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Long-term manure application increased greenhouse gas emissions but had no effect on ammonia volatilization in a Northern China upland field

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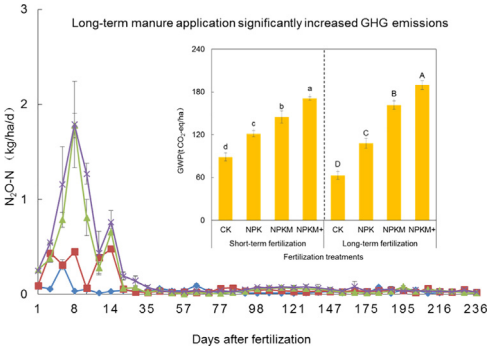
HIGHLIGHTS

- Impacts of manure application to wheat crops on soil NH_3 and GHG emissions were evaluated.
- Swine manure application reduced NH_3 emission factor both in long- and short-term fertilization.
- Long-term excessive swine manure application decreased crop yield and increased GHG emissions.
- Appropriate fertilization management practices need to be developed considering both crop yield and GHG emissions.

GRAPHICAL ABSTRACT



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ABSTRACT

The impacts of manure application on soil ammonia (NH_3) volatilization and greenhouse gas (GHG) emissions are of interest for both agronomic and environmental reasons. However, how the swine manure addition affects greenhouse gas and N emissions in North China Plain wheat fields is still unknown. A long-term fertilization experiment was carried out on a maize-wheat rotation system in Northern China (*Zea mays L-Triticum aestivum* L.) from 1990 to 2017. The experiment included four treatments: (1) No fertilizer (CK), (2) single application of chemical fertilizers (NPK), (3) NPK plus 22.5 t/ha swine manure (NPKM), (4) NPK plus 33.7 t/ha swine manure (NPKM+). A short-term fertilization experiment was conducted from 2016 to 2017 using the same treatments in a field that had been abandoned for decades. The emissions of NH_3 and GHGs were measured during the wheat season from 2016 to 2017. Results showed that after long-term fertilization the wheat yields for NPKM treatment were 7105 kg/ha, which were higher than NPK (3880 kg/ha) and NPKM+ treatments (5518 kg/ha). The wheat yields were similar after short-term fertilization (6098–6887 kg/ha). The NH_3-N emission factors (EF_{amm}) for NPKM and NPKM+ treatments (1.1 and 1.1–1.4%, respectively) were lower than NPK treatment (2.2%) in both the long and short-term fertilization treatments. In the long- and short-term experiments the nitrous oxide (N_2O) emission factors (EF_{nit}) for NPKM+ treatment were 4.2% and 3.7%, respectively, which were higher than for the NPK treatment (3.5% and 2.5%, respectively) and the NPKM treatment (3.6% and 2.2%, respectively). In addition, under long and short-term fertilization, the greenhouse gas intensities for the NPKM+ treatment were 33.7 and 27.0 kg CO_2-eq/kg yield, respectively, which were higher than for the NPKM treatment (22.8 and

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