top dry weight of all four species (forsythia, r=0.73**; ninebark, r=0.43*; dogwood, r=0.65**; and weigela, r=0.48*; **, * $P \leq 0.01$ and 0.05, respectively). This result provided evidence that enhanced growth (Fig. 1), and/or increased foliar nutrient status in three (forsythia, ninebark, and weigela; data not shown) of the four species, were related to higher retention of nutrients (salts) in the compost-amended groups, especially as the rate of biosolids increased. Higher bulk densities and water retention capacities in the compost — versus the bark — amended groups (Table 2) may also have contributed. However, reason(s) for the poor growth of weigela in all treatments compared to the control mix is not clear.

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Mycorrhizal Fungi, and Organic and Inorganic Slow Release Fertilizers Influence Growth of Bush Morning Glory (*Ipomoea carnea* subsp. *fistulosa*)©

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INTRODUCTION

This study investigated the utilization of arbuscular mycorrhiza fungi (AMF) to enhance the efficiency of slow-release organic and inorganic fertilizers during container production of bush morning glory (*Ipomoea carnea* subsp. *fistulosa*). Uniform rooted liners of *Ipomoea carnea* subsp. *fistulosa* were planted into 9.6-liter (2-gal) pots containing a pasteurized soilless medium [pine bark to sand (3 : 1, v/v)]. The mycorrhizal treatments consisted of two commercial AMF inocula: Bioterra Plus and Mycorise Pro, and a noninoculated control [NonAMF]. Fertilizer treatments included an organic slow-release fertilizer (SRF) (Nitrell; 5N-3P-4K) and an inorganic SRF (Osmocote; 18N-7P-10K). Nitrell was tested a three levels: 8.4 kg m^{-3} (14 lb per yd^3), 12 kg m^{-3} (20 lb per yd^3), and 16.8 kg m^{-3} (28 lb per yd^3), which were, respectively, 70%, 100%, and 140% of the manufacturer's recommended rate. Osmocote was tested at two levels: 3.5 kg m^{-3} (6 lb yd^{-3}) and 7.0 kg m^{-3} (12 lb per yd^3) which were, respectively, 50% and 100% of the recommend rate. With organic and inorganic SRF, both mycorrhizal inocula significantly enhanced the marketability, growth index, root, leaf, shoot, and total plant dry mass of bush morning glory. The greatest growth response occurred with the highest level of Osmocote colonized

with Bioterra Plus. The mycorrhizal enhanced growth response was in part due to greater N, P, K, B, Fe, and Mn uptake. Organic and inorganic SRF regimes did not inhibit mycorrhizal development, which ranged from 12% to 27% colonization.

The incorporation of new production systems to reduce fertilizer and pesticide usage without reducing plant quality is one of the most important challengers facing the nursery industry. The utilization of best management practices (BMP) such as recycling irrigation water, increased SRF usage, and biological pest control are some of the practices that the nursery industry has implemented. There is much potential in utilizing AMF in nursery production systems since AMF enhance plants nutrient and water relations and increase plant tolerance to environmental stress. Arbuscular mycorrhiza fungi can also increase disease resistance, increase photosynthesis and plant vigor, and reduce transplant stress — all benefits that enhance crop production value.

The objective of this research were to demonstrate that AMF can enhance the efficiency of organic and inorganic SRF, therefore improving growth and marketability of ornamental plants during production. A long-term goal in utilizing AMF is to enhance fertility efficiency, minimize environmental pollution during production, and increase plant marketability.

RESULTS AND DISCUSSION

With organic (Nitrell) and inorganic (Osmocote) SRF, both commercial AMF inocula significantly enhanced the growth, nutrient uptake, and marketability of bush morning glory. Plants colonized with Bioterra and Mycorise Pro had a greater growth index, root, leaf, shoot, and total plant dry mass, regardless of the SRF source. The greatest total dry mass accumulation was obtained at the highest level of inorganic SRF. While P levels were equilibrated between the organic-140% and inorganic-100% SRF, the nitrogen levels of inorganic SRF were higher, which in part led to the greater growth response. The organic-150% depressed plant growth compared to the 70% and 100% recommended levels.

There were higher yields (shoot, root, and leaf dry mass, and leaf area) with the commercial SRF recommended levels (inorganic-100%) followed by inorganic-50% and organic-70%. The greatest growth response was obtained with Bioterra commercial inoculum with inorganic-100% at the commercial nursery recommended level of 12 lb per yd^3 (7.0 $kg \cdot m^{-3}$). These results are promising since under commercially recommended fertility levels, the addition of mycorrhiza can improve plant growth.

Plant biomass and growth index increased as the levels of inorganic SRF increased. With organic-70% plants colonized with AMF had a greater total plant mass and growth index than plants at 100% and 140% of the recommended rate. The lowest plant dry weight for AMF treatments was the SRF organic-140 %. Growth depression at the higher rate was likely due to ammonium stunting plant growth.

When comparing AMF within a reduced inorganic SRF level (Osmocote-50%), Bioterra increased the total plant dry mass of bush morning glory two-fold and Mycorise Pro increased the total dry mass more than three-fold compared to non-AMF plants.

In general, total leaf elemental status of Bioterra Plus and Mycorise Pro AMF plants were significantly higher than nonAMF plants. Leaf tissue N, P, K, B, Fe, and Mn were highest at inorganic-100% SRF compared to any level of the organic SRF. NonAMF plants fertilized with organic SRF had greater leaf tissue N, P, K, B,

Fe, and Mn at 100% than 70% or 140% of the recommended levels. When colonized with Bioterra Plus, organic-70% SRF had greater elemental uptake than either the 100% of 140% levels. Mycorise Pro colonized plants treated with the organic SRF had similar P and K regardless of fertility level, however, high organic fertility levels depressed leaf N, B, and Mn.

Mycorrhiza colonization among inoculated treatments was high, ranging from 12% to 27%. The higher fertility rates for organic and inorganic fertilizer did not depress AMF colonization. These results suggest that the commercial isolates under study are able to survive, colonize, and be effective in a commercial nursery container production system.

The overall improved plant growth of selected AMF and SRF treatments was also reflected in the marketability of plants evaluated after 56 days of container growth (just prior to terminating the experiment). Marketable plants had compact growth, dark green leaf color, good branching, and the presence of blooms or floral buds. Plants that did not meet this criterion were considered nonmarketable (nonsalable). Mycorrhizal plants were more marketable among all SRF treatments. In general, AMF plants fertilized with inorganic SRF were more marketable than with organic SRF. Bioterra at 50% and 100% inorganic SRF, and Mycorise Pro at inorganic-100% SRF had the greatest number of marketable plants. This is an important result since mycorrhiza inoculation can effectively reduce fertilizer inputs, i.e., high marketability occurred with AMF-treated plants at 50% of the recommended inorganic and 70% of the organic SRF.

CONCLUSION

There are excellent opportunities to incorporate arbuscular mycorrhizal (AMF) in nursery production systems that help reduce fertility and pesticide usage, and enhance crop vigor, productivity, and plant survival rates during transplanting to field conditions. Arbuscular mycorrhiza fungi and inorganic and organic SRF fertilizer regimes increased overall plant growth (plant root, leaf, shoot, and total dry mass) and marketability of container-grown bush morning glory. Mineral elemental status of colonized plants was significantly higher than NonAMF plants. AMF enhanced growth response was in part due to greater N, P, K, B, Fe, and Mn uptake. Both commercial inocula were able to survive and be effective in improving the growth and development of containerized plants at even the highest level of fertility. Arbuscular mycorrhiza fungi also enhanced the growth and marketability of plants fertilized with inorganic and organic SRF at lower than recommended fertility levels — hence the potential to lower fertility inputs and still maintain high marketability.