**Application**

Slurry amendments have the potential to reduce gaseous emissions from storage and landspreading of liquid manures.

**Introduction**

Slurry storage and landspreading can lead to large losses of gaseous emissions to the environment in the form of an air pollutant ammonia (NH3) and greenhouse gases (GHG), mainly methane (CH4; in storage) and nitrous oxide (N2O; at land spreading). In Ireland, manure management is responsible for approximately 10% of agricultural GHGs and 80% of NH3. Considering legally binding targets to reduce both types of emissions, there is an urgent need for mitigation. Slurry amendments or additives have long been of interest to the agricultural industry seeking ways to reduce gaseous emissions, improve nutrient use efficiency and overall sustainability. While slurry acidification is an established abatement technique, questions remain over many alternative additives such as waste products, by-products or commercial materials (Owusu-Twum et al., 2024). This work aimed to quantify NH3 and GHG emissions from storage and landspreading of cattle slurry treated with sulphuric acid, gypsum and biochar compared with untreated slurry. Landspreading experiment also aimed to investigate efficacy of slurry treatments on two contrasting soil types and during varying environmental conditions at spreading.

**Materials and methods**

In this work, two experiments were carried out to assess efficacy of slurry amendments during slurry winter storage (Experiment 1) and land spreading (Experiment 2). Experiment 1 was a large-scale incubation simulating slurry storage under mild, temperate climatic conditions carried out during winter of 2022 at Teagasc Johnstown Castle, Co. Wexford. Twelve pilot-scale underground storage tanks were filled with 660L slurry and amended with either sulphuric acid, biochar or gypsum, or left untreated, resulting in three replicates of each treatment laid out in a randomized block design. Slurry was stored for 77 days post-treatment and NH3 and GHGs were monitored regularly throughout this period using dynamic (acid trap method) and static chamber techniques for both types of gases, respectively.

Experiment 2 was a slurry land spreading trial carried out across three seasonal applications, over two years (2021-2022), at two grassland sites on contrasting soils in Ireland. The sites were: a) moderately to poorly drained soil at Teagasc Johnstown Castle, Co. Wexford and b) an imperfectly drained clay loam at the Agri-Food and Biosciences Institute (AFBI) in Loughgall, Co. Armagh. Slurry amended with the same treatments as during storage (sulphuric acid, biochar, gypsum, untreated slurry) was spread to 1.5 x 1.5 m plots laid out in a fully randomised block design, with five replicates for nitrous oxide measurements and three replicates for ammonia measurements. Ammonia was measured using dynamic chamber technique with an INNOVA 1412 photoacoustic gas analyser for a week following application. N2O was measured using static chamber technique for approximately 2 months following application. Data was checked for normality prior to statistical analysis of variance (SAS version 9.4; SAS Institute Inc). Multiple comparisons between means were done using the Tukey test and differences among means were considered significant at a p-value below 0.05.

**Results**

During storage, slurry acidification with sulphuric acid showed a significant reduction (32%) in NH3 emissions relative to the control, while CH4 was reduced significantly in the sulphuric acid (46%), gypsum (39%) and biochar (15%) treatments relative to the control.

Upon landspreading, acidification with sulphuric acid significantly reduced NH3 whereas the other slurry amendments (i.e., biochar and gypsum) showed variable results. N2O emission factors were in the order; slurry + sulphuric acid (0.23%) > slurry + gypsum (0.17%) > untreated slurry (0.11%) > slurry + biochar (0.09%).

**Conclusions**

Slurry acidification proved a reliable method of reducing NH3 and CH4 in storage under mild winter conditions. Sulphuric acid was also effective at reducing NH3 during land spreading, however it led to a small increase in N2O emissions. However, other tested additives showed variable efficacy of mitigation in both phases of slurry management.

**Acknowledgements**

This research was financially supported by the Department of Agriculture, Food and Marine in the Republic of Ireland and Department of Agriculture, Environment and Rural Affairs in Northern Ireland (grant numbers 2019R554 and 19/4/16).

**References**

Owusu-Twum, M.Y., Kelleghan, D., Gleasure, G., Connolly, S., Forrestal, P., Lanigan, G.J., Richards, K.G., Krol, D.J. 2024. Waste Management & Research, 0(0).