Ammonia volatilization and nitrous oxide emissions from organic fertilizers applied to arable soils in the North China Plain–possible trade-offs and mitigation approaches

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Abstract

Three field experiments were conducted in the North China Plain under different cropping systems during three different years and seasons. One or two different organic fertilizers (biogas digestate, cattle slurry) and two or three application methods were compared. Ammonia and nitrous oxide emissions (in two experiments only) were measured *in situ* following fertilizer application. Generally, an increased incorporation depth strongly reduced NH_3 losses but increased N_2O emissions. The different application methods were evaluated regarding their combined global warming potentials.

Keywords: *in situ* experiments, biogas digestate, slurry

1. Introduction

The Chinese Ministry of Agriculture and Rural Affairs has issued several Regulations for the utilization of livestock and poultry wastes. In 2018, the utilization rate of animal wastes in China was 64%. Systematic research on leaching and geaseous nitrogen (N) losses from animal manures in China has been scarce. In order to quantify ammonia (NH_3) volatilization losses and nitrous oxide (N_2O) emissions from biogas digestates and animal slurries, several field experiments were carried out in the North China Plain under different cropping systems using different substrates.

2. Materials and Methods

Three field experiments were organized in different locations in Baoding and Zhengding, Hebei Province. Experiment (1) was carried out on a Chinese cabbage field in 2016. Surface application of biogas digestate (196 kg N ha^{-1}) was compared with furrow application. The calibrated Dräger Tube Method (DTM) (Roelcke et al., 2002; Pacholski et al., 2006) was used for *in situ* measurements of NH_3 volatilization. In experiment (2) in an apple orchard in 2017, biogas digestate from a pig farm (150 kg N ha^{-1}) was applied as surface application (SA), with uniform incorporation (IA), and into furrows immediately covered with soil (FA).

Ammonia losses (DTM) and N_2O emissions (closed chambers) were quantified simultaneously. In experiment (3) with summer maize in 2019, biogas digestate and slurry from a dairy cattle farm (100 kg N ha^{-1}) were surface applied and incorporated in furrows; NH_3 and N_2O were determined as above.

3. Results and Discussion

Fig. 1 shows the cumulative NH_3 losses under different application methods in field experiment (2).

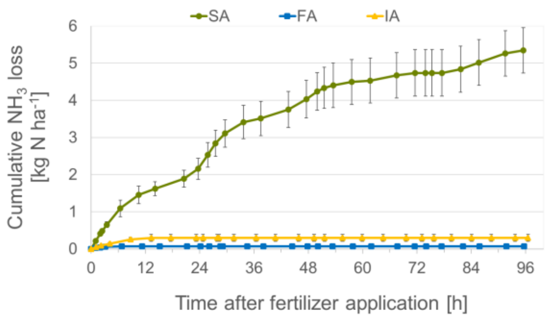

Fig. 1: Cumulative NH_3 losses [kg N ha^{-1}] (mean ± stand. dev., n=3) under different biogas digestate application methods (SA, IA, FA) measured in an apple orchard in 2017.

Generally, surface application of biogas digestate and slurry led to higher N losses in form of NH_3 while uniform incorporation and furrow application resulted in lower NH_3 but higher N_2O emissions. However, the degree of these effects varied in the three experiments, resulting in different global warming potentials (GWP) calculated using the standard IPCC emission factors.

4. Conclusions

The strong NH_3 loss-reducing effect of incorporation compared to surface application was observed on all three sites. Yet the results also showed that "best practice" recommendations would vary for the different application methods regarding their GWPs.

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References

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