; 2) 50% peat, 25% perlite, 25% vermiculite; 3) 25% peat, 25% compost, 25% perlite, 25% vermiculite; and 4) 50% compost, 25% perlite, 25% vermiculite. The plants were grown to marketable size then dried, weighed, and analyzed for nitrogen content. Plants grown in mixes including compost had weights and nutrient levels that were equal to or higher than those grown in peat moss. This study suggests that dairy manure compost may be a suitable substitute for peat moss for greenhouse bedding plant production.

KEY WORDS: compost, peat moss, dairy cow manure, greenhouse production

INTRODUCTION

Dairies and other confined animal feeding operations (CAFOs) produce large amounts of manure that, when not disposed of properly, can lead to contaminated runoff into creeks and rivers or leach into ground water (Leatham et al. 1992; Hutson et al. 1998). Nutrients from manure, especially N and P, have been shown to encourage eutrophication in freshwater systems (Osei et al. 2003). Excess nutrients introduced into surface water may also increase the growth of algae and rooted aquatic plants. Oxygen is consumed when these plants die and decay and can lead to fish kills (Sharpley and Withers 1994). Some blue-green algal blooms produce carcinogens resulting in a direct health risk to humans and animals if consumed. These toxins also contribute to the unpalatability of drinking water derived from these bodies of water (Sharpley and Withers 1994).

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To reduce the amount of nutrients flowing from animal feeding operations into waterways, the Environmental Protection Agency (EPA 2007) requires CAFOs, including any dairy with more than 199 mature dairy cows, to apply for permits. These permits describe what measures must be taken to ensure the protection of the surrounding waterways from dairy waste effluent contamination. Some of the strategies for preventing the release of dairy waste into surface and ground waters include the construction of containment lagoons (Leatham et al. 1992), the application of wastes on crop production areas (Osei et al. 2003), turfgrass fields, and composting of waste material (Munster et al. 2004).

Another possible use for this material is as a substitute for peat moss (peat) in greenhouse growing substrate (Boodley and Sheldrake 2005; Chen et al. 1988; Inbar et al. 1993; Nelson 1991). The demand for peat as a component of growing substrate is rising while the supply is falling (Lohr et al. 1984). More than half of the peat used in the United States is imported, primarily from Canada. About 80% of U.S. peat production occurs in Florida, Michigan, and Minnesota. Domestic development of and the expansion of peat bogs has been reduced because of Federal and State wetland regulations.

Rawe and Cawthon (accessed 2005) replaced the peat constituent of a greenhouse mix with untreated raw dairy cow manure. They found that mixes containing untreated raw dairy manure had lower salinity levels than commercially-prepared potting mixes. These mixes also had low N levels and produced plants with lower dry weight and reduced height when compared to a commercial mix that contained no manure. When similar mixes were prepared using composted dairy manures prepared with an in-vessel composting system, the resulting plants were superior to those grown in mixes with raw manure and were comparable to those grown in the standard peat-lite substrate (Rawe and Cawthon, accessed 2005). Peat-based substrate can become contaminated during use and root, and crown rot diseases can become a problem in the greenhouse. Paviv et al. (2004) have shown that dairy cow manure-based composts can suppress at least some of the organisms that can cause these diseases. They also have demonstrated that these composts suppress some species of nematodes.

METHODS AND MATERIALS

Composted dairy cow manure (compost), sphagnum peat, horticultural vermiculite, and perlite were used to prepare four growing mixes (v/v). The substrates tested were: 1) 100% peat; 2) 50% peat, 25% perlite, 25% vermiculite; 3) 25% peat, 25% compost, 25% perlite, 25% vermiculite; and 4) 50% compost, 25% perlite, 25% vermiculite. The components of each mix were placed in a concrete mixer which was then operated for 10 minutes.

Three 200-cell plug trays filled with 50% peat, 25% perlite, and 25% vermiculite were used to germinate the seeds to produce plants for this research. One tray each was seeded with French marigold, *Tagetes patula* ‘Durango Bolero’, Salvia, *Salvia splendens* ‘Vista Red,’ and periwinkle, *Catharanthus roseus.* The plug trays were placed in a Pro-grow PC-46 germination cabinet at 22º C.

Twenty-seven 4-inch nursery containers were filled with each of the four substrate mixes for a total of 108 containers. Seedlings of marigold, salvia, and periwinkle were transplanted into the prepared containers. The containers were arranged in three plots on benches within a metal and glass greenhouse. The plots contained one row each of marigold, salvia, and periwinkle. Within each row, one seedling was placed into a container with one of the four substrate treatments for a total of 12 pots per row, and arranged randomly at 23 cm on center.

To simulate typical greenhouse procedures and to minimize differences in nutrient levels within the mixes, containers were watered daily and 20-20-20 fertilizer, at 200 ppm N, was applied at each irrigation (Nelson 1991).

After 45 days, three plants from each plot were removed from the growing media and roots cleaned of any foreign material. The plants were placed in paper bags and dried at 60º C for 48 hrs at the Texas Agrilife Experiment Station in Stephenville, Texas. The dried samples were ground to pass a 1 mm screen, weighed, and total dry weight for each plant was determined.

Nitrogen levels were measured using an Elementar vario Macro C:N analyzer (Elementar Americas, Inc., Mt. Laurel, NJ, USA). The experiment was a complete block design and the data were analyzed using Proc GLM (SAS Institute, Cary, NC). Means were separated using ($p < 0.05$) mixed model ANOVA.

RESULTS

There was no significant difference ($P > 0.05$) in total plant weight of periwinkles or marigolds grown in the different substrates (Fig. 1). Salvia grown in compost-amended media were larger ($P < 0.05$) than those grown in either peat-based substrate.

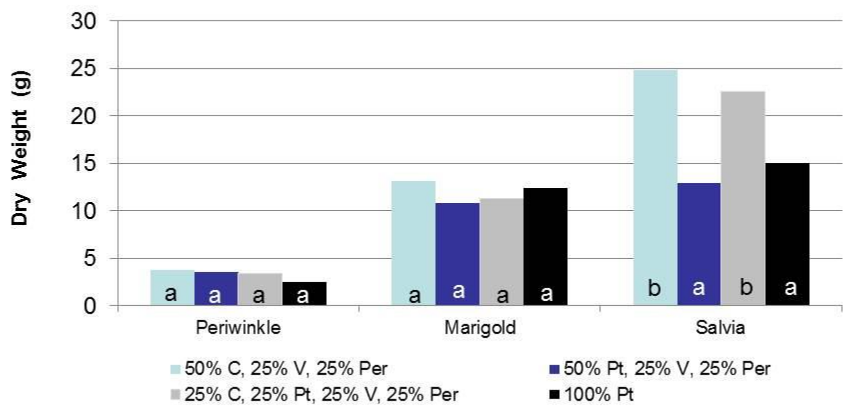

Figure 1. Mean plant weight ±SE of periwinkle, marigold, and salvia grown in four media mixes. Bars with different letters differ ($P < 0.05$; LSD SAS Institute) by mixed model ANOVA.

Total nitrogen in periwinkle plants grown in 50% peat did not differ significantly from those grown in any of the other mixes (Fig. 2). Periwinkles grown in 50% compost and 25% compost, 25% peat had the highest nitrogen levels and did not differ significantly from each other, but were significantly higher than those grown in 100% peat. Total nitrogen in marigolds grown in 25% compost, 25% peat, and 100% peat did not differ from each other or from those grown in any of the other mixes. Those grown in 50% peat had the lowest levels of nitrogen and did not differ significantly from those grown in 25% compost, 25% peat, and 100% peat but did differ significantly from those grown in 50% compost which had the highest levels. Total nitrogen levels in salvia plants did not differ significantly among treatments.

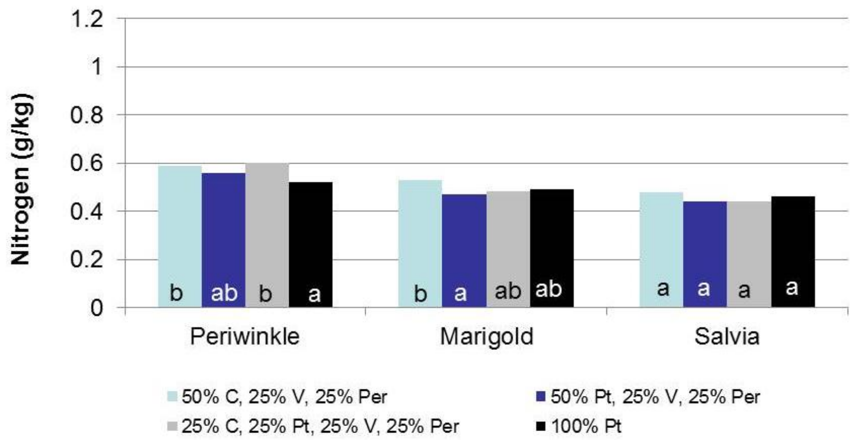

Figure 2. Mean nitrogen content ±SE of periwinkle, marigold, and salvia plants grown in four media mixes. Bars with different letters differ ($P < 0.05$; LSD SAS Institute) by mixed model ANOVA.

DISCUSSION

Salvia plants had significantly greater mass when grown in either of the mixes that contained compost than in the two mixes without compost. All other roots, shoots, and plants of any species grown in 50% compost had masses that were greater than or not significantly different from those grown in the other mixes.

In all species, the shoots and total nitrogen levels were higher than or not significantly different than those in plants that were grown in the mixes with compost compared to those grown in mixes without compost.

Although there were some differences in plant responses among some of the treatments the mixes that contained compost produced weights and nitrogen levels that were equal to or greater than the standard peat-lite mix. Composted dairy cow manure was a suitable substitute for peat in a peat-lite greenhouse substrate. Salvias in particular responded to it as a complete replacement for peat or as a replacement for 50% of the peat.

REFERENCES

Boodley JW, Sheldrake Jr R. 2005. Cornell peat-lite mixes for commercial plant growing. *Cornell Coop. Ext. Serv.* Information Bulletin 43.

Chen Y, Inbar Y, Hadar Y. 1988. Composted agricultural wastes as potting media for ornamental plants. *Soil Sci.* 145:298-303.

EPA. 2007. Method 3050B, acid digestion of sediments, sludges, and soils [Online]. Available at www.epa.gov/sw-846/pdfs/3050b.pdf (accessed 21 July 2007; verified 29 Oct. 2007).

Hutson JL, Pitt RE, Koelsch RK, Houser JB, Wagenet RJ. 1998. Improving dairy farm sustainability II: Environmental losses and nutrient flows *J.Prod. agric. 11:233-239.*

Inbar Y, Hadar Y, Chen Y. 1993. Waste Management (Recycling of cattle manure: The composting process and characterization of maturity). *J.Environ.Qual.* 22:857-863.

Leatham DJ, Schmucker JF, Lacewell RD, Schwart RB, Lovell AC, Allen G. 1992. Impact of Texas water quality laws on dairy viability and income. *J. Dairy Sci. 75:2846-2856.*

Lohr VI, O'Brien RG, Coffey DL. 1984. Spent mushroom compost in soilless media and its effects on the yield and quality of transplants. *J. Amer. Soc. Hort. Sci.* 109(5)693-697.

Munster CL, Hanslik JE, Vietor DM, White RH, McFarland A. 2004. Assessment of manure phosphorus export through turfgrass sod production in Erath County, Texas. J. *Environmental Management*. 73:111-116.

Nelson PV. 1991. <u>Greenhouse Operation and Management - Fifth Edition.</u> (pp.195-197, pp 208-209, pp 211-212) Prentice-hall, Inc., Englewood Cliffs, New Jersey.

Osei E, Gassman PW, Hauck LM, Jones R, Beran L, Dyke PT, Goss DW, Flowers JD, McFarland AMS, Saleh A. 2003. Environmental benefits and economic costs of manure incorporation on dairy water application fields. *J.Environmental Management.* 68:1-11.

Paviv M, Oka Y, Hadar Y, Yogev A, Medina S, Krasnovsky A, Ziadna H. 2004. High-nitrogen compost as a medium for organic container grown crops. *Bioresource Technology*. 96 (2005) 419-427.

Rawe LW, Cawthon DL. In-Vessel Composting of Dairy Cattle Solid Waste and Utilization as a Peat Moss Substitute in Greenhouse Growing Media. Accessed 2005. http://www7.tamu-commerce.edu/agscience/res-dlc/reports/rawe.html#ack