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Apparent recovery of surface applied nitrogen fertilizer by a coastcross pasture[1]

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ABSTRACT

Nitrogen recoveries from five levels of urea and ammonium nitrate surface-applied on coastcross pasture, grown on a dark red latosol (Hapludox), in São Carlos, SP, Brazil, under tropical altitude climate, were estimated. Significant differences occurred within periods (P<0.05), depending on climatic conditions. Under adequate plant growth conditions, mean N recovery from urea was about 67%, sometimes reaching 80%, of that from ammonium nitrate. Recovery of ammonium nitrate varied from 45 to 68% of applied N.

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

INTRODUCTION

Nitrogen is the most important mineral nutrient to optimize dry mater production of tropical forage grasses. Several authors (Vicente-Chandler et al., 1959; Werner et al., 1967; Corsi, 1986) showed responses of tropical forage grasses to high N levels.

Apparent grassland recovery of N fertilizer is usually within limits of 50 and 80%, and often about 65 to 70% (Dilz, 1988 and Morisson et al., 1989, cited by Whitehead, 1995). With increasing N rates, less N is recovered. According to Corsi (1975), a very low N recovery by tropical forage grasses should be expected, due to deep soils and heavy rains in some periods. Corsi (1994) found that up to 80% of N can be recovered when adequately applied.

Soil surface application of urea, the most common nitrogen fertilizer in Brazilian market, can reduce N recovery by plants, due to losses of NH_3 by volatilization (Terman, 1979).

Urea has a high N concentration, it is easy to manipulate and it causes little soil acidification; so, it is potentially superior to other N sources, from the economic view point. This encourages further studies with urea, mainly due to its efficacy on intensively managed pastures, under high evapotranspiratory climatic conditions.

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°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 rate 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 the N treatments, in order to replace K removed by cuttings and to maintain K levels in the forage 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. Dry matter weight as well as N concentration (Malavolta et al., 1989) were determined in forage samples. Nitrogen extraction (ext) was calculated by the formula: N(ext) (kg ha^{-1}) = 0.001*[dry matter (kg ha^{-1})*N concentration (g kg^{-1})]. Apparent N recovery [N(rec)] was estimated by the formula: N(rec) (%) = 100*[(N(ext) by fertilized plot - test plot)/ applied N dose]. The amount of N in herbage of the unfertilized plots provided an estimate of the N supply originated from soil and atmosphere.

The data were submited to Variance Analysis and the means were compared using Tukey test (SAS Institute, 1993).

RESULTS AND DISCUSSION

Apparent N fertilizer recovery varied (P<0.01) with N sources, N rates and periods. With increasing N rates occurred a decrease in the apparent N recovery (Table 1), due to a reduction of the dry matter production efficiency. Except for the first period, in which climatic conditions were not adequate (beginning of rainy season, still with dry soil), N recovery was relatively high for both sources, mainly for ammonium nitrate. Therefore, under adequate conditions for plant development (second and fifth period), mean N recovery from urea was 72%, sometimes up to 80%, of that obtained from ammonium nitrate, which ranged from 45 to 75% of the applied N. Data show the high N extraction potential by plants, considering that part of the nitrogen, not determined, is immobilized in roots and stolons, and soil microbial biomass, mainly in intensive rotational systems. Impithuksa and Blue (1985), cited by Monteiro (1998), recorded a 20% N immobilization by roots and stolons, and 30% N by soil microbial biomass, for each of 45% N recovered by forage. This high N extraction by tropical forage grasses may contribute in the reduction of environmental risks, such as nitrate losses, mainly in deep tropical soils.

It could be concluded that apparent N recovery by coastcross herbage was high, and affected by N sources, N doses and period.

Table 1- Nitrogen extraction (E) and N recovery (R) by coastcross, in five consecutive periods.

	Periods											
N rates	1st		2nd		3rd		4th		5th		mean	
(kg ha^{-1})	E kg/ha	R %	E kg/ha	R %	E kg/ha	R %	E kg/ha	R %	E kg/ha	R %	E kg/ha	R %
							Urea					
0	1	0	9	0	10	0	37	0	12	0	14e	0
25	2	3	22	50	24	55	54	57	26	60	26d	45ab
50	4	6	54	88	29	36	76	74	40	56	41c	52a
100	13	11	86	74	48	36	105	59	67	52	64b	46ab
200	31	15	146	65	65	25	141	41	93	37	95a	37b
							Ammonium nitrate					
0	1	0	10	0	8	0	39	0	12	0	14e	0
25	3	7	32	87	25	65	64	92	33	87	32d	67a
50	13	24	63	100	48	79	85	77	60	96	54c	75a
100	26	34	108	94	82	70	136	77	84	66	89b	68a
200	118	58	142	61	78	32	147	39	89	35	115a	45b
Tukey critical range:												
N sources											4.8**	5.2**
rates and periods											9.0**	9.7**

Ext. = dry matter N extraction, in kg ha^{-1}; Rec. = N fertilizer recovery, in %.

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Short-term study on ^{13}Carbon discrimination on irrigated tropical pasture

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ABSTRACT

A better understanding of pasture ecosystem can be obtained through the use of ^{13}C discrimination technique. In this context, an experiment, assigned in a randomized complete block design with four replicates, was conducted to evaluate the $D^{13}C$ (‰) discrimination, nitrogen (N) yield (kg N ha^{-1}), total nitrogen content (g kg dry matter (DM)$^{-1}$) and dry matter yield (kg DM ha^{-1}) on an irrigated Tanzania grass pasture (*Panicum maximum*, Jacq.) receiving increasing rates (0, 30, 60, 90 and 120 kg N ha^{-1} cut^{-1}) of N fertilizer during the summer. Dry matter yield, N yield and nitrogen concentration increased quadratically with increasing levels of N fertilizer ($P < 0,05$). On the other hand, D values tended to decrease linearly with increasing levels of N fertilizer ($P > 0,05$). Besides that, negative and significant correlations ($P < 0,05$) were evident between either D values and dry matter yield ($R = -0,4807$) and D values and N yield ($R = -0,5245$). Overall results allow to establish the following conclusions: 1) at lower N fertilizer inputs tropical pastures tended to show higher discrimination against ^{13}C though this effect might be associated with lower N concentrations in plant tissue that, in turn, might add inefficiency to the C4 photosynthetic pathway and 2) lower dry matter and N yields were associated with higher ^{13}C discrimination values. Conversely, higher dry matter and N yields were associated to lower ^{13}C discrimination values.

Table 1 - Equations relating several variables to nitrogen fertilizer rates.

Equations	R^2	CV (%)	P-value
Dry matter yield (kg DM ha^{-1}); Y= 3528 + 78,2 x – 0,465 x^2	41,97	24,96	0,0169
Nitrogen yield (kg N ha^{-1}); Y= 54,7 + 1,8 – 0,011 x^2	49,65	26,62	0,0058
N concentration (g N kg DM^{-1}); Y= 15,8 + 0,08 x – 0,0004 x^2	78,03	4,07	0,0001
Δ = 4,3 –0,003 x	10,76	9,39	0,1839

Table 2 - Correlation matrix among several variables as a result of increasing rates of nitrogen fertilizer.

Variable	Dry matter yield	Nitrogen conc.	D value
Dry matter yield	-	-0,1495	-0,4807
	-	(0,5669)	(0,0435)
Nitrogen yield	0,9777[1]	0,0080	-0,5245
	(0,0001)[2]	(0,9758)	(0,0255)
Nitrogen concentration	-	-	-0,3007
	-	-	(0,2408)

[1] Correlation; [2] P-value.

KEYWORDS: ^{13}C discrimination, N fertilizer, tropical pasture

INTRODUCTION

The ratio between stable isotopes of organic and inorganic elements in nature generally indicates the type and rate of processes forming these components and the prevailing environmental conditions by the time these components were formed (Trivelin, 1999). In this context, stable isotope analysis has the potential to characterize and provide ecological informations about an environment. Very little information exists in literature regarding carbon (C) discrimination in intensively-managed tropical pastures, even though studies on this topic can provide further insights on the understanding of the complex interactions that characterize pasture systems, namely the effect soil use management has on the overall structure of the ecosystem and the rates and profiles of vegetation dynamics in these systems. Many different scenarios can be investigated in order to provide a better understanding of the ecosystem through ^{13}C discrimination technique but for intensively managed highly fertilized pasture systems it would be quite interesting to relate nitrogen (N) status/input of the system to discriminated ^{13}C. This paper reported preliminary results on ^{13}C isotope discrimination on an irrigated Tanzania grass pasture (*Panicum maximum*, Jacq.) receiving increasing rates of N fertilizers during the summer.

MATERIAL AND METHODS

The experiment was carried out at Escola Superior de Agricultura "Luiz de Queiroz" (ESALQ/USP; 22° 42' S and 47° 38' W) during the summer (from January 12 to February 17/2000) and consisted of an irrigated (central pivot) Tanzania grass pasture (3.5 x 2.5 m plots) that received five rates of N (0, 30, 60, 90 and 120 kg N/ha) as ammonium sulfate. Lime, phosphorus, potassium and trace elements were corrected according to soil analysis. Treatments (N rates) were assigned in a randomized complete block design replicated four times. To determine the dry matter yield (DMY) (kg dry matter (DM) ha^{-1}) the forage was cut at a 30 cm-cutting height (two sampling areas of 0,25 m^2 each to form a composed sample) and samples collected in the field were oven dried (55° C) during a 48 h period, weighed and grounded. N concentration (NC) determination followed the Kjeldahl procedure and N yield (NY), i.e., kg N ha^{-1}, was obtained by the product between DMY and NC. Subsequently, samples were analyzed for $d^{13}C$ (‰) using an automated nitrogen and carbon analysis mass spectrometry (ANCA; Europa Scientific, model SL 20-20). Carbon isotope composition was expressed as $d^{13}C$ relative to that of the PDB standard with a precision of ± 0.02 ‰. The resulting $d^{13}C$ (‰) values were used to calculate isotopic discrimination (D) as indicated by Farquhar (1983). Data was first tested for homogeneity of variance and normality and the statistical package SAS System (1989) was used to perform the overall analysis of variance.

RESULTS AND DISCUSSION

DMY, NY and NC all increased quadratically with increasing levels of N fertilizer ($P < 0,05$), reaching a maximum (inflexion) point at 83,2, 82,6 and 100 kg N ha^{-1}, respectively (Table1). NY was positively related to DMY while both DMY (-0,4807) and NY (-0,5245) were negatively related to D ($P < 0,05$; Table 2). D values are within the typical range found in tropical grasses (Trivelin, 1999), yet this variable weakly responded to increasing levels of N fertilizer (Table 1). However, a linear non-significant tendency of higher discrimination against ^{13}C in tropical pastures at lower N fertilizer inputs was evident and seems feasible to admit that, at least in