Effects Of Pasture-Applied Biosolids (Municipal Sewage Sludge) On Forage Nutrient Concentrations Over A Grazing Season in North Florida

Mark Tiffany  
Lee McDowell  
George O’Connor  
Frank Martin  
Nancy Wilkinson  
Elizabeth Cardoso  
Patricia Rabiansky

The use of biosolids as pasture fertilizer may improve forage nutritive value as well as providing a means for sludge disposal. Copper supplementation is important to cattle as biosolids fertilization results in elevated forage S (0.40%) which interferes with the metabolism of Cu.

Summary

The experiment rationale was to determine forage mineral and in vitro organic matter digestibility (IVOMD) and crude protein (CP) concentrations as effected by biosolids (Municipal Sewage Sludge) fertilization. We determined the effects of two exceptional quality biosolids on bahiagrass nutrient concentrations as related to beef cattle requirements. Twenty-five 2-acre pastures were divided into five blocks. Two biosolids were applied at normal and double agronomic rates. The control received NH₄NO₃. Crude protein concentrations were elevated above the control for all biosolids treatments late in the season, whereas only small differences were observed at early sampling times. Applications of biosolids to pastures had little effect on IVOMD, calcium (Ca), phosphorus (P), sodium (Na), and potassium (K) forage concentrations, but forage magnesium (Mg) was elevated in several treatments late in the season. Some increases (P<0.05) in forage cobalt (Co), copper (Cu), iron (Fe), zinc (Zn), and selenium (Se) were observed at various sampling times, but the increases were generally small and biologically insignificant. Although forage molybdenum (Mo) samples from pastures with the Tampa biosolids applied, were consistently higher than the control (P<0.05), at no time did they approach levels considered toxic. In relation to beef cattle requirements, the majority of forages were deficient in Na, Co, Cu, Se, and Zn.

Procedure

In 1996, a 176-d grazing experiment evaluating biosolids-treated pastures began May 9 and ended November 2. Twenty-five 2-acre bahiagrass (Paspalum notatum) pastures were divided into five blocks, with each treatment represented once in every block. Biosolids were surface-applied to pastures 20 to 38 d before grazing, soils were acid and well drained. Biosolids application rates were based on the local nitrogen (N) recommendation (159 lb N/acre) for well-fertilized bahiagrass, assuming that 40% of the biosolids N becomes available. The treatments were 1) Baltimore biosolids (B1X: 1X=159 lb N/acre), 2) Baltimore biosolids (B2X: 2X=319 lb N/acre), 3) Tampa biosolids (T1X: 1X=159 lb N/acre), 4) Tampa biosolids (T2X: 2X=319 lb N/acre), and 5) the control, NH₄NO₃ applied at the “x” rule (159 lb N/acre) half at the beginning (April 29) and half in the middle (June 27) of the experiment. These biosolids contained varying concentrations of a number of elements, including Mo at 12 and 33 ppm, respectively, for Baltimore and Tampa biosolids. Metal loading rates varied with application rates. Exceptional quality biosolids, like those used in the present experiment, can be applied at any rate, although the Environmental Protection Agency (EPA) recommends deriving application rates based on crop N needs. Forage and soil samples were collected at the Santa Fe Beef Research Unit, a 1600-acre beef cattle operation owned by the University of Florida, located in Alachua County in north Florida. Soil series are Millhopper sand, Bonneau fine sand, and Gainesville sand.

Forage samples were collected six times, once every 4 wk, beginning on June 14, 1996, with a transect technique. Two composite (three subsamples per composite) forage samples were taken from each pasture. For the 176-d experiment, only the final collection (November) will be reported for this document.

2003 FLORIDA BEEF REPORT 7
Results

Mean forage Ca concentrations were all higher ($P<0.05$) for biosolids treated pastures than the control (Table 1). There were no treatment differences for P, K, and Na, however Mg, CP, and IVOMD concentrations were all higher for biosolids treated pastures compared to the control. Crude protein concentrations were particularly higher for pastures receiving biosolids, 14.0 to 15.6% vs 11.3% for the control. All treatment means for forage Na (Table 1) concentrations were well below the critical limit of 0.06% (NRC, 1996).

Forage Co was extremely low (0.036 ppm, the requirement is 0.10 to 0.20 ppm) in the control pasture but was higher as a result of the Baltimore biosolids treatment (Table 2). The Cu concentrations were very deficient in Na (<0.06%), Co (<0.1 to 0.2 ppm), Cu (<10 ppm), Zn (<30 ppm), and Se (<0.2 ppm). Even though the biosolids contained high amounts of Mo, this did not greatly increase forage Mo when grown on acid well-drained soils. However, forage S was high (0.40%), which did increase the likelihood of Cu deficiency.

All biosolids treatments resulted in higher (P<0.05) forage Mn compared to the control. Iron was also generally increased by biosolids applications. Zinc forage concentrations were increased in all but one biosolids treatments over the control. Iron in relation to beef cattle requirements, forages were very deficient in Na (<0.06%), Co (<0.1 to 0.2 ppm), Cu (<10 ppm), Zn (<30 ppm), and Se (<0.2 ppm). Molybdenum forage content was higher for biosolids treated forages. However, the highest level of 1.23 ppm was still insufficient to result in a Cu deficiency. For Mo to interfere with Cu metabolism the Cu:Mo ratio should be less than 2:1.

In relation to beef cattle requirements, forages were very deficient in Na (<0.06%), Co (<0.1 to 0.2 ppm), Cu (<10 ppm), Zn (<30 ppm), and Se (<0.2 ppm). Molybdenum forage content was higher for biosolids treated forages. However, the highest level of 1.23 ppm was still insufficient to result in a Cu deficiency. For Mo to interfere with Cu metabolism the Cu:Mo ratio should be less than 2:1.

1Mark Tiffany, former Graduate Student, Department of Animal Sciences, North Carolina State University, Raleigh, NC; Lee McDowell, Professor, Department of Animal Sciences, University of Florida, Gainesville; George O’Connor, Professor, Department of Soil and Water Science, University of Florida, Gainesville; Frank Martin, Professor, Department of Statistics, University of Florida, Gainesville; Nancy Wilkinson, Chemist, Department of Animal Sciences, University of Florida, Gainesville; Elizabeth Cardoso, Professor, Empresa Brasileira de Pesquisa Agropecuária, Centro de Pesquisa Agroflorestal de Amazônia Oriental (EMBRAPA-CPATU), Belém-Pa, Brazil; Patricia Rabiansky, former Graduate Student, Veterinary School, University of Florida, Gainesville.