Optimising N_2O measures following the application of mineral and organic nitrogen fertiliser to sugarcane

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Daniel Mika-Nsimbi Poultney [1,2,3*], Frédéric Feder [1,2], Charles Detaille [1,2], Laurent Thuriès [1,2] and Antoine Versini [1,2]

[1]CIRAD, UPR Recyclage et risque, 97743 Saint-Denis, La Réunion, France

[2] Recyclage et Risque, Univ Montpellier, CIRAD, Montpellier, France

[3] Department of Geosciences and Natural Resource Management, University of Copenhagen, Copenhagen DK-1350, Denmark

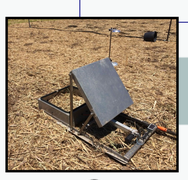
* dmp@ign.ku.dk

Background

- Agricultural soils are the primary source of N_2O emissions, a major greenhouse gas[1]
- Manual measurements remain the most common and accessible means of measuring emissions
- However, time and energy-consuming. Sample analysis can become expensive
- Information is currently limited on optimising sampling for organic fertilisers in soil-sugarcane systems

Objectives

- To determine pattern of N_2O emissions per fertiliser type
- To minimise number and frequency of measures according to emission patterns, without reducing accuracy of N_2O emissions



Patterns of N_2O emissions over crop growth-cycle

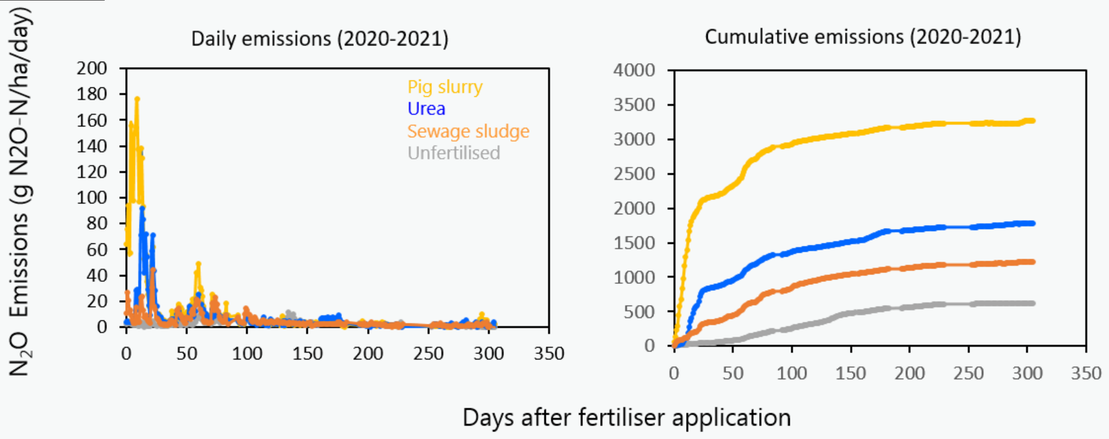


Figure 1. Daily and cumulative N_2O emissions for each fertiliser type over the sugarcane ratoon growth-cycle between October 2020 and September 2021.

Methods:

- 3 x automatic chambers in each fertiliser treatment plot with continual measures over the year growing season 2020-2021

Findings:

- Highest emissions directly after fertiliser application
- Majority of emissions first 90 days for urea and pig slurry. More gradual emissions for sewage sludge

Measures over 60 minutes

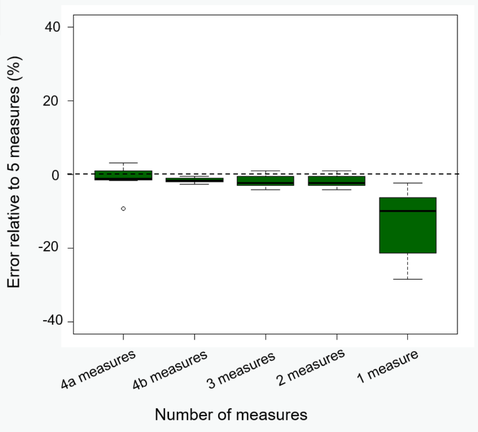


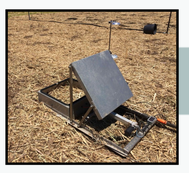
Figure 2. Number of measures using manual chambers over 60-minute duration, relative to five measures (i.e. every 15 minutes).

Methods:

- 18 x static chambers per fertiliser treatment plot
- Reference value is 5 measures over 60 minutes

Findings:

- Number of measures required per 60-minute sampling
- 2 measures sufficient over 60-minute, at 0 and 60 minutes (less than 5 % difference from 5 meaures)



Sampling scenarios

Methods:

- Various sampling scenarios tested by interpolating automatic chamber data over three consecutive years for each fertiliser treatment
- Compared to daily (morning) measures

Findings:

- For the high mineral-N fertilisers, urea and pig slurry, sufficient to have 24 measures with a logarithmic tendency of the choice of measuring days over the first 6 months after fertiliser application (less than 20 % difference from daily measures)
- More progressive emissions over the first 180 days for sewage sludge pellets, where 48 measures over 6 months would be most appropriate

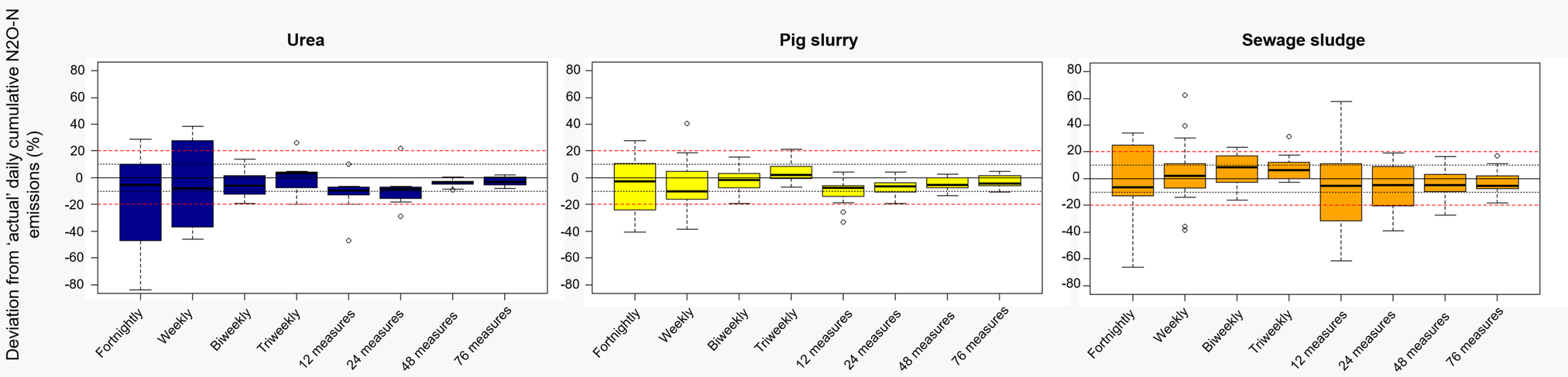


Figure 3. Sampling scenarios for each of the fertiliser treatments over the three sugarcane growth-cycles (2018-2019, 2019-2020, 2020-2021).

Key Findings:

- Highest N_2O emissions over the first 90 days directly after fertiliser application
- 2 measures over the 60-minute sampling using manual chambers is sufficient
- 24 measures over the first 6 months after urea and pig slurry applications, and 48 measures with days for sewage sludge, chosen logarithmically, are sufficient to capture emissions over the crop-cycle

References

Reay, D. S., Davidson, E. A., Smith, K. A., Smith, P., Melillo, J. M., Dentener, F., & Crutzen, P. J. (2012). Global agriculture and nitrous oxide emissions. *Nature climate change*, 2(6), 410-416.