The response of nitrous oxide emitting microorganisms following manure application to semi arid soils

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Climate change is a serious threat to agricultural productivity and global food security yet paradoxically agriculture is a major contributor of greenhouse gas (GHG) emissions, especially nitrous oxide (N2O). Manure application to soil is a major source of N2O emissions but the microorganisms and mechanisms involved in these emissions are not fully understood, especially in semi-arid regions that are widely used for agricultural production. Previous work has indicated that nitrifying microorganisms are largely responsible for nitrous oxide (N2O) emissions in the semi-arid soils. However, the impact of adding animal manure on the N2O emitting microbial populations in these soils is largely unknown. Developing effective abatement methods for reducing N2O emissions from soils amended with manure requires a better understanding of the microorganisms and mechanisms involved. This paper investigates the relationship between N2O emissions and the microbial response following the addition of different manure inputs (stockpiled, composted or pelletised manure) either surface applied or incorporated to two soils of contrasting texture. The short-term N2O flux was analysed at 0, 2, 6, 24 and 48 hours by gas chromatography. Key components of the microbial community associated with elevated N2O emissions were identified using next generation sequencing approaches. Additionally, changes in gene abundance of ammonia-oxidizing bacteria and archaeal (amoA gene) and denitrifying bacteria (norB and nosZ genes) were determined using quantification PCR. The N2O flux and population response differed according to the manure treatment added but were most pronounced in soils amended with stockpiled manure either broadcast or incorporated. Nitrous oxide emissions from soils amended with manure were attributed to both nitrifying and denitrifying populations and related to increased availability of ammonium and nitrate, respectively. Thus, abatement methods that decrease nitrification and nitrate concentration could be a good strategy to reduce GHG emissions from manured semi-arid soils.