Emission of greenhouse gases from soils under pastures submitted to diferent grazing managements and nitrogen fertilization rates, and intercropping with macrotyloma

Andrade, C.A. *; Vaso, L.M. †; Trettel, M.††; Gerdes, L.†††; Barbosa, C.M.P.†††; Rodrigues, P.H.M. ††; Ligo, M.A.V. ††††; Nogueira, S.F. ††††; Lima, M.A. ††††; Carvalho, T.A. ††††; Uzan, B.Z. †††; Zamboin, S. †††; Perna, F. ††; Bettanin, V.C. ††††; Marcatto, J.O.S. ††††

* Embrapa Environment; † Agronomic Institute; †† University of São Paulo; ††† Institute of Zootechnics; †††† Embrapa Environment

Abstract - Pastures occupy extensive areas in Brazil and represent the main land use in the country. The recovery of pastures and intensification of management are part of a public policy for higher productivity and environmental efficiency in the agricultural sector. The objective of this research was to evaluate emissions of nitrous oxide and methane from pastures submitted to different strategies for production intensification. To achieve this objective, N_2O and CH_4 emissions were monitored in two pastures of *Urochloa brizantha*, between the months of September 2019 and March 2020. Treatments involved the application of nitrogen fertilizer, the use of intercropping with *Macrotyloma axillare* and two grazing systems (deferred and rotational) combined with animal protein supplementation (urea and ammonium nitrate). The results indicated very low N_2O emissions. The emission factors calculated as a function of N input via fertilizer varied between 0.06 and 0.54. Soils under pasture acted as consumers of CH_4.

Key words: emission factor, nitrous oxide, Macrotyloma axillare, *Urochloa brizantha*

Introduction

Land is mostly used in Brazil as pastures; therefore, management practices for the sustainable intensification of pasture and livestock productivity have important effects on the economy and the achievement of clean development goals. It should also be considered that in Brazil the agricultural and livestock sectors and land use change are responsible for around 70% of greenhouse gas emissions, which makes it important to assess the impacts of management practices and production systems on the emission of greenhouse gases.
Based on this context, the objective of this research was to evaluate the emission of nitrous oxide and methane from pastures submitted to strategies for production intensification.

Methods

Two experiments were carried out involving *Urochloa brizantha* pastures: one of them in an area belonging to the Instituto de Zootecnia (IZ), in Nova Odessa, SP, and another at USP in Pirassununga, SP. The climate of both locations is classified as humid subtropical. The soil in the IZ area was classified as Ultisols of medium texture, and the soil at USP was classified as Oxisol of clayey texture.
In Nova Odessa, there were three treatments involving fertilization and intercropping: (i) *Urochcloa* pasture fertilized with 60 kg ha^{-1} of N; (ii) *Urochloa* pasture fertilized with 60 kg ha^{-1} of N and protein supplementation; and (iii) *Urochloa* pasture intercropped with macrotyloma (*Macrotyloma axillare*).
At USP, the treatments involved grazing systems (rotational or deferred), combined with two forms of protein supplementation to the animals (with urea or ammonium nitrate). All pastures received 100 kg ha^{-1} per year of N.
Nitrous oxide (N_2O) and methane (CH_4) emissions were monitored for about six months, from Sptember 2019 to March 2020, with two assessments per week. Static chambers were used (Varner et al., 2003) and the gas samples were analyzed by gas chromatography, using the Shimadzu GC-2014 equipment (Shimadzu Co., Columbia, MD, USA).

The results were treated in terms of daily flows and accumulation of N_2O in the period, in addition to the estimation of N_2O emission factors (N_2O-EF, %), which is the emission of nitrous oxide in relation to the total N applied.
Comparison between treatments was based on mean values and a 95% confidence interval.

Results and Discussion

In Nova Odessa the average daily fluxes of nitrous oxide (N_2O) during the experimental period were the following: 178.15 ug N m^{-2} day^{-1} in exclusive pasture; 117.14 ug N m^{-2} day^{-1} on pasture with protein supplementation; and 47.20 ug N m^{-2} day^{-1} in pasture intercropped with macrotyloma.
In Pirassununga, the highest N_2O fluxes were in the rotational grazing system (200 to 600 ug N m^{-2} day^{-1}), regardless of the type of protein supplementation. The daily flows in the deferred treatments were below 100 ug N m^{-2} day^{-1}.
Cumulative N-N_2O results weighted by N input via fertilization were used to derive N_2O emission factors (Table 1).

Table 1. Nitrogen emitted as nitrous oxide (N_2O) and N_2O emission factors (N_2O-EF) from pasture soils.

Identification	N_2O-N emitted	N applied (fertilizer)	N_2O-EF
	kg ha^{-1}	kg ha^{-1}	%
Brizantha grass ††	0.14 (0.04) †	60	0.17
Brizantha grass + protein supplementation ††	0.11 (0.04)	60	0.12
Brizantha grass + macrotyloma ††	0.07	-	
Rotated + ammonium nitrate †††	0.60 (0.06)	100	0.54
Rotated + urea†††	0.20 (0.02)	100	0.18
Deferred + ammonium nitrate †††	0.12 (0.01)	100	0.11
Deferred + urea †††	0.07 (0.01)	100	0.06

† Values in parentheses refer to the accumulated emission of N_2O-N in the soil without fertilization, which was deducted from the accumulated value emitted in the treatment with fertilization in the calculation of the respective emission factor. †† Experimental area in Nova Odessa, SP. ††† Experimental area in Pirassununga, SP.

The N_2O emission factors obtained were much lower than the 1% default value recommended by the IPCC (IPCC, 2007) and also lower than the 1.12% value found in a literature review carried out by Mazzetto et al. (2020) for nitrogen sources in Brazil. The observed N_2O emissions can be explained by the low levels of nitrate and ammonium in the soil (data not shown), in addition to lower levels of soil moisture.
In general, there was consumption of methane in most of the evaluation dates, resulting in the removal of something around 0.04 to 0.14 kg CH_4 ha^{-1} in the period. Higher rates of CH_4 consumption were observed in treatments that received nitrogen fertilization, which also suggests a relationship, even if indirect, between lower N_2O flows and better forage development.

Conclusions

N_2O emission factors for the nitrogen applied as fertilizer in pastures subjected to intensification strategies are much lower than the default value recommended by the IPCC.
Soils under grazing consume atmospheric methane.

Acknowledgements

To FAPESP for funding the research and to the Agronomic Institute and CAPES for making students and scholarships available for the team.

References

IPCC (INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE), 2006. N_2O emissions from managed soils, and CO_2 emissions from lime and urea application. Chapter 11. In: IPCC guidelines for national greenhouse gas inventories. v.4: Agriculture, forestry and other land use. **Institute for Global Environment Strategies**, Hayama, Japan.

MAZZETTO, M.; STYLES, D.; GIBBONS, J.; ARNDT, C.; MISSELBROOK, T.; CHADWICK, D. Region-specific emission factors for Brazil increase the estimate of nitrous oxide emissions from nitrogen fertiliser application by 21%. **Atmospheric Environment**, v.230, n.1, jun. 2020. 8p.

VARNER R.K.; KELLER M.; ROBERTSON J.R.; DIAS, J.D.; SILVA, H.; CRILL, P.M.; MCGRODDY, M.; SILVER, W. Experimentally induced root mortality increased nitrous oxide emission from tropical soil. **Geophysical Research Letters**, v.29, n.3, feb.2003. 7p.