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Arbuscular Mycorrhizal Fungi Increase the Abundance of Ammonia-Oxidising Bacteria, but Suppress N_2O Emissions after Fertilisation

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Abstract

The potential of the symbiosis between plants and arbuscular mycorrhizal fungi (AMF) to reduce greenhouse gas emissions from soil is gaining scientific attention in the last years. Given the relatively high nitrogen (N) requirements of the AMF and their generally positive effect on host plant growth, AMF may reduce the availability of mineral N that would otherwise be subject to nitrification, which is associated with N_2O emissions. We investigated the impact of AMF on the growth of tropical grass *Brachiaria decumbens* Stapf. and N_2O released after urea application. To detect the role of nitrification in N_2O emissions we used the nitrification inhibitor dicyandiamide (DCD). A mesocosm study (106 days) with two AMF treatments (with and without AMF) and three fertilisation treatments (control, urea and urea+DCD) was set up and plant growth, soil properties and N_2O emissions were measured for two weeks after fertiliser application. Without DCD, the production of N_2O was significantly increased by urea, suggesting that inhibition of nitrification can mitigate N_2O emissions. The cumulative emissions of N_2O after urea application were reduced by 46 % in the presence of AMF when compared to non-AMF pots. Nevertheless, the abundance of ammonia-oxidising bacteria (AOB) was increased by urea and AMF, while plant growth was reduced by the AMF presence. The increased root:shoot ratio of the biomass in AMF- pots suggests competition for N between AMF and plants. In this study, we demonstrated that immobilisation of N by AMF may significantly reduce N_2O emissions, at least in the short-term, even when plant growth is reduced. Furthermore, the inverse relationship found between (higher) AOB abundance and (lower) nitrification rates suggests that changes in the activity of AOB, rather than abundance, may be indicative of the impact of the mycorrhizal symbiosis on N cycling in tropical grasslands. Alternatively, the difference between N_2O emissions from AMF and non-AMF pots may (partly) be explained by increased reduction of N_2O in the presence of AMF. Longer-term studies are needed to verify whether the observed effects of AMF on N_2O emissions and/or plant growth persist or are limited to initial immobilisation of N by AMF in N-limited systems.

Keywords: Arbuscular mycorrhizal fungi, *Brachiaria*, N_2O emissions, nitrification, urea

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