Effect of fertilizer management on nitrate concentration in soil solution from a pastoral/silvopastoral system

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Abstract

Fertilizer management is important to maximize nutrient-use efficiencies and reduce losses, especially on sandy soils. Both organic and inorganic fertilizers have been used for increasing crop/forage productivity.
A research was initiated under a USDA-NRCS funded project to study land use alteration in urban-rural interface. Urban treatment facilities have been processing wastewater and producing biosolids that are suitable for using in nearby rural pastoral systems. While application of biosolids can improve forage quality and livestock performance, biosolids-treated sites have been also evoked as a source of pollution. The magnitude of N-cycling in pastoral systems is higher than other nutrients. Although studies have been carried out to clarify acceptable rates for applying biosolids on grassland, the N-based rate is site specific and still challenging.
The objective of this study was to assess potential leaching by monitoring NO3-N concentrations in soil solution from bahiagrass pasture plots fertilized with both inorganic and organic sources of nitrogen.
The study was conducted at the Florida A&M University Research & Extension Center, Quincy on Ultisols of the Orangeburg series. Soil solution was sampled from tension (suction cup) lysimeters randomly installed below root zone of silvopastoral and pastoral plots. The samples were analyzed for pH, EC, and NO3-N concentration. The preliminary results are discussed in relation to the potential leaching and an attempt is made to find possible relationships and distribution patterns. The proposed research will improve our understanding of beneficial effects from recycling biosolids on pastoral system and some potential detrimental impacts on water quality as well. The study aims to develop an integrated agenda for assisting students, local communities, and USDA agencies in their conservation efforts.

Objective

The overall objective is to: (i) evaluate fate and transport of nitrogen and phosphorus derived by both inorganic and organic (biosolids) fertilizers, and (ii) assess whether potential buildup in soil and soil solution at different depths below root zone of pastoral/silvopastoral system will occur.
This objective will be pursued by following specific objectives:
Conduct research and develop programs to aid underserved farms in meeting water quality standards
Contribute to the efforts of resolving critical problems in nutrient and waste management planning
Provide education to students and training to farmers and public in water quality issues
Offer short courses and workshops on topics and subject matter related to nutrient and waste management

Material and Methods/Field experimental approach

A split plot complete randomized design is used for this study, with a factorial combination of two systems (pastoral vs. silvopastoral) and two stocking rates (1 AU vs. 0.6 AU) randomly applied in the main system-plot of the experiment. A factorial combination of two fertilizer sources and soil solution samplers is randomly assigned to pasture plots in the subplots for every combination of system and stocking rate.
Tension lysimeter technique is used for soil-solution samples collection (1-bar, high-flow, round bottom ceramic cups from Soilmoisture Equipment Corporation, Santa Barbara, CA, USA). The samplers were assembled and tested via a 55-kPa tension-vacuum procedure, washed in 0.1 M HCl and rinsed in distilled H_2O. Soil solution samples are taken monthly and analyzed for pH, electrical conductivity, and nitrate-nitrogen; the analyses are performed at the Water Quality Laboratory of the Center.

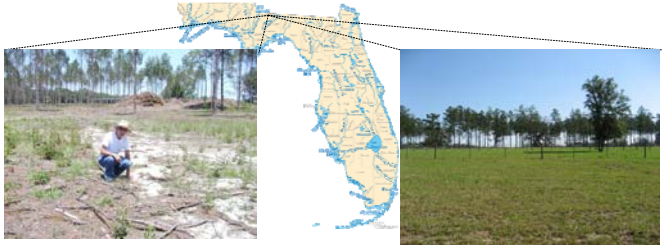


Fig. 1. Location of the Florida A&M University Research & Extension Center in Quincy, Gadsden County (30º 37' N, 84º 36' W) ; the site before the silvopastoral/pastoral plots were established by Dr. O. Onokpise (left) and after (right).

Fig. 2 Preceding the installation a trench (3.5 m apart from the fence, 0.61 m wide and 0.45 m deep) was excavated in the middle of each of the experimental silvopastoral (left) and pastoral (right) plots.

Fig. 3. Class AA biosolids were provided in kind by the Tallahassee Wastewater Treatment Facility; the biosolids were transported and applied to the field according to the experimental scheme. Note the PVC-secured tubing ends outside of the plot for sampling (picture on the right).

Fig. 4. Two months after biosolids were applied a small goat-herd is introduced to graze the bahiagrass growth (left). No visible difference is observed between the treatments of silvopastoral plots, while a clear difference between pastoral plots is observed; t he cow-cattle herd grazing pastoral plots (middle), plots after grazing (top-right) and one month later (right).

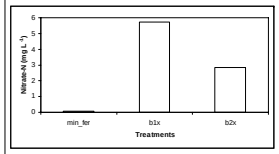
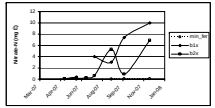


Fig. 5. Mean (left) and monthly dynamic (right) of nitrate-N concentrations in soil-solution from mineral fertilized (min_fer) and biosolids-amended pasture plots (b1x the recommended rate and b2x double rate).



Preliminary Results

The nitrate-N concentration in the soil solution varied greatly from 0 to a maximum of 31 mg L^{-1} with highest levels being recorded under the plots fertilized with biosolids at recommended N-rate of 160 lb/a (b1x). However, the means were lower ranging from 0.08 to 5.71 mg L^{-1} (Fig. 5). Despite a greater range of nitrate concentrations, a tendency for higher nitrate-N in the soil solution from biosolids-amended plots was observed. The N-concentrations were relatively lower and constant for all the treatments during May-June but were higher during July-November for biosolids-treated plots. (Fig. 5). Occasionally, nitrate-N concentration in samples was higher than MPL of 11 mg/L. The mean concentrations however, were below the US drinking water quality standards.

Future Activities

The sampling of soil solution will continue; the samples will be analyzed for non-nitrogen nutrients and trace elements in addition to nitrate-N. Forage samples will be taken and analyzed for yield and nutritional values. There are also plans to monitor the grazing animals for their performance under the different fertilizer management.

Acknowledgments:

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