Initial Nitrous Oxide Fluxes from a Maize–legume Cropping System in a Soil of the Derived Savanna Zone of Nigeria–Effect of Fertilizer and Incorporated Organic Matter

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Abstract

Legume–maize crop rotations are used as a mechanism to reverse declining soil fertility in West Africa. However, such crop rotations exhibit a relatively low recovery of legume N. Temperate region studies partly attribute low N recovery to gaseous N losses, but this has not been established for most cropping systems in the moist tropical savannas. The effect of incorporating added organic residues and fertilizer application on gaseous N_2O fluxes was studied in a field trial at the International Institute of Tropical Agriculture (IITA), Ibadan (7 °30'N, 3 °54'E) in the derived savanna zone of Nigeria. Gaseous N_2O fluxes were obtained 1, 3, 5, 8, and 15 days after incorporation of organic residues using a vented closed chamber system. Fluxes were examined in relation to soil mineral N status and rainfall patterns. Fertilizer application and incorporation of *Pueraria phaseoloides* organic residue increased soil mineral N contents as well as gaseous N_2O fluxes. Over the 15-day period, the total N_2O fluxes were in the range of 21–30 mg N m^2 for *P. phaseoloides* and 12–15 mg N m^2 for natural fallow. Fertilizer-derived N_2O fluxes were less than 1% of applied fertilizer N.

Introduction

In sub-Saharan Africa, increased pressure on agricultural land due to population increases has led to shortened fallow periods. Intensified cropping of these typically nutrient-poor ferric Lixisol soils has resulted in decreasing yields in farming systems with low-external inputs, increased soil acidification, and a general decline in soil fertility. The use of N-fixing legumes in rotation with maize is a promising technology for reversing this decline and nitrogen fertilizer replacement values between 50 and 120 kg have been reported for different legumes (Tian *et al.*, 2000, Schulz *et al.*, 2001).

Although biological N-fixation legumes in the tropics can fix up to 300 kg N ha^{-1} (Sanginga *et al.*, 2001, Tian *et al.*, 2001; Carsky *et al.*, 2001; Giller, 2001), only 10–30 % of the legume N is recovered in such rotations and losses are attributed to erosion, leaching, and gaseous losses (Giller *et al.*, 1995). Temperate region studies suggest annual gaseous N losses of up to 32 kg N ha^{-1} from grasslands and arable soils under varying N input levels (Vermoesen *et al.*, 1996; Goossens *et al.*, 2000).

Gaseous N fluxes from tropical agricultural systems are receiving increasing attention not only due to their influence on global warming