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Discussions

Interactive comment on "Linking phosphorus and potassium deficiency to microbial methane cycling in rice paddies" *by* Rong Sheng et al.

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Dear Editor, Thank you for your comments and suggestions on our manuscript. We have revised the manuscript accordingly, and highlighted the changes in the revised version. The detailed corrections are listed below point by point:

#Comment 1: The abstract. please clearly describe the patterns of methane emission fluxes in the field as a starting point in your abstract. And then explain the discrepancy of methane flux in the field by the variations of mcrA and pmoA genes and their transcripts in the context of P and K nutrient status. The soil properties and plant biomass can also be used to interpret the methane flux variations, and the abstract can be concluded with the statistically most significant factors that may determine methane flux in the field.

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Discussion paper

Answer: The abstract was rewrite as follows: Nutrient status in soil is crucial for the growth and development of resident microorganisms. Soil methanogens and methanotrophs can be affected by soil nutrient availabilities, which in turn modulate methane (CH4) emissions. However, it is not clear about the influence of nutrient limitation on the methanogenic and methanotrophic communities and their functions. We assessed whether deficits in soil available phosphorus (P) and potassium (K) modulated the activities of methanogens, methanotrophs in a long term (20 y) experimental system undergoing limitation in either one or both nutrients. Results showed that a large amount of CH4 emitted from paddy soil at rice tillering stage (flooding) while CH4 flux was minimum at ripening stage (drying). Compared to NPK treatment, the soils without P input significantly reduced methane flux rates, whereas without K input did not. Under P limitation, methanotroph transcript copy number significantly increased in tandem with a decrease in methanogen transcript abundance, suggesting that soils lacking P induced CH4 emission reduction would be via reduced methane production in tandem with increased methane consumption potential. In contrast, K deficits reduced both methanogen and methanotrophs transcript abundance. Assessments of community structures based upon transcript indicated the treatment without P amendment induced greater shifts in the active methanotrophic community than for K deficits while similar community structures of active methanogens were observed in both treatments. Correlation analysis indicated that soil phosphorus availability, SOC contents and plant biomass were important factors in regulating CH4 emission from the field.

#Comment 2: The title. The title might be reasoned whether it can actually reflect the most important findings in this study. Indeed it seems for me that soil water management played a much more important roles than nutrient fertilizers

Answer: Soil water management indeed plays an important role in regulating CH4 emission, and it has been already proved by previous studies (Cai et al., 1997; Nishimura et al., 2004; Towprayoon et al., 2005). In this study, we focused on the nutrient status on the process of CH4 emission at two rice growing stages. The long-term paddy rice fertilization field experiment utilized in this study was established in 1990, the rice plants in the plots without P input showed severe P deficiency symptoms and loss of about 55% of yield, and the plants in the plots without K input exhibited clear K deficient symptoms and lost about 20% of yield. However, how the functional microorganisms such as methanogens and methanotrophs respond to the soil P and K exhausting environments remains unknown. Here we hypothesised that the depleting soil available P and K obviously restricted rice plant growth, and simultaneously, it may also affect the community compositions and functions of methanogens and methanotrophs. And we subsequently used a multi-level approach to resolve the impact of phosphorus and potassium upon the community composition and abundance of both resident (DNA based) and active (mRNA-based) methanogens and methanotrophs and its subsequent influence upon overall methane flux. For clarity, we have changed the title from “Linking phosphorus and potassium deficiency to microbial methane cycling in rice paddies” to “Linking the soils lacking phosphorus & potassium for rice plant to the behaviors of methanogens and methanotrophs and methane emission”.

#Comment 3: The relevant reference might be added as follows. Veraart, A. J., Steenbergh, A. K., Ho, A., Kim, S. Y., & Bodelier, P. L. E. (2015). Beyond nitrogen: the importance of phosphorus for CH4 oxidation in soils and sediments. Geoderma, 259-260(December), 337-346.doi:10.1016/j.geoderma.2015.03.025

We have added this reference in the manuscript.

References

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