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Soil nitrate level variation under intensive nitrogen fertilized coastcross pasture[1]

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ABSTRACT

Nitrate levels in soil profile after the first N application on coastcross pasture, grown on a dark red latosol (Hapludox), in São Carlos, SP, Brazil, under tropical altitude climate, were measured at 7-day intervals, to monitor possible losses in depth. Soil nitrate rates varied with high rates of N-ammonium nitrate (200 kg ha^{-1} per cutting) in surface layers. Danger of environmental impact was low in the studied conditions.

KEYWORDS: Ammonium nitrate, *Cynodon dactylon* cv. Coastcross, pasture, soil nitrate, urea

INTRODUCTION

Nitrogen fertilization is one of the most important factors to improve forage yield per area unit. Several authors (Vicente-Chandler et al., 1959; Werner et al., 1967; Corsi, 1986) showed the response of tropical forage grasses to high N rates, sometimes up to 1,800 kg ha^{-1} (Vicente-Chandler et al., 1959).

Doubts rise about the possible environmental stress caused by these high N applications, due to the potential losses of NO_3, with contamination of ground water, in humid climate or in the rainy season (Mello et al., 1984), when N fertilizers are normally applied. Intense limestone use can speed up soil organic matter decomposition and further increase nitrification (Mello et al., 1984). Increase of nitrate levels may occur down to 200-cm depth in fertilized pastures (Primavesi and Primavesi, 1997; Turpin et al., 1998).

Thus, the goal of this work was to monitor nitrate level in soil profile, under intensive rotationally grazed pasture, with high fertilizer inputs, to know how to avoid future environmental quality damage.

MATERIAL AND METHODS

The experiment was carried out from November 1999 to March 2000 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°01´S, longitude 47°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 level of 100 kg of P_2O_5 ha^{-1} as single superphosphate, and 30 kg ha^{-1} of micronutrients 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 the dry matter at a minimum of 20 g kg^{-1}.

Experimental design was a randomized block one, in a 2 x 5 factorial arrangement (two N sources: urea and ammonium nitrate and five rates: 0, 25, 50, 100 and 200 kg ha^{-1} per cutting), with four replications. Treatments were applied after each of five consecutive periods (cuttings), in the rainy season. Plot size was 4 x 5 m^2, in which an area of 6 m^2 was used to evaluate forage yield. Forage was cut at 24 to 37-day intervals, 10 cm above soil surface. After the first N application (Nov 10, 1999), four soil samples of each block were taken in a 7-day interval from the plots receiving 0, 100 and 200 kg N ha^{-1} of both sources, at 0-10, 10-20, 20-40, 40-60, 60-80, 80-100, 100-120, 120-140, 140-160 cm depths. Immediately after sampling they were carried to the lab for NO_3 extraction and determination, following methods described in Tedesco et al. (1985).

Analysis of variance was done for F-test and Tukey test, to compare the mean values of the variables (SAS Institute, 1993).

RESULTS AND DISCUSSION

Nitrate levels varied ($P<0.01$) with N sources and N rates. Ammonium nitrate resulted in the highest levels, mainly at the N rate of 200 kg ha^{-1} per cutting. The greatest nitrate level variations occurred at the first two soil layers ($P<0.01$), with a trend for nitrate to move to depths below 100 cm, for the N rates greater than 100 kg ha^{-1} per cutting, mainly as ammonium nitrate. No problems are expected with the most efficient rates lower than 100 kg ha^{-1} per cutting, in this deep soil.

Nitrate levels increased after N application followed by rain (see seven and seventy days after; Table 1), and after dry periods during the rainy season (see 28 days after). They also increased with increase in rain intensity, even at the control

Table 1 - Soil nitrate variation (mg kg^{-1}) as a function of source and rates of N, and rainfall.

Treatments	Days										
	7	14	21	28	35	42	49	56	63	70	77
0 to 10 cm depth											
Test	0.0	1.1	0.6	7.0	3.6	1.7	1.7	2.8	4.2	6.2	4.2
U100	10.1	0.3	0.0	0.0	4.5	0.3	3.9	1.1	3.4	12.0	5.6
U200	19.3	19.3	2.0	4.5	6.4	2.0	5.0	2.0	1.7	8.7	15.7
N100	33.3	4.2	0.6	5.0	5.9	2.0	8.4	3.9	5.0	19.9	6.7
N200	81.2	24.9	3.6	16.5	1.1	9.8	29.7	4.2	11.5	56.3	33.9
10 to 20 cm depth											
Test	0.6	0.0	0.0	3.9	2.5	1.1	2.0	1.4	2.0	1.1	4.2
U100	5.0	1.4	2.0	4.8	2.5	0.0	3.4	0.0	1.7	10.9	7.0
U200	5.0	1.4	2.0	4.8	2.5	0.0	3.4	0.0	1.7	10.9	7.0
N100	16.2	3.6	0.3	2.8	5.9	2.0	6.4	4.8	4.5	3.9	2.0
N200	18.8	6.4	0.6	31.6	0.0	6.7	5.0	3.4	3.6	22.4	15.7
140 to 160 cm depth											
Test	0.0	0.8	0.6	0.0	0.8	0.0	1.4	1.1	0.0	4.8	4.8
U100	0.0	0.3	0.0	4.8	0.8	0.0	0.0	0.8	1.7	5.3	4.8
U200	0.3	1.1	0.6	0.6	2.8	0.0	0.0	0.8	3.6	3.1	5.6
N100	0.3	2.2	0.6	2.5	0.0	0.0	1.4	2.2	5.0	6.7	2.5
N200	2.5	1.1	0.3	6.2	0.0	0.0	2.8	2.2	5.9	3.1	5.0
sum of 0 to 160 cm soil profile											
Test	3.6	5.0	2.5	17.6	7.4	5.6	16.8	8.7	23.2	35.3	28.3
U100	17.1	13.2	2.0	13.7	15.7	1.4	7.8	6.2	10.1	57.4	36.7
U200	26.9	34.2	9.2	17.9	17.9	6.4	15.1	16.2	18.8	48.7	70.8
N100	56.6	12.3	2.2	27.2	21.3	9.8	33.3	26.3	38.4	54.0	42.0
N200	113.4	37.8	6.7	109.5	2.0	26.3	48.4	39.8	53.8	111.7	86.8
Rainfall, mm	17	12	8	70	126	1	45	195	66	30	4

Tukey critical range:	
N sources	0.8**
N rates	1.1**
layers	2.9**
7-day periods	2.8**

Note: N application: Nov 10, 1999, Dec 16, 1999 (35 days after the first application) . Jan 11, 2000 (63 days after the first). U = urea. N = ammonium nitrate. 100/200 = 100 and 200 kg N ha^{-1} per cutting.

plot, perhaps due to the organic material decomposition returned to the soil after cutting (before each N application). This increase was stronger at the fertilized areas, with greater dry matter production and higher N fertilizer residues, mainly at the higher rates of ammonium nitrate.

Mello et al. (1984) mention NO_3 levels higher than 100 mg kg^{-1} at the surface layers of agricultural soils. Values higher than 100 mg kg^{-1} occurred in this experiment only when the whole 160-cm profile was considered (Table 1). The low nitrate contents could be explained partially by the high N extraction potential of the grass used, due to its high dry matter production potential. In intensively managed pastures also occurs an intense renewal of roots, with a greater consumption of soil N. Well managed pastures also, when intensively managed, seem to present a positive environmental impact (Boddey at al., 1996).

In the studied conditions, nitrate levels in the soil varied with tested N sources and rates, and no environmental risk seems to exist.

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Saturated field hydraulic conductivity variation in intensively managed tropical pastures[1]

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ABSTRACT

Saturated field hydraulic conductivity was measured, using a Guelph permeameter, at the depths of 10, 20 and 60 cm, to verify the effect of intensively managed, compared to extensively managed ones, beef cattle production systems on pastures grown on three soils (Hapludox, Eutrudox, Paleudalf), in São Carlos, SP, Brazil, under tropical altitude climate. Significant differences occurred within depths ($P<0.05$). However, differences decreased with years and, therefore, differences among soils and between management systems were also reduced. Highest mean conductivity values occurred at 60-cm depth and at the extensively managed sward on the sandy Hapludox. Intensively managed Paleudalf showed high resistance to reduction of conductivity at 10-cm depth. A general year effect appeared claiming for more studies on this matter.

KEYWORDS: Beef cattle, *Brachiaria decumbens, Brachiaria brizantha*, Management, Soil permeability

INTRODUCTION

Increase of pasture productivity per area, with decrease in production costs to allow greater competitiveness, is possible for beef and dairy cattle farmers in the tropics. However, increases of intensive limestone applications and in stocking rate can lead to soil compaction and reduction in rain water infiltration rate, therefore decreasing subsoil water and aquifers replenishment. Preliminary data showed that adequate soil surface management of organic materials, in an intensively managed dairy cattle production system (Primavesi et al., 1998), can reduce or avoid this problem. This case study was carried out in order to evaluate saturated field hydraulic conductivity in intensive tropical pasture beef cattle production systems, since no such data are available in literature.

MATERIAL AND METHODS

The case study was carried out from November 1997 to 1999 on *Brachiaria decumbens* and *Brachiaria brizantha* pastures. The pastures of the former species, extensively managed, with a stocking rate of one animal-unit (450 kg live weight) per hectare per year, were grown on red-yellow latosol (LVe) and dusky red latosol (LRe) (both Hapludox), with 23 and 46% clay, respectively, and the pastures of the latter species, intensively managed, with three (in dry season) to eight (in rainy season) animal-units per hectare, on LVi (Hapludox), LRi (Eutrudox), dark red latosol (LEi; Hapludox; 20%

Table 1 - Field hydraulic conductivity of soils under different management intensities.

Depth	Field hydraulic conductivity			Standard deviation		
	(m d^{-1})			(m d^{-1})		
	1997	1998	1999	1997	1998	1999
	Dusky red latosol (LRe), extensively managed					
10 cm	5.89	7.05	1.11	2.84	5.41	1.01
20 cm	20.89	15.03	0.94	12.66	9.90	0.99
60 cm	69.90	27.29	2.36	52.87	23.99	3.16
	Red-yellow latosol (LVe) . extensively managed					
10 cm	7.39	6.53	1.93	3.04	4.76	1.95
20 cm	12.13	13.59	5.57	6.82	7.37	6.11
60 cm	84.05	44.07	1.56	49.21	21.34	2.17
	Red-yellow latosol (LVi). intensively managed					
10 cm	5.67	3.57	1.12	2.79	1.37	0.87
20 cm	7.89	1.11	1.82	5.08	0.78	1.40
60 cm	52.33	11.63	6.36	29.58	6.70	8.69
	Dusky red latosol (LRi). intensively managed					
10 cm	11.85	5.23	0.74	5.33	4.12	0.46
20 cm	16.46	5.37	1.47	7.07	3.37	1.12
60 cm	41.25	29.35	4.16	25.52	15.96	3.19
	Terra rossa (TEi). intensively managed					
10 cm	7.35	7.29	1.56	3.42	3.43	1.26
20 cm	13.72	8.49	1.19	6.63	6.24	0.90
60 cm	55.32	9.12	1.61	27.20	4.35	1.04
	Dark-red latosol (LEi). intensively managed					
10 cm	3.64	1.42	1.27	5.09	0.52	1.04
20 cm	7.47	2.33	0.80	3.19	1.14	0.61
60 cm	53.22	10.46	2.17	24.37	7.32	1.44
Tukey critical range:						
Soil		3.35				
Year and Depth		1.94				