AMMONIA LOSSES BY VOLATILIZATION FROM COASTCROSS PASTURE FERTILIZED WITH TWO NITROGEN SOURCES[1]

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Abstract

Ammonia losses by volatilization from five rates of urea or ammonium nitrate surface-applied to coastcross pasture, grown on a dark red latosol (Hapludox) in São Carlos, SP, Brazil, under tropical altitude climate, were measured. Volatilized ammonia was absorbed in traps placed on soil surface. The mean losses from urea applied after five successive cuttings of the grass were 15, 24, 34, and 40% for N rates of 25, 50, 100 and 200 kg N ha^{-1} per cutting, respectively.

Keywords: Ammonium nitrate, *Cynodon dactylon* cv. Coastcross, pasture, surface application, urea, nitrogen loss

Introduction

Large responses of forages to high N supply in tropical regions have been shown by several researchers (Vicente-Chandler et al., 1959; Werner et al., 1967). However, surface application of urea is subjected to N losses by NH_3 volatilization (Terman, 1979), which decreases grass efficiency of fertilizer use. Whitehead (1995) found losses of 2 to 36% of the N-urea applied to pastures, with a mean value of 20%. Considering that climatic conditions in São Carlos may favor N-NH_3 losses, the goal of this work was to quantify N losses of a coastcross pasture submited to five rates of surface-applied N fertilizers.

Material and Methods

The experiment was carried out from November 1998 to April 1999, on a coastcross (*Cynodon dactylon* cv. Coastcross) pasture grown on a dark red latosol (Hapludox), with 30% clay, in São Carlos, São Paulo State, Brazil (latitude 22^{o}01´ S, longitude 47^{o}54´ W and altitude of 836 m) under a tropical altitude climate. Lime was applied to raise soil base saturation to 70% of the cation exchange capacity, and fertilizer was added at a rate of 100 kg of P_2O_5 ha^{-1} as single superphosphate, and 30 kg ha^{-1} of micronutrients as FTE BR-12. Potassium was applied as KCl, along with N treatments, in order to replace K removed by cuttings and to maintain K levels in dry matter (DM) at a minimum of 20 g kg^{-1}. Traps used to measure volatilized ammonia were those described by Nommik (1973) and modified by Cantarella et al. (1986). Traps consisted of PVC cylinders, 20 cm in diameter and 40 cm in length, containing two discs of polyurethane plastic foam, 20 cm in diameter and 2-cm thick, in order to absorb ammonia gas. Discs were moistened with a solution containing phosphoric acid and glycerin and were placed inside the cylinder, about 20 to 30 cm from its lower end. The PVC cylinder was fit on a 19cm in diameter and 10-cm height PVC ring, which was partially buried in soil, keeping a length of about 5 cm above soil surface. The upper end of the cylinder was covered with a plastic plate, in such a way that it allowed gaseous exchange with air outside the chamber. The lower disc was made to trap ammonia gas evolved from soil inside the cylinder and the upper disc, the gas from outside. Polyurethane discs were replaced every 1 to 3 days, for about 20 days or when N-ammonia losses decrease were close to the control treatment. Ammonia retained in the discs was extracted with a 1 mol L^{-1} KCl solution and was determined by steam distillation (Bremner and Keeney, 1966).

Experimental design was a randomized block design in a 2 x 5 factorial arrangement, with four replications, consisting of two N sources (urea and ammonium nitrate) and five rates (0, 25, 50, 100, and 200 kg ha^{-1}). Treatments were applied after each of five consecutive cuttings, during the rainy season. Plot size was 4 x 5 m, in which an area of 6 m^2 was used to evaluate the forage yield. In each plot four PVC rings were partially buried into the soil in order to receive the ammonia trap, and were treated with amounts of N fertilizer corresponding to those of the rest of the plot. After each change of the polyurethane discs or after a rainfall of 10 mm or more, traps were moved to another ring. Grass was cut in 24-day intervals, 10 cm above soil surface. Dry matter weight as well as N content was determined in forage samples.

The N-NH_3 losses of the coastcross pasture was estimated within N source and cutting period, considering N doses, by a polynomial regression using REG procedure (SAS, 1993).

Results and Discussion

Nitrogen levels and sources affected ($P<0.01$) N losses. Losses of ammonia by volatilization from plots treated with ammonium nitrate reached a maximum of 1.6% of N added, whereas losses varied from 1.1 to 52.9% in those receiving urea. Losses of N did depend on applied N level and on climate, especially the amount of rainfall in the period (Table 1). Nitrogen losses occurred mainly in the first three days after urea application, suggesting that a rapid hydrolysis of the fertilizer took place under the experimental conditions (Figure 1). After this time, rate of losses decreased, probably due to a drop of soil pH associated with OH^- consumption during volatilization and with nitrification of ammonium (Whitehead, 1995). Nitrogen losses were related to rates of N applied, with mean losses of 14.6 and 40.2% for 25 and 200 kg N ha^{-1} per cutting, respectively. Intensity of N losses was reduced by rain, mainly in the first three days after N fertilizer application, when hydrolysis of urea was higher. For a rainfall above 10 mm, N losses from urea were only 12.5% in an area treated with 200 kg N ha^{-1} per cutting, whereas it reached almost 53% when no rain occurred after the application of the same rate of urea (Figure 1: P2 and P5, respectively).

It could be concluded that in the studied conditions: 1. Nitrogen losses from urea were higher in the first three days after surface application; 2. Intensity of ammonia volatilization increased with increase in rates of N fertilizer application and it was reduced by rain occurring in the first three days after urea application.

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Table 1 - Climatic conditions in the first three days after N-application to the five grass cuttings.

	1st Period (P1)	2nd Period (P2)	3rd Period (P3)	4th Period (P4)	5th Period (P5)
Rainfall, 3 days before fertilization, mm	10	79	138	20	45
Rainfall, mm	0	10	0.6	0	0
Relative humidity, %	77	88	80	67	74
Evaporation, mm	15	9	12	13	11
Maximum temperature, ^{o}C	24.4	28.7	29.2	31.5	30.0
Minimum temperature, ^{o}C	15.8	19.2	19.2	19.1	18.2
Average temperature, ^{o}C	20.1	24.0	24.2	25.4	24.1
Soil water storage, mm	54	100	93	85	91
Water deficit, mm	6	0	0	0	0

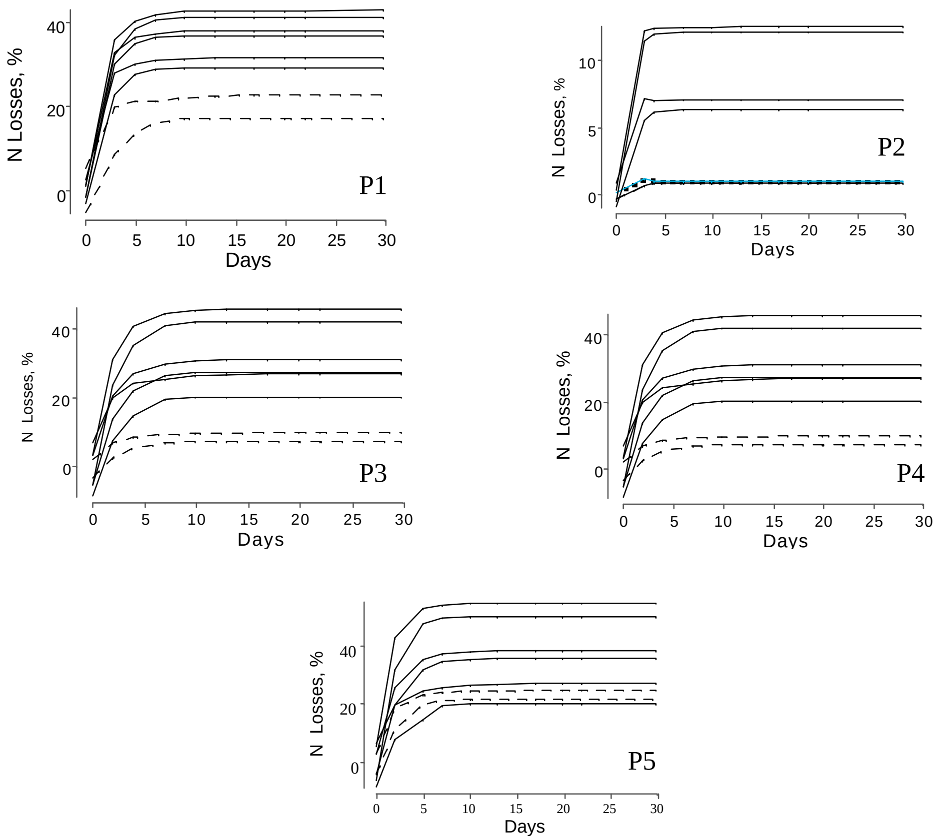

Figure 1 - Upper-and-lower 95% confidence limits (CL) for the mean expected values of ammonia losses from a coastcross pasture, in five periods (P1 to P5). The CL, in decreasing order of losses are associated to N doses of 200, 100 and 50 kg ha^{-1} per cutting, respectively. Dashed lines represent 25 kg ha^{-1} of N per cutting.