Effect of long-term application of fertilizers and manures on nitrous oxide emissions from soils under maize-wheat cropping system in Northern India

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Introduction

Nitrous oxide (N_2O) emissions from agricultural soils are major contributor towards global anthropogenic emissions of greenhouse gases (GHG). Among various factors contributing to N_2O emissions, application of nitrogenous fertilizers and manures is the key factor. In Northern India, soil N and C mineralization processes in soils under maize-wheat cropping system are entirely different from soils under rice-wheat system, as the fields remain mostly aerobic throughout the year, except, for few days during extensive monsoon rains. In the coarse textured soils, redox potential seldom drops to limits favouring methane production, but conditions become conducive for N_2O production. Although N_2O emissions from agricultural fields under rice-wheat system in India have been reported from some field studies conducted over short term, but information about N_2O fluxes from soils under long-term maize-wheat cropping system is lacking. The present study was undertaken to study the impact of long-term application of fertilizers and manure in maize-wheat cropping system on N_2O emissions.

Materials and Methods

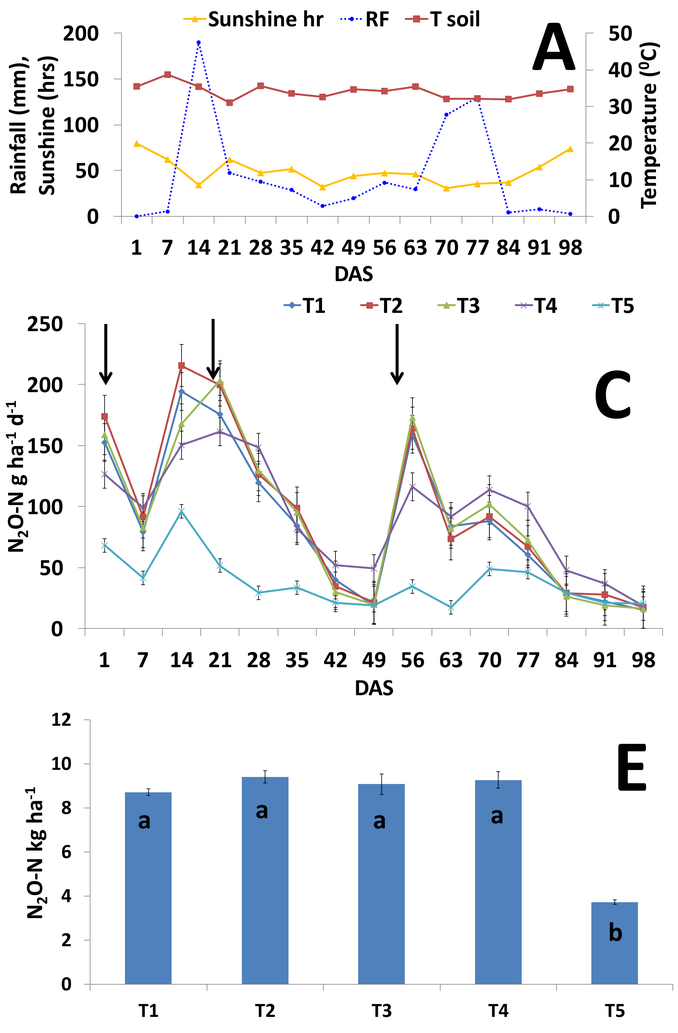
N_2O fluxes were measured by static chambers and gas chromatography in five treatments, viz., 100% NPK* (T_1), 150% NPK (T_2), 100% N (T_3), 100% NPK+FYM (T_4) and Control (T_5) of a long-term field experiment in progress for past 42 years at Punjab Agricultural University, Ludhiana, India, research farm.

Air samples were collected at 0, 15 and 30 minutes after the closure of chambers. Gas sampling was continued throughout the maize and wheat seasons. N_2O concentration in the samples was determined by using Shimadzu 2010 Gas Chromatographer, equipped with a electron capture detector. The N_2O flux (mg ha^{-1} day^{-1}) was calculated from linear temporal increase in mixing ratio of N_2O in the chamber. Surface soil (0-15 cm) samples were collected from selected treatments before sowing of maize and wheat crops for the determination of soil organic carbon (OC), and total (TC) along with available (AvlN), nitrate (NO_3^--N), and total (TN).

* 100% NPK = 120 kg N ha^{-1}, 26.2 kg P ha^{-1}, 25 kg K ha^{-1}

Results

A. Soil temperature, rainfall and sunshine hrs during maize season
B. Soil temperature, rainfall and sunshine hrs during wheat season
C N_2O fluxes in maize season from different fertilizers and manure treatments
D N_2O fluxes in wheat season from different fertilizers and manure treatments
(in figure C and D, downward solid arrows indicate N fertilization)
E Seasonal cumulative N_2O emissions during maize season
F Seasonal cumulative N_2O emissions during wheat season



Conclusions

N_2O emissions during maize were comparatively higher than wheat, probably due to higher soil temperature and intense rainfall events. But in both the seasons, peaks in N_2O fluxes were found coinciding with the rainfall and fertilization events. Further, after the rainfall or fertilization events emissions peaks were sharp in chemical fertilizer treatments, but in long-term FYM treatment (T_4), peaks were lower but with tailing effect, due to which seasonal cumulative emission were at par with higher fertilizer-N application (T_2). Significantly positive correlation of N_2O emissions was observed with NO_3^--N both in maize and wheat seasons.

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