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Quantification of Ammonia Volatilization in Pastures of Integrated and Non-Integrated Beef Cattle Production Systems

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Introduction

Nitrogen (N) is the most limiting nutrient for forages; it has a good cost/benefit ratio and, considering the necessity to increase food production without new deforestation, nitrogen fertilization has become one of the most used techniques to enhance productivity in livestock feed production (BOARETTO et al., 2007). Nonetheless, the characteristics of some N fertilizers and some application methods may cause N losses, reduced profits and environmental problems (VITTI et al., 1999).

Urea is the most used N fertilizer due to its high N content and lower cost compared to other N sources but concerns exist with potentially high losses via ammonia (NH_3) volatilization, which may reach up to 80% of the N applied (ROCHETTE et al., 2009). Some forms of urea application, like incorporation into the soil, may reduce NH_3 volatilization but in no-till farming and in normal pasture management the fertilizer is topdressed, what may result in up to 78% loss of NH_3 (LARA CABEZAS et al., 2000).

This study aimed at evaluating N losses, via NH_3 volatilization, in

pastures under different managements to better understand important beef cattle production systems in Brazil and improve the efficiency of N fertilization.

Material and Methods

The study was carried out at Embrapa Pecuária Sudeste, SP (21°57'42"S, 47°50›28» W, 860 m) from 18/01/2014 to 02/09/2015. The climate is classified as Cwa (Köppen), with two well defined seasons: dry season - April to September, with average temperature and precipitation of 19.9ºC and 250 mm, respectively; rainy season - October to March, with average temperature and precipitation of 23.0ºC e 1,100 mm, respectively. The soil in the area is classified as dystrophic red yelow Latosol. Ammonia volatilization was evaluated in pastures belonging to five production systems: 1) Intensive (INT) - dryland rotational grazing system; 2) Integrated Silvopastoral System (SP) - rotational grazing with eucalyptus trees (15 x 2 m spacing); 3) Integrated Crop-livestock System (CL) - rotational grazing system with crop rotation in each paddock in four year cycles (three years with pasture and one year with corn); 4) Integrated Crop-livestock-forestry System (CLF) - the same as CL with eucalyptus trees (15 x 2 m spacing); 5) Extensive (EXT) - continuous grazing system. Soils in EXT and in an adjacent area of Atlantic Forest were used, respectively, as negative and positive controls.

Pastures in INT, SP, CL and CLF were established in 2012 with *Urochloa* (sin. *Brachiaria*) *brizantha* (Hochst ex A. Rich.) Stapf cv. Piatã and were fertilized with 50 kg of N ha^{-1} $year^{-1}$ via urea. Each of these systems had two replicate pasture areas, of 3 ha each, divided in six paddocks in a rotational system with six days of occupation and 30 days rest. The pasture in EXT was established in 2007 with *Urochloa* (sin. *Brachiaria*) *decumbens*

(Stapf) R. Webster and was not fertilized. The EXT system had two pasture areas of 2,85 ha each managed under continuous grazing.

The stocking rate was adjusted in all pastures using the "put and take" technique (Mott and Lucas, 1952) and visual evaluation of forage availability.

Volatilization of ammonia was evaluated following the procedure by Alves et al. (2011). Collectors were composed of 8 × 8 cm foam (density of 0.02 g cm^{-3}) pads soaked with 10 ml of phosphoric acid solution (0.5 N). Each foam pad was placed over a polyvinyl chloride (PVC) plate (10 × 10 × 0.2 cm) and wrapped with one layer of polytetrafluoroethylene tape (PTFE), which is permeable to ammonia and impermeable to

water. The foam pads were placed 1 cm above the soil surface with the PVC plate on the upper side, to restrict the collection of NH_3 to that originated in the soil. Foams were changed every day during five days and, subsequently, in three days intervals until the 23rd day. Ten collections were done during the experimental period. In each collection day, the foams were put in individual plastic bags, sealed and stored in a freezer. For analysis, the foams, the PVC plates and the PTFE tapes were washed with approximately 300 ml of deionized or distilled water inside a Bückner funnel attached to a Kitassato and a vacuum pump. A 50 ml sample was than collected and analyzed by Flow Injection Analysis (FIA).

Results and Conclusions

Accumulated N-NH_3 losses (Figure 1A) were similar ($P > 0.05$) in INT, SP, CL and ALF pastures (average of 11.8 kg ha^{-1}), corresponding to 23,6% of the N applied. Ammonia losses were similar in the EXT pasture and in the forest (average of 4.6 kg ha^{-1}) but much lower than in the intensively managed pastures, probably because no N was applied.

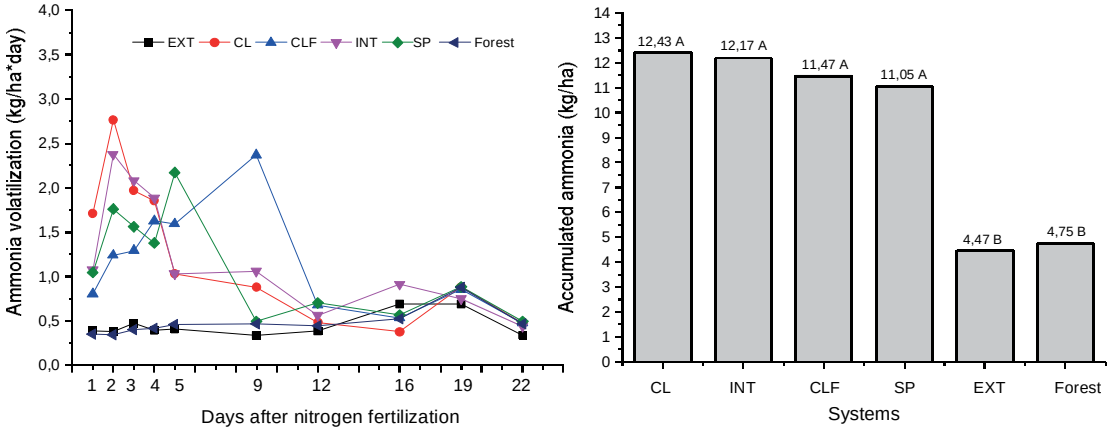

Figure 1 - (A) accumulated N-NH3 losses and (B) - flux of N-NH3 losses (Kg ha^{-1} dia^{-1}), by volatilization in the grazing systems and in the forest. A, B: Means with different letters differ by the Duncan test ($P<0.05$). INT: Intensive; SP: Silvopastoral; CL: Crop-livestock; CLF: Crop-livestock-forestry; EXT: Extensive.

Despite the similarity in accumulated NH3 losses obtained in INT, SP, CL and CLF, the flux of NH3 volatilization, after N fertilization, was different among these systems (Figure 1B). The maximum levels of rate volatilization occurred latter in the pastures with trees (SP and CLF) compared to those without trees (INT and CL). Similar results were obtained by Santana et al. (2011) who observed that the length of time it takes to occur 90% of urea hydrolysis is longer in soil under eucalyptus forest than in soils in pastures and in areas of no- till and conventional crop production, what may be related to the amount of organic residues present in the soil.

Conclusions

Total ammonia volatilization from the soil is similar in integrated and non-integrated beef cattle production systems and higher than in extensively managed pastures and forests. The daily rate of volatilization is affected by the presence of trees in the pastures.

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