Effects of beef-cattle grazing and biosolids application on P concentration in soil solution from a bahiagrass pasture in North Florida

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Rationale

Grassland is frequently fertilized to improve forage yield and quality as the application of biosolids on pastureland is considered an important source of available plant nutrients. While land-application of biosolids can improve forage quality and livestock performance it might increase nutrients losses through run-off and/or leaching; fertilized and biosolids-treated soils have been continually evoked as a source of water contamination.

Although studies have been carried out to clarify environmentally acceptable rates for applying biosolids on grassland, the N-based rate is site specific and still challenging. It is difficult to predict the fate and transport of both soil inherited and added organic matter, nutrients and mineral-organic complexes. In addition to weather variables and management practices, the soil-plant systems are experiencing complex processes that may transmit water and soluble elements including P to surface and/or ground waters.

About 70% of the biosolids in Florida are land-applied for recycling organic residuals and essential nutrients through soil-plant system. Because pasture is a predominant land use in Florida, the risk of nutrients leaching in relation to livestock grazing outdoor almost year-round needs more attention. Therefore, investigation of soil solution properties including P concentration is an important step in understanding how natural and anthropogenic factors have a combine effect on P mobility in the soil-water system.

Objective

The objective of this study was to evaluate P concentration in soil solution from a bahiagrass pasture under two grazing beef-cattle groups – with (G2) and without (G3) medicated feed; and to look for potential aftereffect of a single biosolids application six years earlier.

Material and Methods

Beef-cattle feeding trials were carried out at the University of Florida Santa Fe Beef Research Center in northern Florida, USA (29º51' N, 82º31' W) to determine whether grazing of a Bahiagrass (Paspalum notatum) pasture affect weight gain of two cattle groups – with (G2) and without (G3) medicated feed. A monitoring program was also initiated to address the impact of grazing on nutrients (Anguelov, 2005 and 2006), including phosphorus (P) concentration in soil solution from a well drained sandy loam soil associated with Ultisols of Millhopper series (Table 1), and to assess potential aftereffect on soil-solution P of a single biosolids application six years earlier at agronomic N-rate (B1) and twice that rate (B2) in comparison with a mineral-fertilized at the agronomic rate control-C1 (Tiffany et al., 2000). Tension-lysimeter technique was used for soil-solution samples collection.

Table 1. Selected properties of Millhopper sand (Soil survey of Alachua County, 1985)

Depth cm	Clay %	Moist bulk density g cm³	Permeability cm hr⁻¹	Available water capacity cm³ / cm³	pH
61	2-8	1.50-1.67	15-51	0.127-0.254	4.5-6.5
122	8-14	1.60-1.80	5-15	0.20-0.30	4.5-6.0
183	12-28	1.80-1.90	0.15-5.1	0.20-035	4.5-6.0

Results

Climate characteristics and soil data (Tab. 1) for the experimental site had shown potential risk for nutrients leaching. The total annual mean precipitation of about 1300 mm and aggregated monthly means of 110 mm were unevenly distributed during the study period with a few monthly precipitations exceeding evapotranspiration (Figure 1).

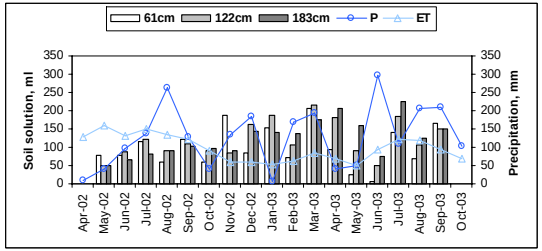

Figure 1. Precipitation, evapotranspiration and volume of soil solution obtained by tension (suction cup) lysimeters from a bahiagrass (Paspalum notatum) pasture on Ultisols of Millhopper series; University of Florida Santa Fe Research Center

Before installing soil solution samplers in the field, soil samples were taken from the pasture-plots. The samples were analyzed for pH and extractable P. Although the differences of pH values were insignificant a slight increase was seen for pasture-plots where Tampa-biosolids were applied at the agronomic rate, as well as for both biosolids that were applied twice the agronomic rate. The plots amended with Tampa-biosolids however, had higher soil-P concentrations.

As per phosphorus in the soil solution, no significant differences between two grazing treatments were detected although a tendency for higher P concentration from middle (122cm) lysimeters was observed (Fig. 2 a). On the contrary, a significant higher P concentration was recorded in soil solution as aftereffect of biosolids application (Fig. 2 b).

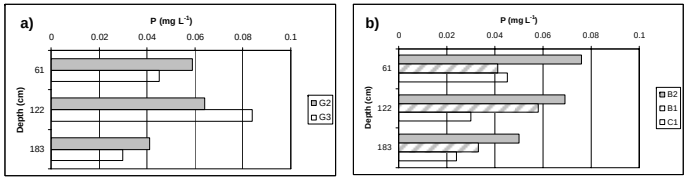

Figure 2. Effect of grazing with (G2) vs. without (G3) medicated feed (a); and aftereffect of applied-biosolids at agronomic rate(B1) and double-rate (B2) vs. mineral-fertilized at agronomic rate control-C1 (b) on P concentrations in soil solution

Application of biosolids to some of the pasture plots seems to affect soil solution several growing season after the amendment; under both agronomic (p5 and p6) and double (p1 and p20) rates that were applied the P concentrations in soil solution were higher when comparing to the non-amended (p14 and p27) plots (Fig. 3). It should be mentioned however, that often soil solution samples contained P either close to, or bellow detectable limit of 0.03 mg L^{-1}.

A significant tendency for higher P concentrations from both shallow (61 cm) and middle (122 cm) depth-layers is observed under pasture plots previously amended with biosolids. Although P is not so mobile as N, leaching can occur when soil holding capacity is reached.

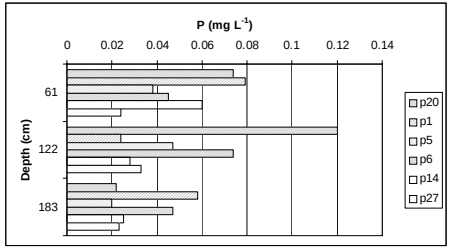

Figure 3. Combine effects of recent grazing and former biosolids application on P concentration in soil solution

Conclusion

The results of this study showed that tension lysimeter technique (suction cup) is suitable for monitoring the combine impact of natural and management variables on soil solution of pastureland. A tendency for higher quantity of soil solution volume obtained under biosolids-amended pastures is the indirect sign for soil quality improvement. Livestock management, particularly medicated feed supplements, had no significant effect on the soil solution mean P concentrations although a downward P migration was observed. The study also confirmed an effect of biosolids-derived phosphorus demonstrating higher P concentrations in soil solution of the plots where double-rate biosolids was applied.

Acknowledgments:

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