Field Production

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Section Editor

Biosolids-based Fertilizer Performance in Annuals Trials

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Index Words Dianthus, kale, petunia, sewage sludge, soil amendments, Swiss chard

Relevance to the Industry This project shows that nursery and landscape professionals can successfully use properly vetted biosolids as part of their suite of fertilizer and soil amendment choices in landscape installations. With a few modest exceptions, growth and flowering of all species provided with adequate amounts of biosolids application was comparable to that seen with conventional or slow release fertilizer. Other than perhaps the bulkiness of biosolids relative to other fertilizers and the possible negative impacts of over application, as seen with dianthus, we saw no significant negative aspects of the EQ biosolids used in this study. Biosolids provide organic matter that can improve soil structure, along with macro- and micro-nutrients for plant growth. In addition, any EQ biosolids meet stringent USEPA rules for heavy metals and pathogen content, minimizing safety concerns.

Some possible large volume uses for EQ and Class A biosolids include right-of-way plantings, park and recreation development, and new construction installations. For smaller volumes, local biosolids may be appropriate as complete or partial replacements for other natural or synthetic fertilizers in container or pack production, something we are still investigating. EQ biosolids can also be bagged and sold or blended into production substrates and sold (1). Biosolids users should ask to see independent lab tests and only work with products meeting the horticultural, client and business needs of a particular situation. Some markets will welcome the appropriate use of this societal by-product as a cost-efficient and helpful part of integrated environmental management. Still others may have unalterable concerns about biosolids application, despite the permitting, testing, and regulations surrounding it.

Introduction Biosolids is a term describing the dried solid residuals of sewage processing. Sewage residuals tend to be rich in plant nutrients and high in organic matter which makes them good candidates for fertilizer and soil amendment uses. Indeed, they are used throughout the world to fertilize farmland and ornamental production and landscape installations. However, they can also contain heavy metals and human pathogens. Because of variation in quality across the nation, some care must be exercised when selecting and using biosolids.

The production, handling and use of biosolids are highly regulated in the United States. At the national level, the U.S. Environmental Protection Agency (USEPA) regulates sewage disposal, handling and processing. There are also additional regulations at the state and local level. In Mississippi, the state Department of Environmental Quality regulates water treatment facilities and issues permits and Beneficial Use Determinations (BUDs) for land application of biosolids.

Despite the myriad of regulations and laws, there are several common traits outlined in USEPA regulations that make a local study of biosolids for agricultural application relevant across production zones. To classify biosolids, producers or processors are required to submit samples for testing by certified laboratories to document regulated pollutant/metals concentrations, pathogen content, and vector attraction. The USEPA separates biosolids into two main regulated classes: A and B. Class A, Exceptional Quality (EQ) biosolids can be made by meeting a stricter subset of standards for pollutants, and mitigation of odors and fly populations within the standards for Class A biosolids. The USEPA writes that "EQ biosolids are considered a product that is virtually unregulated for use,…" (1). Class B biosolids, which may have lower standards for pollutant and pathogen content, have significant timing and handling restrictions on their application and can never be used for residential applications (1). The environmental quality of Class A biosolids is consistent among municipalities across the nation because they all must meet specific safety standards outlined by the USEPA. For this study, we tested the landscape performance of four annual crops using two synthetic fertilizers and four rates of a locally available EQ biosolid product.

Materials and Methods Biosolids were acquired from the City of Clinton (Mississippi) Department of Public Works in September 2015. The biosolids were EPA Class A, EQ (1) derived from the city's sanitary sewer system, much of which is separated from the storm sewers. The product from Clinton falls under a BUD issued by the state of Mississippi, as well. Clinton is a mostly residential suburb of Jackson, with little industrial or urban contribution to the sewer system in-flow. In Clinton's sewage processing system, sludge is removed from lagoons after primary and secondary treatment steps of screening, treating, flocculating, settling and dewatering. The city then uses the Thermo-System (Parkson Co., Fort Lauderdale, FL) to complete the processing into EQ biosolids. In this system, the processed solid fraction is removed from the dewatering system and spread on concrete floors in large, ventilated greenhouses to a depth of 1 ft. The solids are stirred daily by autonomous, programmed tilling machines (Electric Moles®, Parkson), exposing them to the drying sunlight and sanitizing UV rays. After six weeks, the product is removed from the greenhouse and held in static piles on site for later dispersal to area farmland or the landfill. We took delivery of approximately 10 cu. yd. of the fully processed EQ biosolids for our experiments. We used plant nutrient content data provided by the City of Clinton to calculate application rates. Test results provided by the City of Clinton from an independent lab indicated that the material was well below regulatory standards for concentration of arsenic, mercury, lead, and several other regulated metals.

The influence of EQ biosolids was tested on four fall planted annuals: dianthus (*Dianthus chinensis x barbatus* cv. Floral Lace Cherry), petunia (*Petunia x hybrida* cv. Dreams Coral Morn), kale (*Brassica oleraceae* var. *acephala*, cv. Pidgeon White), and Swiss chard (*Beta vulgaris* Cicla Group, cv. Bright Lights), of which dianthus, chard and kale are edible landscape plants.

We pre-bedded field rows 6 in. tall and 24 in. wide, set 6 ft. apart. Fertilizer and amendment treatments were applied by hand in a wide band to the top of the pre-bedded area of each plot, after which, the beds were reworked with the commercial bed shaper mulch layer to incorporate the products. Treatments 1-4 included: 2, 8, 14 and 20 t/a biosolids (as delivered weight), with an estimated nitrogen (N) availability of 50% of total N during the study period; a conventional fertilizer blend applied to provide 100 lb/a N (trt 5) and to mimic the nitrogen:phosphorus:potassium ratio (N:P:K), a 15-9-12 slow release fertilizer (Osmocote®, Scotts-Miracle Gro, Marysville, OH) (trt 6) applied to provide 100 lb/a N. The synthetic fertilizer ratios were selected to approximate the N:P:K ratio of the biosolids, which was very close to 5:3:4. During this pass, high-flow drip irrigation tape with 12-inch emitter spacing (Aqua-Traxx, The Toro Co., Bloomington, MN), was placed under black polyethylene mulch in the center of the bed, approximately 2 in. below the soil surface. Ten plants of each crop were transplanted to the center of the beds, resulting in four sub-plots in each amendment main plot. A 10-foot gap was left in the row between main plots to minimize N movement among plots.

Plants were grown out to landscape finish through early December, when the study was terminated. The plants were sampled for height, growth index [((longest width + perpendicular width)/2) + height)/2], and flower count at 43 and 56 days after transplanting (DAT). Half of the plants in each sub-plot were harvested by clipping at the soil line at each of these two dates and their whole shoot fresh and dry weights were determined. Dry weights were recorded after drying at 65°C in a forced air oven.

The experimental design was a randomized complete block design with a split-plot arrangement of treatments. There were four replications, six amendment/fertilizer main plots, and four crop sub-plots within each main plot. Data were initially analyzed with PROC ANOVA, PROC GLMIX, PROC MIXED, or PROC REG, as appropriate, using SAS (SAS Inst., Cary, NC).

Results and Discussion The season was unusually warm and dry. Application of the biosolids was easy and proved less dusty and produced less odor than many organically-based fertilizers we have tested. From transplanting to termination, all plots grew well and there were few disease or insect pressures that influenced the trial. Less than 1% plant loss occurred during the growing period, although there seemed to be a negative influence of the highest rate of biosolids (20 t/a) on establishment of the dianthus which exhibited poor early vigor and some death in that treatment in all replications.

Growth index (GI) for dianthus was greatest in the 2 t/a biosolids and the slow release fertilizer treatment. Higher application rates of biosolids reduced growth indexes. Similar results were seen in Swiss chard, where the 8 and 20 t/a biosolids treatments produced smaller GI than the other treatments (Fig. 1). The trends in kale and petunia were less clear, with no significant differences seen in kale GI among treatments, and marginal differences seen between the conventional fertilizer treatments and two of four biosolids treatments in kale.

Flower counts in petunia and dianthus were similar for all treatments on each date tested, with dianthus flowering beginning a week to ten days after that for petunia (data not shown).

At 43 DAT, there were no differences in total shoot dry weight within species due to fertilizer source or rate, except in Swiss chard (Fig. 2). The two lowest rates of biosolids, 2 and 8 t/a applied to Swiss chard, produced less dry matter than the synthetic sources of fertilizer, while the two highest rates produced similar amounts of dry matter to both the lowest rates of biosolids and the two synthetic sources.

Overall, landscape performance was very similar for all crops across all fertilizer treatments. There was a bit of damage to dianthus at the highest rate of biosolids but we suspect that a different placement technique that kept the biosolids from being quite as concentrated in the planting zone would reduce transplant damage. There was also an indication that Swiss chard did not have adequate N availability late in the test period at the lowest rate of biosolids tested and may require supplemental N if lower biosolids rates are used. However, in all cases, biosolids were able to grow crops with consistent growth, vivid coloration and, for petunia and dianthus, flowering equal to that provided by the synthetic fertilizers used for comparison.

This publication is a contribution of the Mississippi Agricultural and Forestry Experiment Station. This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, Hatch project under accession numbers 0209485 and 1006346.

Literature Cited

1. USEPA, 1994. A plain English guide to the EPA Part 503 biosolids rule. EPA/832/R-93/003 September 1994. < https://www.epa.gov/sites/production/files/2015-05/documents/a_plain_english_guide_to_the_epa_part_503_biosolids_rule.pdf> Accessed July 15, 2016.

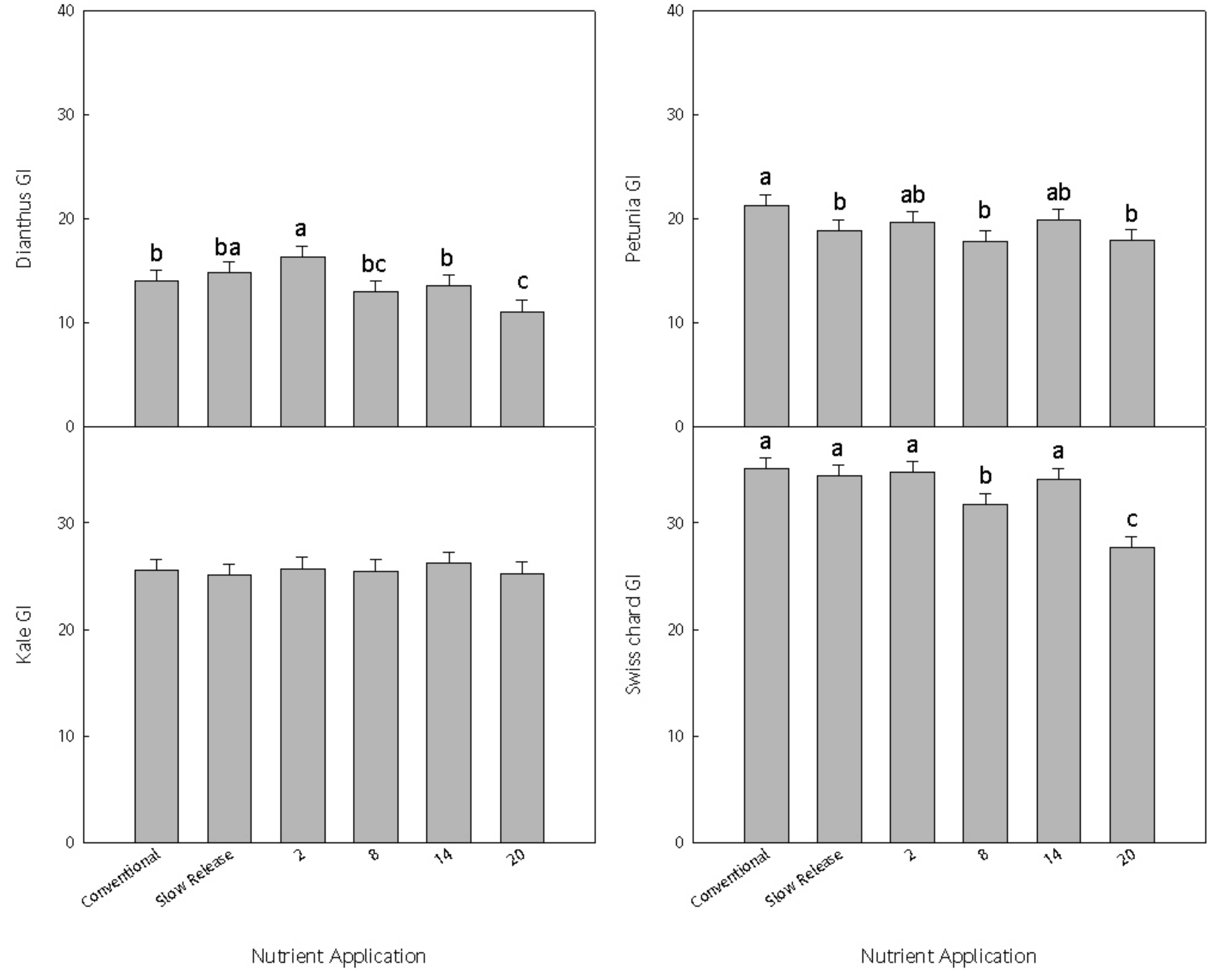

Figure 1. Growth index of four crops 29 DAT in response to fertilizer treatments. (Conventional = 670 lb/a of 15-9-12 blend of ammonium sulfate, triple super phosphate and potassium chloride; 670 lb/a 15-9-12 Osmocote® slow release fertilizer; or 2, 8, 14 or 20 t/a biosolids). Within species, bars with no common letters are significantly different from one another at the p < 5% level, bars without letters are nonsignificant.

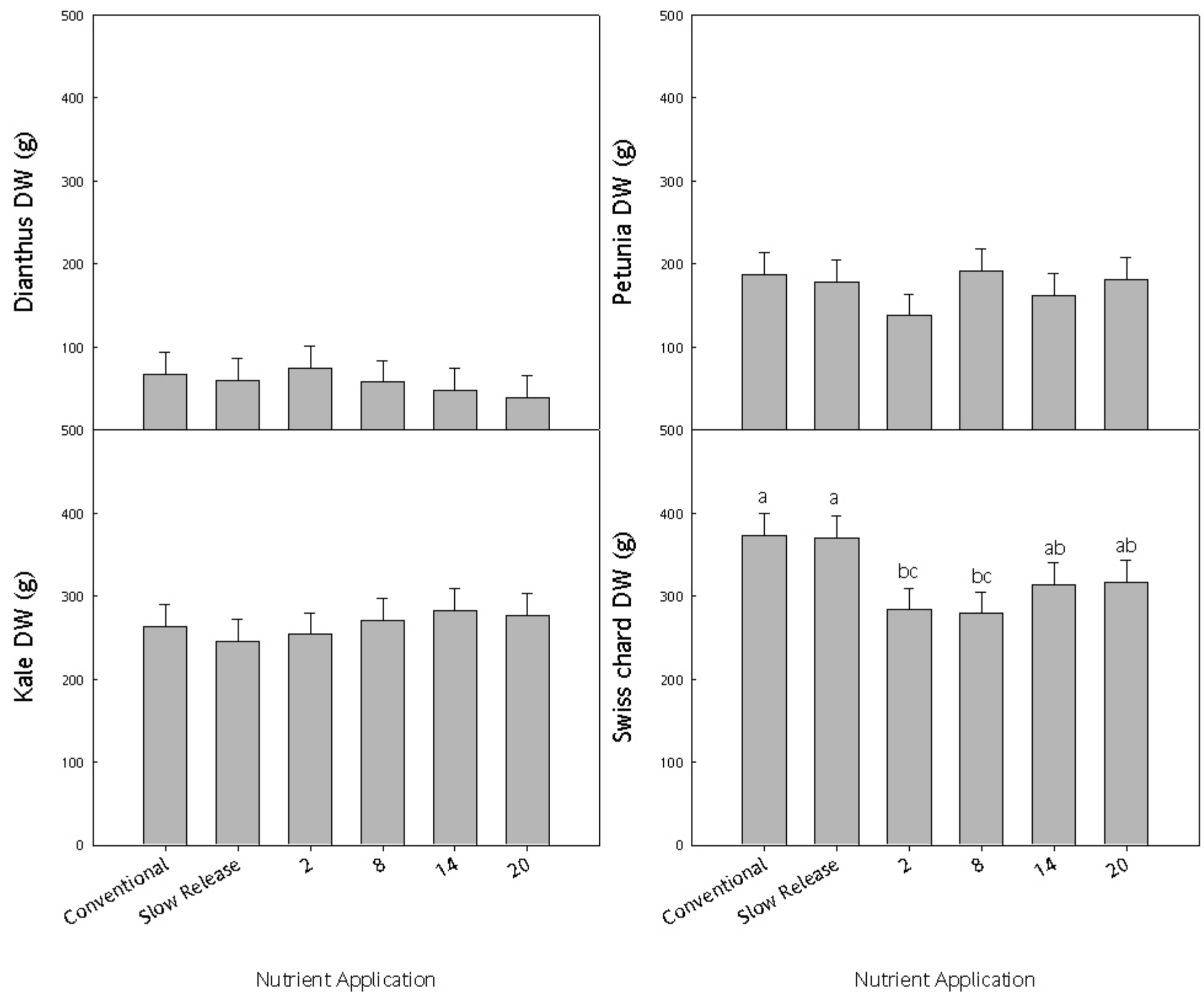

Figure 2. Influence of fertilizer source and rate on whole shoot dry weight in four species, 43 days after transplanting. (Conventional = 670 lb/a of 15-9-12 blend of ammonium sulfate, triple super phosphate and potassium chloride; 670 lb/a 15-9-12 Osmocote ® slow release fertilizer; or 2, 8, 14 or 20 t/a biosolids.). Within species, bars with no common letters are significantly different from one another at the $p < 5\%$ level, bars without letters are nonsignificant.