FARMING PRACTICE
MANURE PROCESSING TECHNIQUES

IMPACT: GHG EMISSIONS

Reference 8

Xia, F; Mei, K; Xu, Y; Zhang, C; Dahlgren, RA; Zhang, MH 2020 Response of N2O emission to manure application in field trials of agricultural soils across the globe SCIENCE OF THE TOTAL ENVIRONMENT, 733, 139390. 10.1016/j.scitotenv.2020.139390

Background and objective

The response of soil nitrous oxide (N2O) emission to manure application has been widely reported for laboratory experiments. However, the in-situ effects ofmanure application on soil N2O emission from field trials (i.e. real- world conditions) and related mechanisms are poorly understood at the global scale. 1) to investigate how manure application influences soil N2O emission fluxes and emission factors in field trials and to elucidate potential regulating mechanisms; and 2) identify important factors related to soil properties, manure characteristics and agricultural practices that regulate N2O emission fluxes following manure application. Results from this study provide a scientific basis for developing strategies to mitigate soil N2O emission associated with manure application.

Search strategy and selection criteria

Peer-reviewed articles that reported N2O emission following manure application in field trials were searched in the Web of Science. Literature prior to December 2017 with 'manure', 'field',and 'N2O/nitrous oxide emission' present in the title, keyword or abstract was collected. 1) studies were performed by field trial and with at least 3 replicates; 2) studies reported soil N2O emissions in both manure applied treatments and non-manure controls; and 3) at least one crop season was included at the same experimental site. If multiple growing seasons were available, each grow- ing season was considered as a separate observation. If multiple crops were cultivated at different periods in the same experimental site, each crop type was considered as one observation, as crop type contrib- utes greatly to changes in soil properties. If an experimental site included multiple measurements of N2O emission, only the final time point was chosen for this meta-analysis. When a treatment was applied as a mixed manure plus mineral fertilizer, the comparison was considered as one observation only if another treatment with the same mineral fertilizer application was set up as a control.

Data and analysis

For studies not reporting the standard deviation, a value of 29.2% was assigned for N2O emission, which was the average value for the standard deviation in the dataset. MetaWin 2.1 software was used to calculate cumulative effect size using a random-effects model and weighted resampling method. The 95% confidence intervals (CIs) were generated in MetaWin using a bootstrapping procedure with 4999 iterations. The cumulative effect size was significantly positive or negative at $p < 0.05$ if the 95% confidence interval did not overlap with zero.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
44	Arable land and grassland	Fertilisation with pre-treated manure (either composted or digested farmyard manure (FYM), pig, cattle or poultry.	Fertilisation with raw manure (farmyard manure (FYM), pig, cattle or poultry)	Metric: N2O emissions; Effect size: 1) Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control. 2) N2O emission factor (EF, % of total nitrogen in manure), to investigate the net manure effect on soil N2O emission.	68.75

Results

- Raw and pre-treated manures significantly increased soil N2O emission. However, the increase in N2O emission from raw manure (lnR = 1.31) was significantly higher than pre-treated manure (lnR = 0.84) ($p < .05$).

Factors influencing effect sizes

- Climate : Soils emitted more N2O in warm temperate (LnR = 1.29) with manure application, which is followed by cool temperate (LnR = 1.04). In contrast, soils in tropical areas were identified with lowest N2O emission (LnR = 0.74).
- Crop type : Soils with grass were identified with largest effect size for N2O emission with manure application (lnR = 1.60), which is followed by maize (lnR = 0.99) and wheat (lnR = 0.74). Soils in rice and bean cropping systems showed similar effect sizes of N2O emission with manure application (0.13 and 0.09, respectively), which is relatively lower when compared with other cropping systems.
- Water filled pore space : N2O emission increased most in soils with water-filled pore space (WFPS) of 50–90% (lnR = 1.44), which was higher than soils with WPFS <50% (lnR = 1.00, $p > 0.05$) and WPFS >90% (lnR = 0.62, $p < 0.05$).
- Duration of treatment : Short-term application of manure (<3 months) produced higher N2O emission than long-term application (1–5 years).
- Soil organic carbon : The effect size (lnR) of N2O emission in the soils with medium SOC content (10–30 g kg−1) (1.25) was greater than low (<10 g kg−1) (0.84) and high (>30 g kg−1) (0.93) SOC contents.

Conclusion

Raw manure resulted in significantly higher N2O emission than pre-treated (either composted or digested) manure.