Effect of nitrification inhibitors and soil pH on N_2O emissions

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Abstract

Continued N addition in agricultural soils leads to soil acidification, which affects crops yield and soil nitrification and denitrification processes. Liming is the most common strategy to reduce soil acidity. A laboratory experiment was conducted based on the application of nitrification inhibitors DMPP and DMPSA at three different soil pHs (4.5, 5.5 and 6.5). Both inhibitors demonstrated a higher efficiency reducing soil N_2O emissions at higher pHs.

Keywords: DMPP, DMPSA, N fertilization, nitrous oxide, soil acidification

1. Introduction

Agricultural soils are becoming acidic worldwide in intensive farming systems due to high application rates of N fertilizers. This acidification is a major agricultural problem since limits several crops yield. On the other hand, soil pH affects nitrification and denitrification pocesseses, consequently affecting the N_2O fluxes derived from both processes.

2. Materials and methods

A grassland soil (pH 4.5) was sampled (0-10 depth), sieved and homogeneized. A total of 12 treatments were assayed resulting from the combination of 3 different pHs (4.5, 5.5 and 6.5) and 4 different N fertilizer treatments. The pHs were induced after the application of $CaCO_3$ at doses of 0.3 and 6 Mg $CaCO_3$ ha^{-1}. The fertilizer treatments consisted on a dose of 100 kg N ha^{-1} of ammonium sulphate applied alone or combined with the nitrification inhibitors (NI) DMPP and DMPSA. An unfertilized control was included. Soil was incubated in darkness at 21ºC during 45 days at a water filled pore space of 75%. N_2O emissions were measured every two days after incubating the soils during 60 minutes. Gas samples were analysed by gas chromatography.

2. Results and discussion

The application of fertilizer did not induce N_2O emissions in soil with pH 4.5, where emissions were 15 and 43 times lower than in pH 5.5 and pH 6.5, respectively. These low emissions were atributed to the effect of acidity on nitrification (de Boer and Kowalchuk, 2001). So, under pH 4.5 conditions, where N_2O emissions should be coming from denitrification of the nitrate previously present in the soil, the efficiency of both NIs reducing N_2O emissions was around 50%. This suggests an NIs non-target effect on denitrification of N_2O up to N_2 as described by Torralbo et al. (2017).When soil pH was 5.5 and 6.5, both nitrification and denitrification should be contributing to N_2O emissions. In this case, both NIs showed efficiencies higher than 95% mitigating N_2O emissions from fertilization.

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