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# Chrysanthemum Production in Composted and Noncomposted Organic Waste Substrates Fertilized with Nitrogen at Two Rates Using Surface and Subirrigation

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***Abstract*. As nursery and greenhouse growers adopt more sustainable production practices, interest has grown in local, recycled organic materials (ROM) as partial or complete substitutes for peat in container substrates. *Chrysanthemum ×morifolium* Ramat. 'Shasta' was grown in substrates formulated from ROM: 1) 100% Groco, an anaerobically digested biosolids composted with sawdust; 2) 100% Tagro, a thermophilically digested class A biosolid mixed with sawdust and sand; 3) 100% dairy compost, the solids screened from dairy manure slurry and then composted; 4) 100% dairy fiber, the solids fraction from an anaerobic dairy manure digester; 5) 50% Groco:50% douglas-fir bark (mixed by volume); 6) 50% Tagro:50% bark; 7) 50% dairy compost:50% bark; 8) 50% dairy fiber:50% bark; and 9) the control, a commercial peat–perlite mixture. Soluble fertilizer [200 mg·L$^{-1}$ nitrogen (N)] was applied every second day (high N) or every fourth day (low N). Water was applied through capillary mat subirrigation or overhead sprinkler surface irrigation. Surface irrigation and high N produced shoot dry weight, shoot growth index (SGI), quality, and flower bud counts similar to controls in all ROMs but Groco. Groco SGI was similar to the control but the other parameters were lower. Surface-irrigated, low N shoot dry weight, SGI, and flower buds in all ROM equaled or exceeded the control and quality was similar to or better than controls in all but dairy compost:bark. Subirrigated and high N substrate comparisons indicated that growth, quality, and flower bud measurements were similar to the control except for Groco in which performance was reduced. Low N rate subirrigation produced dry weight, SGI, quality, and flower buds similar to or better than the control in all but the Groco and dairy compost:bark substrates. The generally inferior performance in Groco is likely the result of its low water-holding capacity. In substrates with higher available N (Groco, Tagro, Tagro:bark, and dairy fiber), plant growth parameters generally did not respond to doubling the applied N; in the other substrates, including the control, growth generally increased in response to additional N. Measured differences in leaf color across treatments were not large. Root growth of plants in the experimental substrates was similar to the control in both irrigation systems. Substrate effects on leachate nitrate-N were small and inconsistent. When properly constituted, biosolids and dairy manure can be used as substrates under reduced fertilization with both surface and subirrigation systems.**

Sphagnum peat has been the standard base component for most container growing substrates in the United States since the 1950s. It is an ideal container substrate because it has low bulk density, high water-holding capacity, good aeration porosity, low soluble salts, acceptable pH, and high uniformity across batches (Schmilewski, 1983; Stamps and Evans, 1999). As nursery and greenhouse growers seek to adopt more environmentally and economically sustainable practices, interest has grown in the use of local, recycled organic materials as partial or complete substitutes for peat in container substrates (Fitzpatrick, 2001; Raviv, 2005). Because these materials have typically entered the waste stream, their use as container substrates reduces solid waste production and the subsequent need for disposal.

Alternative components include various composted materials (Carlile, 2008; Corti et al., 1998) using feedstocks such as yard debris and pruning waste, animal manures, biosolids, agricultural green waste, woody debris, municipal solid waste, and food waste. In general, substrates made from these materials have greater bulk density, soluble salts, and pH; lower porosity and available water capacity; and less uniformity than peat-based substrates (Corti et al., 1998). Despite these shortcomings, numerous studies have shown that container substrates with acceptable quality can be made using composts, supplying nutrients and producing plants of equivalent and sometimes better growth and quality compared with standard substrates (Bugbee, 2002; Clark and Cavigelli, 2005; Estévez-Schwarz et al., 2009; Grigatti et al., 2007; Hummel et al., 2000, 2001; Tittarelli et al., 2009). High salt content and lack of uniformity frequently have been the greatest problems to overcome in developing alternative container substrates (Bugbee, 2002; Ozores-Hampton et al., 1999).

Bark, another component of container substrates often used at rates as high as 60% to 100% by volume, is decreasing in availability and rising in cost (Buamscha et al., 2007; Lu et al., 2006). The demand for sustainable alternatives to bark has prompted research to develop substrates composed of whole pine trees (Fain et al., 2008; Jackson and Wright, 2009) and clean chip residual (Boyer et al., 2009). Other uncomposted materials may also have potential as inexpensive and sustainable peat substitutes (Ingelmo et al., 1998), but many of these materials have had little study. Some uncomposted recycled organic materials currently in use or with potential as substrate components include coir (Stamps and Evans, 1999), poultry feather fiber (Evans, 2004), rice hulls (Evans and Gachukia, 2004), and a noncomposted residential refuse (Kahtz and Gawel, 2004).

Reducing water and fertilizer use and managing leachate are also key to sustainable container production systems (Biernbaum, 1992; Uva et al., 1998). Research has demonstrated the efficiencies of subirrigation with recirculation in reducing water, fertilizer, and labor inputs while maintaining plant growth and quality (Argo and Biernbaum, 1995; Klock-Moore and Broschat, 1999; Molitor, 1990; Morvant et al., 1998, 2001; Neal and Henley, 1992; Uva et al., 1998). Subirrigation relies on water uptake through capillary action, and substrates suitable for subirrigation systems must readily absorb water by capillarity (Reed, 1996). Gabriëls et al. (1986) stress the importance of substrate physical parameters, especially aeration, in subirrigation systems. Most of the research on subirrigation systems has been done using substrates with peatmoss as a primary component. Incorporation of recycled organic materials into sustainable container production systems requires testing their efficacy as substrates for subirrigated crops.

This project compares a range of locally available peat substitutes for greenhouse production of chrysanthemum fertilized at two N rates using conventional overhead irrigation and a capillary mat subirrigation system. Alternative substrates include biosolids compost, an uncomposted class A biosolids (U.S. Environmental Protection Agency, 1994) blend, dairy manure compost, and solids from an

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