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Antibiotic Effects on Microbial Communities Responsible for Greenhouse Gas Emissions

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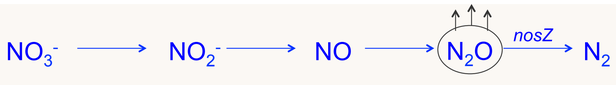
Introduction

- ✓ Nitrous oxide (N_2O) is a powerful greenhouse gas depleting the stratospheric ozone.
- ✓ Recent studies show that fungi produce N_2O by denitrification.
- ✓ Bacteria can be a source or sink of N_2O depending on the presence of nitrous oxide reductase genes (*nosZ*).
- ✓ Fungal denitrification produces N_2O as an end product due to lack of *nosZ* genes.

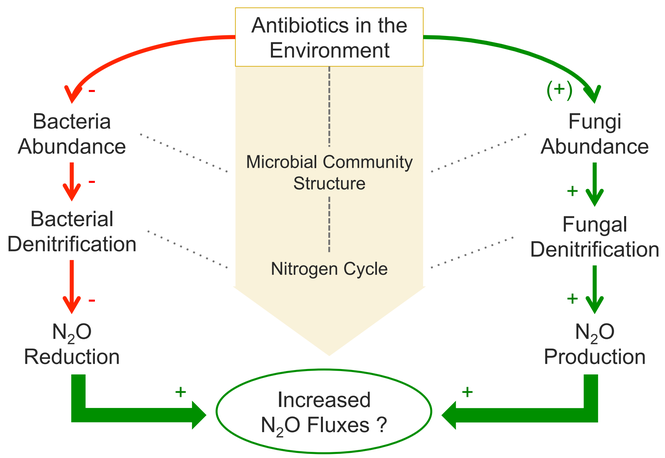


Denitrification. Step-wise reduction of nitrate (NO_3^-) to nitrite (NO_2^-), nitric oxide (NO) and N_2O to N_2. The *nosZ* gene is present in bacteria but is missing in fungi.

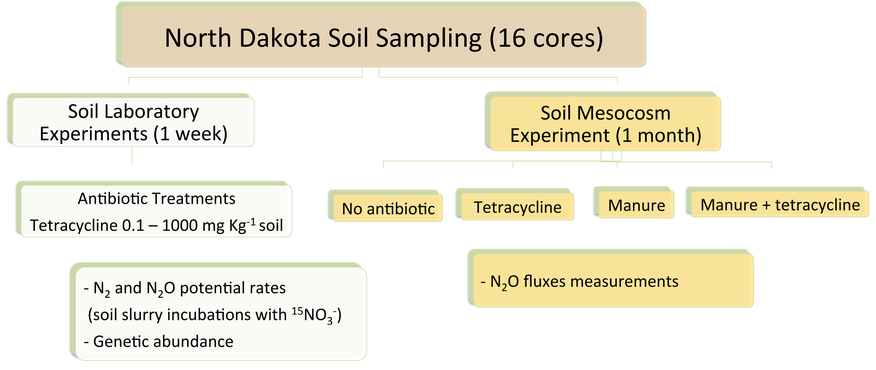
- ✓ Higher fungal denitrification can increase soil N_2O emissions.
- ✓ Animal manure application affects N_2O emissions from agricultural fields.
- ✓ Antibiotics carried in the animal manure due to livestock administration mostly repress bacteria, promoting fungal growth.

Objective

To study the effects of antibiotics on microbial communities responsible for N_2 and N_2O production in agricultural soils and estuarine sediments



Methods



Results

Soil Laboratory Experiments (1 week incubations)

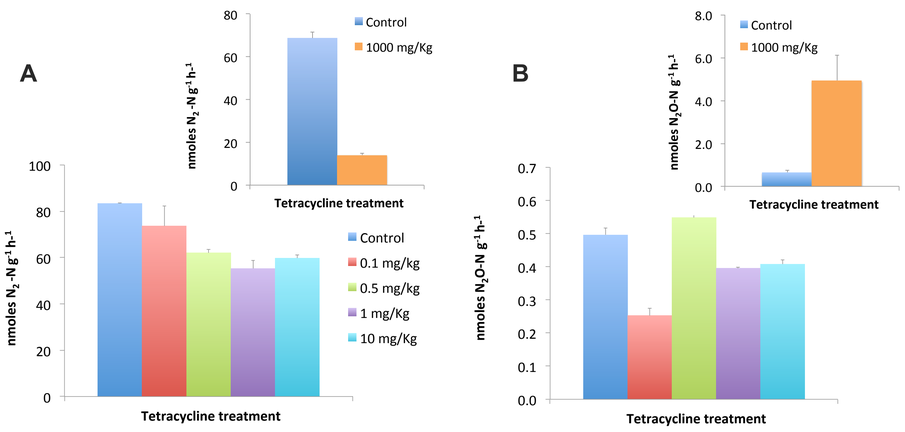


Figure 1. Rates of N_2 (**A**) and N_2O (**B**) production measured in soil slurry incubations with tetracycline. Different concentrations of tetracycline were used. Water was added to the controls. Columns represent mean ± SE.

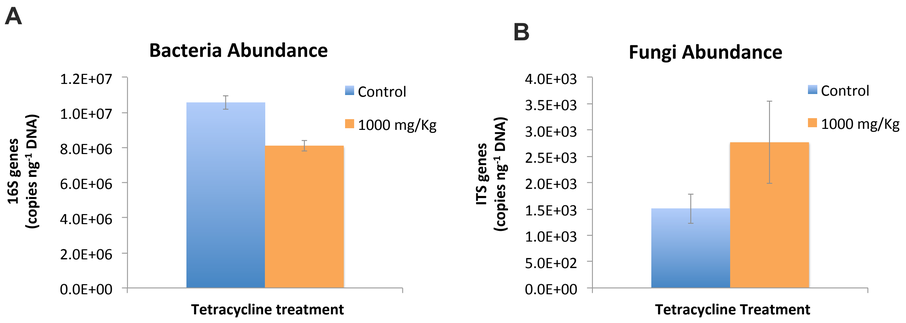


Figure 2. Quantification of bacterial 16S (**A**) and fungal ITS (**B**) genes in DNA extracted from the soil slurry incubations with antibiotic. Columns represent mean ± SE.

Soil Mesocosm Experiment (1 month)

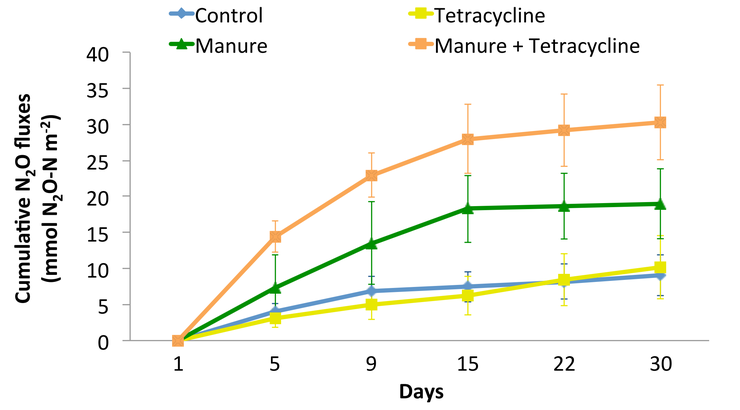


Figure 3. N_2O cumulative fluxes measured in soil mesocosms treated with manure and antibiotic. Tetracycline in the manure (2 mg Kg^{-1}) was applied to the soil cores. Markers represent mean ± SE.

Mesocosm Experiment

Soil Core

Slurry Incubations

Conclusions

1. N_2O production was enhanced 8 times in the soils treated with high concentration of tetracycline.
2. Antibiotic inhibition of N_2 production was dose-dependent, reaching 25 and 80% inhibition in the samples treated with 0.5 mg Kg^{-1} and 1,000 mg Kg^{-1} of tetracycline, respectively.
3. Higher abundance of fungi with decreasing bacterial abundance was observed after tetracycline exposure.
4. Cumulative N_2O fluxes in the mesocosm experiment show that the application of manure contaminated with tetracycline enhances soil N_2O emissions.

Acknowledgements

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