Effect of drying temperature on nitrogen mineralisation and soil N_2O emissions following addition of thermally-dried sludges

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Objectives

To investigate the effect of sewage sludge drying temperature on

- Sludge total and ammonium N content
- N mineralisation and N_2O emissions after application to soil
- Interactions of soil water level (pF 1 and 2) on above processes

Table 1. Advantages and disadvantages of thermally-drying sludge

Advantages	Disadvantages
Results in a class A biosolid product	The economic and energetic costs can be high
Biosolid product is physically, chemically and biologically more stable	Some loss of available nutrients, particularly ammonium
Lower transportation costs due to high dry matter content (> 85%)	The process generates dust which can be a work hazard

Background

Sewage sludge has long been used as an agricultural amendment. Thermal drying is a sludge processing technique that is used in a number of waste water treatment plants (WWTP) (Rigby et al., 2010).

There are a number of potential advantages and disadvantages attributed to thermally-drying sludge compared to other sludge treatment processes (Table 1).

Drying can have a significant effect on N contents of sludge. However, the effect of different drying temperatures on the N mineralisation of dried sludge is unknown.

Dried sludges may also affect soil greenhouse gas emissions such as nitrous oxide (N_2O). However, this has not been considered in previous dried-sludge application studies.

Finally, the effect of organic fertiliser amendment on soil N cycling is likely to vary with soil water content.

Material and Methods - Incubation experiment:

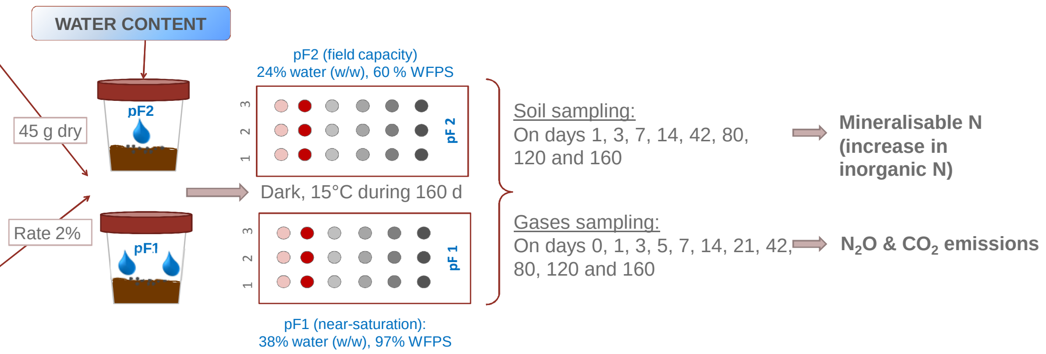
SOIL:

- **Sandy loam soil** from the **NPK**-amended arable plots from CRUCIAL trial in Taastrup, DK
- Low NH_4^+ and NO_3^- contents (< 10 mg N kg^{-1})

SLUDGES

Collected from Randers municipality WWTP (DK):

- ADRS: Anaerobically-digested raw sludge
- FSD: ADRS full-scale dried at ca 95°C
- LD-70: ADRS lab-scale dried 70 °C
- LD-130: ADRS lab-scale dried 130 °C
- LD-190: ADRS lab-scale dried 190 °C
- LD-250: ADRS lab-scale dried 250 °C



Results and discussion

Increasing drying temperature resulted in significantly lower ammonium content of the dried sludge (Figure 1). Mineralisable N was significantly different between sludges and water contents; highest for raw and full-scale dried, lower for lab-scale dried sludges (Figure 2a); at pF2 it decreased for lab-scale sludges with higher drying temperature. N_2O emissions were significantly higher at pF1 than pF2; at pF2 lab-dried sludges at low temperature (70 and 130°C) produced a significantly higher N_2O emissions (Figure 2b).

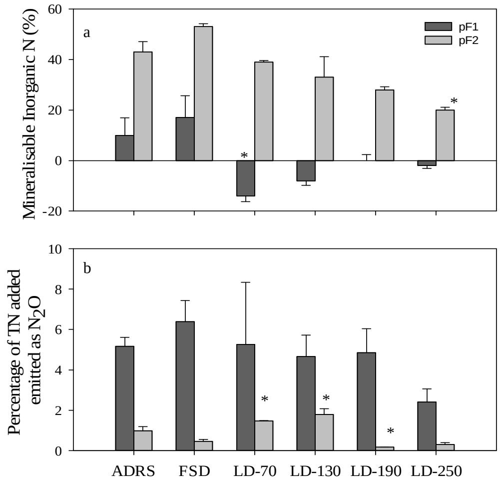


Figure 2. Percentage of mineralisable inorganic N (a) and percentage of N added emitted as N_2O (b) after 120 days of incubation. * indicate significant difference from the control, un-dried sludge (ADRS) at the same pF level.

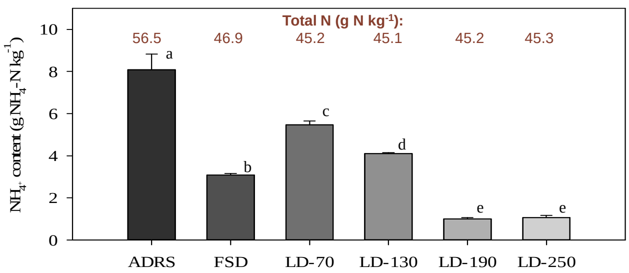


Figure 1. Total and NH_4-N of sludge samples. Different letters denote significant differences (p > 0.05).

Conclusions

- Thermal drying of sludge reduced its NH_4^+ content, but less so the mineralisable N following addition to soil
- Higher drying temperatures resulted in lower N mineralisation though
- N_2O emissions following addition to soil was only moderately affected by sludge drying, but much higher at high water content

Rigby, H., Pritchard, D., Collins, D., Walton, K., Allen, D., Penney, N., 2010. Improving guidelines for the plant available nitrogen value of biosolids from wastewater treatment. Journal of Residuals Science and Technology 7, 13–19.

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