Quantification and mitigation of ammonia emissions from paddy fields in subtropical central China

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Abstract

The new designed method for quantifying ammonia emissions can realize measuring ammonia emission at every five minutes automatically. The measured daily ammonia fluxes showed good correlation with solar radiation and air temperature. More than 50% of the ammonia emitted from paddy fields was reduced under treatments with reduced N application combined with deep application of basal fertilizer or urease inhibitor as compared with conventional treatments, while rice grain yield did not show significant difference among the treatments. Deep application of basal N fertilizer and using of urease inhibitor can be good measures to mitigate ammonia emissions from paddy fields.

Keywords: ammonia volatilization; N cycling; non-point source pollution; paddy soil

1. Introduction

Ammonia emissions from croplands contribute in a large portion to the atmospheric reactive nitrogen species, which can return back to earth surface by wet and dry depositions and thus cause eutrophication, soil acidification and loss of biodiversity. The dynamic chamber method is the common method used for quantifying ammonia emissions from croplands. However, this method is usually labor costly, and can also cause overestimate of ammonia emissions due to limited measuring frequency (e.g., 2 h or 4 h per day). In this study, an automatic and continuous ammonia emission measuring system was designed to quantify ammonia emissions from paddy fields. For mitigating ammonia emission from paddy fields, a field experiment was conducted with treatments of reduced N application rate, deep application of basal fertilizer and use of urease inhibitor.

2. Methods

An automatic and continuous ammonia emission measuring system was designed to quantify ammonia emissions from paddy fields. A field experiment was conducted with treatments of reduced N application rate, deep application of basal fertilizer and use of urease inhibitor.

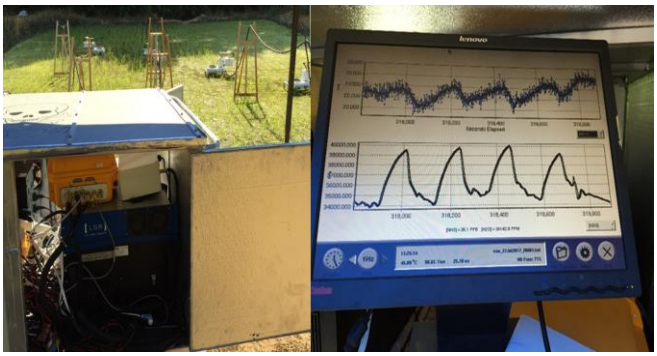

Fig. 1: The automatic and continuous NH_3 emissions measuring system

3. Results

3.1 Daily and seasonal variation of NH_3 fluxes

The NH_3 fluxes showed a large daily and seasonal variation. NH_3 emissions almost stopped in the nighttime.

Daily NH_3 emisisons showed positive corelation with soilar radiation. High NH_3 emissions were found during the two weeks after N fertilizer application.

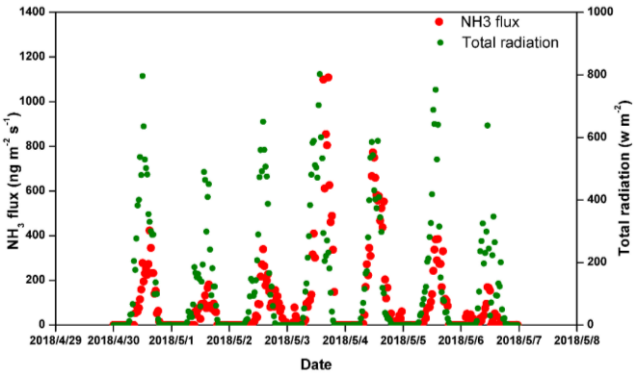

Fig. 2: Daily variation of NH_3 fluxes and solar radiation

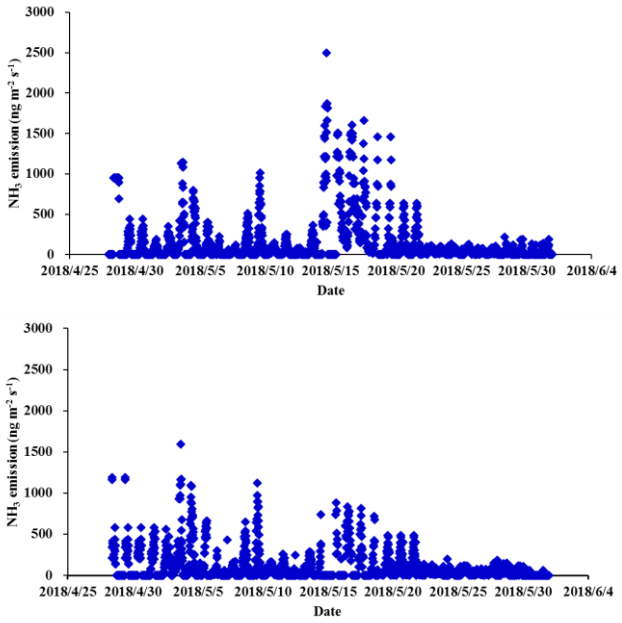

Fig. 3: Variation of NH_3 fluxes in a rice season

3.2 NH_3 emissions for NH_3 reduction treatments

As compared with the conventional treatments, reducing N fertilizer application rate, deep application of N fertilizer, using urease inhibitor largely decreased NH_3 emissions by 36% to 65%.

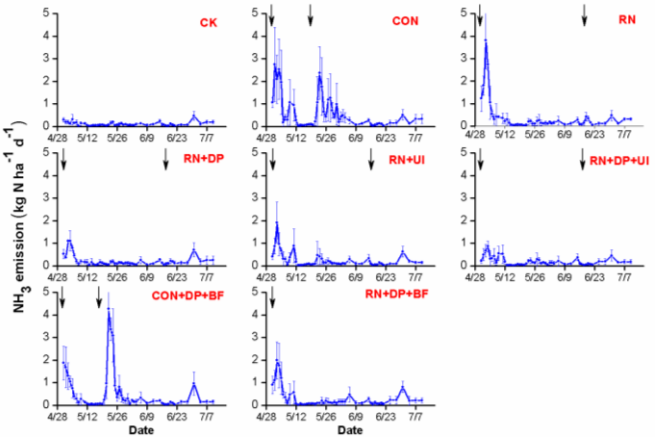

Fig. 4: NH_3 fluxes for the NH_3 reduction treatments

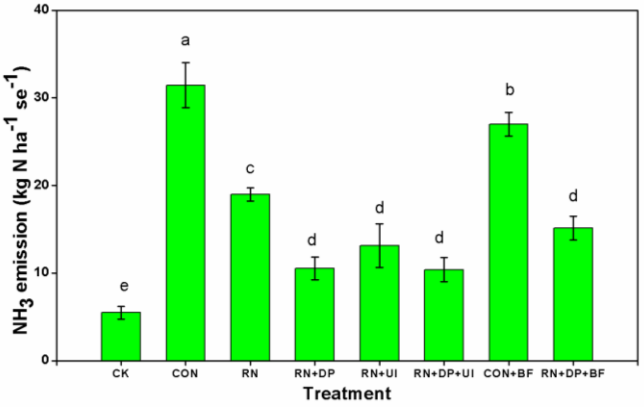

Fig. 5: Total NH_3 emissions in a rice season

4. Conclusions

The automatic and continuous NH_3 emission measuring system can be used as an effective method to measure NH_3 emissions from croplands. Deep application of N fertilizer and using urease inhibitor reduced NH_3 emissions from paddy fields by > 50%.

Acknowledgements

The work was supported by the National Key Research and Development Program of China (2018YFC0213302).

References

Liu X J, Xu W, Duan L, *et al*. 2017 Atmospheric nitrogen emission, deposition and air quality impacts in China: An overview. *Current Pollution Reports* 3: 1~19