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ANTHROPOGENIC AND CLIMATIC VARIABLES INFLUENCING N_2O EMISSIONS FROM AN UPLAND CROPPING SYSTEM

MI Khalil[1,4], O Van Cleemput[2], AB Rosenani[3], U Schmidhalter[4]
[1]Soil Sci. Div., Bangladesh Inst. Nuclear Agric., P.O. Box 4, Mymensingh 2200, Bangladesh.
E-mail: khalilmi@bttb.net.bd
[2]Faculty Agril. Appl. Biol. Sci., Ghent University, Coupure Links, Ghent, Belgium
[3]Dep. Land Manage., Universiti Putra Malaysia, Serdang, Selangor D.E., Malaysia
[4]Chair Plant Nutrition, Dep. Plant Sci., Technical University Munich, Freising, Germany

Introduction

Nitrous oxide (N_2O), formed during nitrification and denitrification, contributes to global climate change. Agricultural systems contribute about 60% of the total annual anthropogenic N_2O emission (Mosier et al. 1996). Its emission from soil-crop systems depends on anthropogenic and environmental factors. To elucidate the factors and for a reliable estimate of N_2O emissions, N management practices were evaluated in a groundnut-maize crop rotation in the humid tropics.

Materials and Methods

A field experiment was conducted on a Typic Paleudults (loamy) of Malaysia with 1.25% organic C and pH of 5.3. The crops received either inorganic N alone as ammonium sulfate (T_1) or inorganic N plus crop residues (T_2) or half of the inorganic N along with crop residues and chicken manure (T_3), amounting to 180, 322 and 400 kg N ha^{-1} yr^{-1}, respectively. Ammonium sulfate and amount of crop residues applied for groundnut and maize were 30 and 150 kg N ha^{-1}, and 3.0 and 4.6 Mg ha^{-1}, respectively. The rate for chicken manure was 10 Mg ha^{-1}. An additional experiment was conducted to investigate diurnal variations. Gas samples were collected using closed chambers to measure N_2O concentrations and information on soil and environmental factors were generated based on that.

Results

The N_2O fluxes from the groundnut-maize rotation ranged from -58 to 9889 µg N_2O-N m^{-2} d^{-1} and were log-normally distributed. Spatial variability of N_2O in terms of coefficients of variations (CV) ranged from 22 to 752%. Under both the crop covers, insignificant relationships for N_2O fluxes with the soil and air temperature were depicted (*Figure 1*). The temporal variations of N_2O emissions were large (CV= 60-81%) and the linear interpolation showed a significant contribution ($P<0.0001$) by both the treatments and month (43%). The relative deviation from the annual mean emissions increased with the period of large N application, the maximum with chicken manure (*Figure 2*). The contribution of seasons to the N_2O emissions was insignificant but exponentially decreased with the rainfall events. The direct annual N_2O emissions were enhanced exponentially with the increasing amount of applied N ($0.206e^{0.0099x}$, R^2 =0.83***) and it was 1.41, 1.90 and 3.94 kg N ha^{-1} from T_1, T_2 and T_3 treatments, respectively. The corresponding N_2O loss of applied N (plus N fixed by groundnut) was 0.59, 0.49, and 0.83%.

Discussion

The high N_2O emissions were mostly governed by the availability of mineral N under favourable soil water conditions, showing large spatial and temporal variability of N_2O, in line with Kaiser et al. (1998). Diurnal variations were negligible, and even distribution of air temperature masked the seasonal variations whereas N_2O fluxes decreased with higher rainfall events. Larger N loads, either from inorganic and/or organic forms, increased annual N_2O emissions. However, the amount of N loss as N_2O was insignificant from agronomic standpoint (Khalil et al., 2002).

Conclusion

The results suggest that agricultural practices viz., the amount, time and method of N application from either sources could be the major factors affecting N_2O fluxes in humid tropic soils.

Acknowledgements

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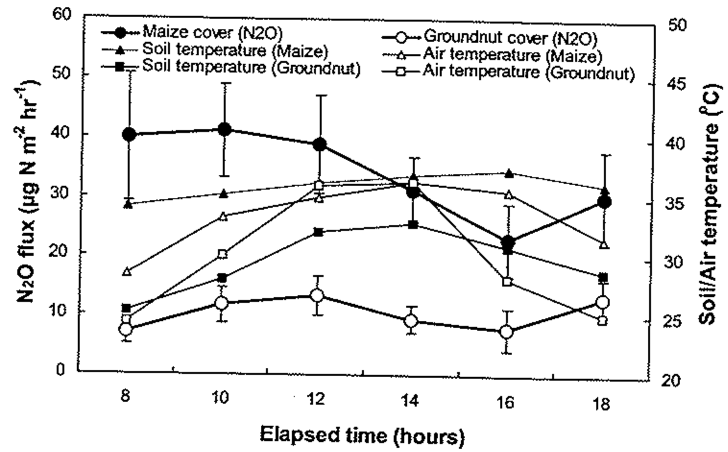

Figure 1. Diurnal variations of N_2O fluxes and changes in soil and air temperature measured during the gas collection period under both maize and groundnut cover (Mean of treatments). The vertical bars indicate standard errors.

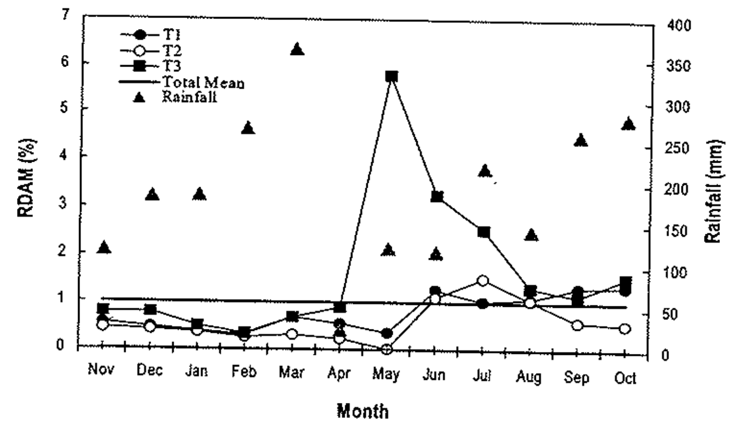

Figure 2. Relative deviation from the annual mean (RDAM) of the total N_2O emission (solid line) as affected by inorganic and organic N sources during the groundnut-maize crop rotation and monthly rainfall (T_1= Recommended N + crop residue, T_2 = Recommended N only and T_3 = ½ of the recommended N + crop residue + chicken manure).