Characterization of N Dynamics and Soil Microbial Communities as a Result of Biological Nitrification Inhibition by *Brachiaria* Grasses

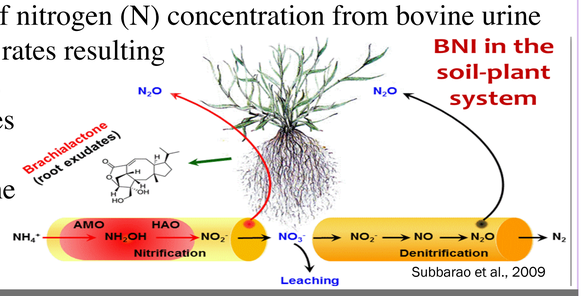
Johanie Rivera-Zayas[1*], Ashly Arevalo[2], Catalina Trujillo[2], Sandra Loaiza[2], Ngonidzashe Chirinda[2], Jacobo Arango[2], Charles W. Rice[1*]

[1] Department of Agronomy, Kansas State University, Manhattan, KS; [2]International Center for Tropical Agriculture, Cali, Colombia

Corresponding author: johanie@ksu.edu, cwrice@ksu.edu

Introduction

Brachiaria spp. are the most widely planted tropical forage with niches from Southeast Asia, Sub-Saharan Africa, Latin American and the Caribbean. This tropical forage grass have a mechanism known as biological nitrification inhibition (BNI) able to inhibit nitrifiers activity. On grazing systems were hotspots of nitrogen (N) concentration from bovine urine deposition generally exceeds plant N uptake rates resulting in environmental losses by leaching and gas emissions the BNI on the *Brachiara* enhances N utilization in soils, reduces NO_3^- leaching and minimizes N_2O emissions minimizing the environmental footprint of cattle grazing systems.



Objectives

This study analyzes the behavior of inorganic N dynamics, microbial activity and CH_4 and N_2O in *Brachiaria spp*. on a tropical pasture in order to:

1. Determine an quantify soil inorganic N dynamics and soil microbial community as a result of the BNI on two *Brachiaria* grasses
2. Quantify BNI capacity for reduce N losses in the soil from cattle urine patches.

Methodology

- The study is located on a 10 years long term field experiment in the International Center for Tropical Agriculture (CIAT) at Palmira Valle of Cauca, Cali, Colombia. Soil at the experimental site is classified as a Mollisol with a silt clay loam texture with clay content of 40–60% in the plough layer.
- The experiment was and *in situ* incubation organized as a completely randomized block design with three replicates.
- Bovine urine was collected, sealed and storage at 5°C until applied. Before application the urine was mixed, and applied at a rate of 1L.
- Gas sampling- static chamber method
- in 15 min interval 45 min. Samples were taken during 1 hr, and 1, 2, 3, 7, 10, 14, 17, 21, 25, 28, 32, 35, 39 and 42 days after urine application (AUA); and analyzed for CO_2, CH_4 and N_2O using the Hutchinson-Mosier method and linear equations (Pedersen et al., 2010).
- Biomass was harvested on a 15 days basis AUA.
- Soil inorganic N (NH_4^+ and NO_3^-) concentrations were determined at depth 0-5 during 2, 4, 7, 28 and 56 AUA.
- Soil nitrification rates were determined within 0-5 cm soil depth before urine application (BUA) and 7, 28 and 56 AUA.
- Phospholipid fatty acid analysis (PLFA) was extracted from the first 0-5 cm of soil, BUA and 28 AUA, using a modification of the Bligh and Dyer (1959) extraction (White and Rice, 2009).
- Statistical Analysis System (SAS) 9.3 was used to analyze results using an analysis of variance (ANOVA) method (α=0.05) and a Post-hoc comparisons with Tukey at α=0.05.

Main Factor	Secondary factor
Bare soil (BS)	Control (CO)
	Cattle Urine (UR)
Brachiaria humidicola 16888 (BH)	Control
	Cattle Urine (UR)
Brachiaria mulato hybrid 1 (MH)	Control
	Cattle Urine (UR)

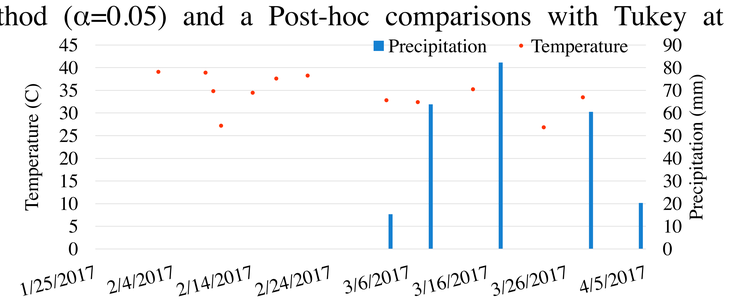


Fig. 1. Temperature and precipitation patterns during the incubation.

Results

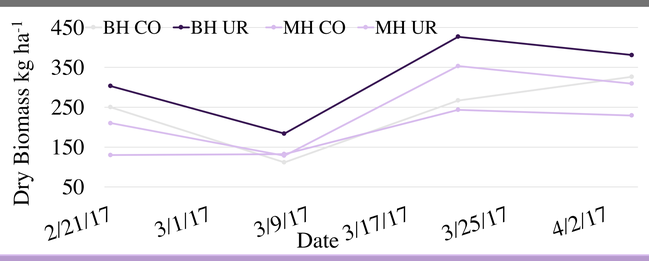


Fig. 2. *B*. humidicola 16888 produce 20% more biomass compare to *B*. mulato hybrid 1. Drought for a 15 days period decrease biomass growth rate by 46%.

Results

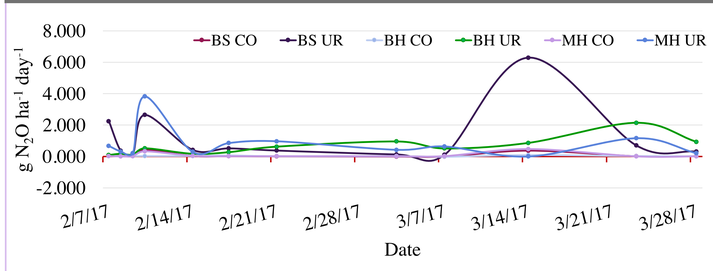


Fig. 3. *Brachiaria* grasses interaction with UR and time showed higher N_2O emissions, specially after precipitation over time.

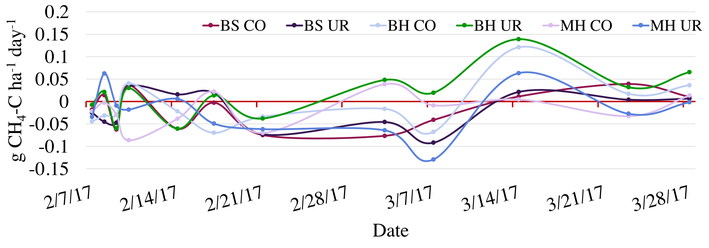


Fig. 4. Fluxes of CH_4 in *Brachiaria sp*. grasses showed higher CH_4 emissions after precipitation, and high uptake after dry periods. *B*. humidicola 16888 CH_4 were significantly higher than *B*. mulato hybrid 1 and bare soil .

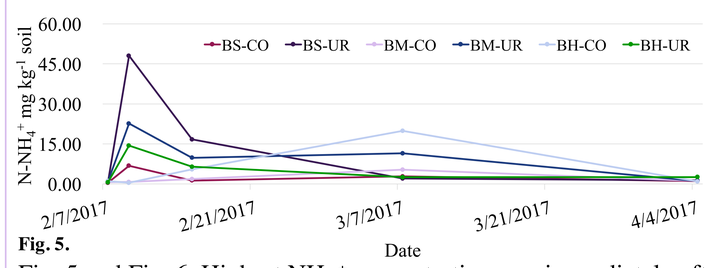


Fig. 5.

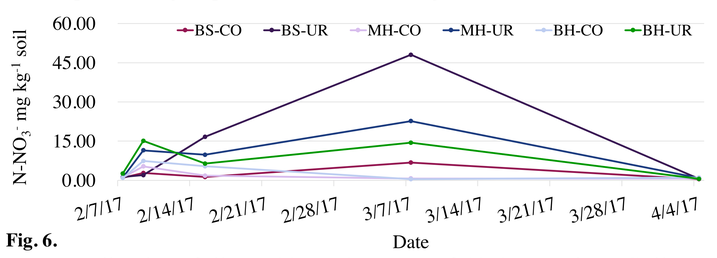


Fig. 6.

Fig. 5 and Fig. 6. Highest NH_4^+ concentration was immediately after UR application, followed by a decrease of 48% over time. Soil cover interaction with UR and time showed highest NO_3^- available during 28 days AUA on bare soil with UR, followed by a decreased of 87% on soil with *Brachiaria sp*. grasses with UR, with no significant difference between *B*. humidicola 16888 and *B*. mulato.

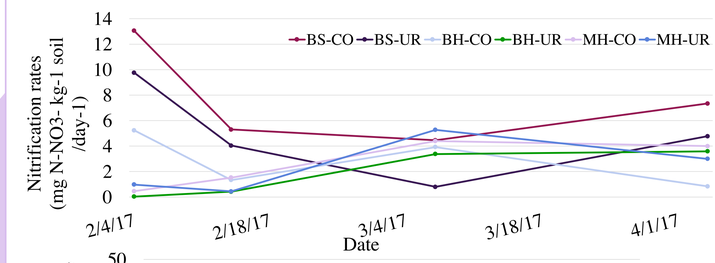


Fig. 7. A significant interaction between soil cover, urine and time showed a decrease on 49% from the *Brachiaria sp*. Grasses, compare to bare soil after urine application.

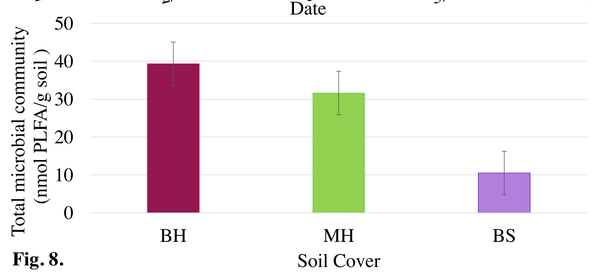


Fig. 8.

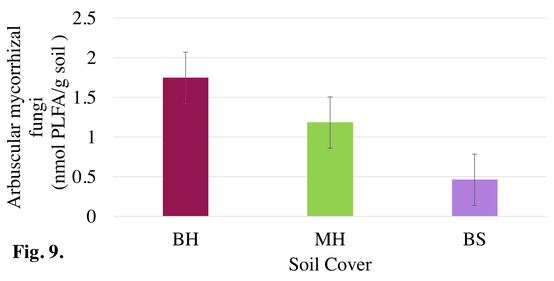


Fig. 9.

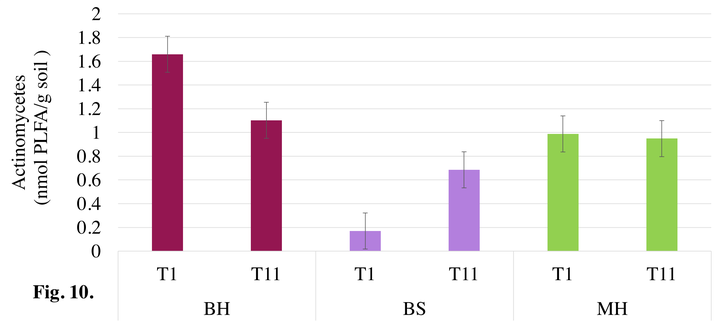


Fig. 10.

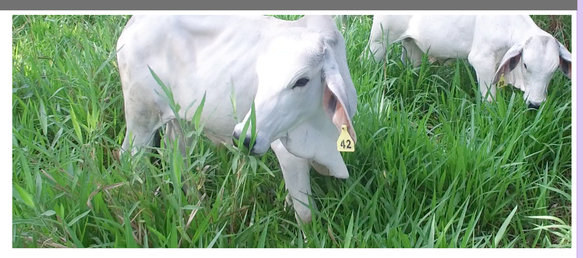
Fig. 8. Long term soil cover (10 yr) from *Brachiaria* grasses increase soil microbial community by 80% compare to bare soil.

Fig. 9. Arbuscular mycorrhizal fungi is 32% higher in *B*. humidicola 16888 than in *B*. mulato, and than bare soil.

Fig. 10. On *Brachiaria* grasses Actinomycetes showed a decreased over time, with higher values from the *B*. humidicola.

Experiment Highlights

- ✓ The long term use of *Brachiaria* grasses as soil cover maintain microbial population.
- ✓ *Brachiaria* humidicola 16888 produce more biomass, have lower nitrifications rates, and create proper soil conditions for higher population of arbuscular mycorrhizal fungi and actinomycetes.
- ✓ Nitrogen from cattle urine affect N_2O and CH_4 dynamics over 35 days after applications; the variability is also affected by weather conditions and soil cover.



Acknowledgements

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