Fact sheet:

How does long-term urban and agricultural waste application affect Nitrogen availability, crop uptake efficiency and soil fertility?

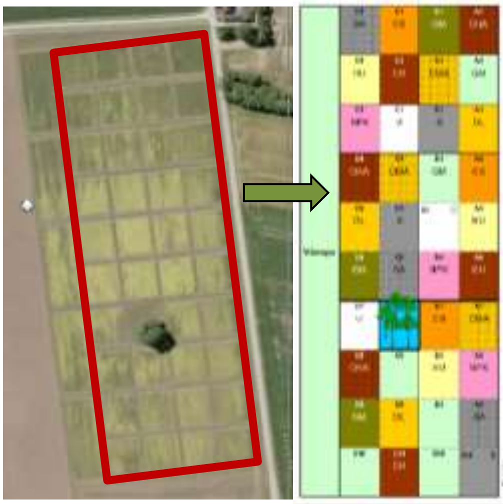
- Results from a long-term field experiment

Summary

Currently, the global demand for food, feed, fibre and bioenergy is growing. In parallel, the production of urban, agricultural and industrial organic wastes (OW) is increasing worldwide. These OW contain significant amount of organic matter and nutrients and their use in agriculture can potentially contribute to increased productivity and closing the natural ecological cycle. Long-term experiments are essential to evaluate the effects of OW application on long-term soil fertility and crop productivity, in order to optimize overall Nitrogen (N) use efficiency from their application. The aim of the current study was to evaluate the improvement of overall soil fertility, soil N supply capacity and crop N uptake in a long-term field experiment with continuous application of different urban and agricultural organic waste amendments.

CRUCIAL long-term field experiment

The long-term CRUCIAL field experiment (University of Copenhagen, Taastrup, Denmark) was established in 2003 with 11 urban and agricultural organic waste treatments in a randomised block design with three replicate plots (Fig. 1). The fertilisers were applied at two levels: single, equivalent to 100 kg available-N ha^{-1} y^{-1}, and accelerated (A), equivalent to 3 times the single application.



Treatments:

NPK	NPK fertilizer (21-3-10)
U	Unfertilized
UC	Unfertilized, undersown Clover green manure
HU	Human urine from source-separating toilets
DL	Livestock deep litter, straw rich *(30% DM, C:N 15)*
CS	Cattle slurry *(7% DM, C:N 10)*
CMA	Cattle manure accelerated *(19% DM, C:N 17)*
S	Sewage sludge *(22% DM, C:N 5)*
SA	Sewage sludge accelerated (3 x S)
CH	Composted household waste *(72% DM, C:N 10)*
CHA	C. household waste accelerated (3 x CH)

Figure 1

Soil properties after 11 years of amendment

The annual inputs of organic wastes ranged up to 4.6 / 14 t Carbon (C) and 100-315 / 474-917 kg N y^{-1} ha^{-1} in singles and accelerated levels, respectively (highest values in CHA). Fertilisation with the organic wastes improved soil physical fertility by increasing soil organic matter as well as soil water retention, through increasing total C (TC) from 1.5% to up to 3.9% and total N (TN) from 0.16% to 0.42% (highest value in CHA).

N dynamic and gaseous emission

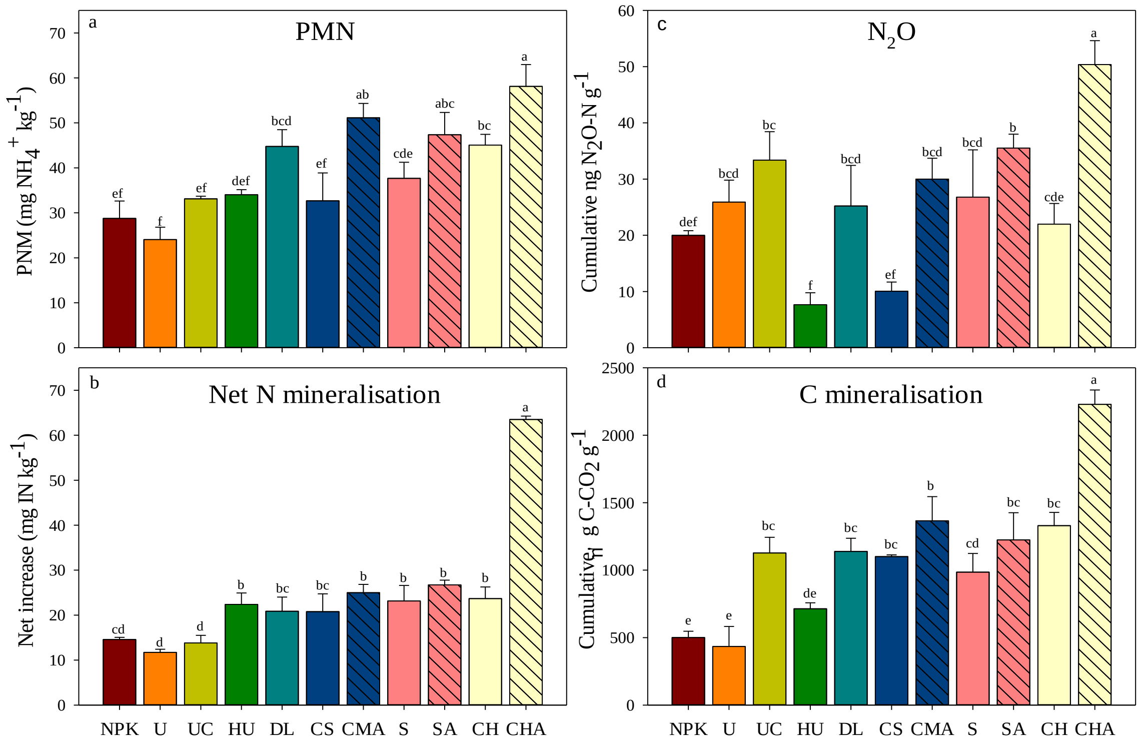


Figure 2

- The addition of the different OW increased the potentially mineralizable N (PMN, by 15-100%, Fig 2a) and the actual net N mineralisation compared the mineral NPK fertilised (by 40-80%, except for CHA by 340%, Fig. 2b) – in other words, the fertility and N supply capacity of the soil had increased significantly.
- N_2O-N and CO_2-C emissions were variable, but generally low for all OW (Fig. 2cd) 0.0004-0.002% of soil TN and 4-7% of soil TC, respectively, indicating that overall N cycling and C stabilisation is efficient.

Nitrogen Use Efficiency and Mineral Fertiliser Equivalent

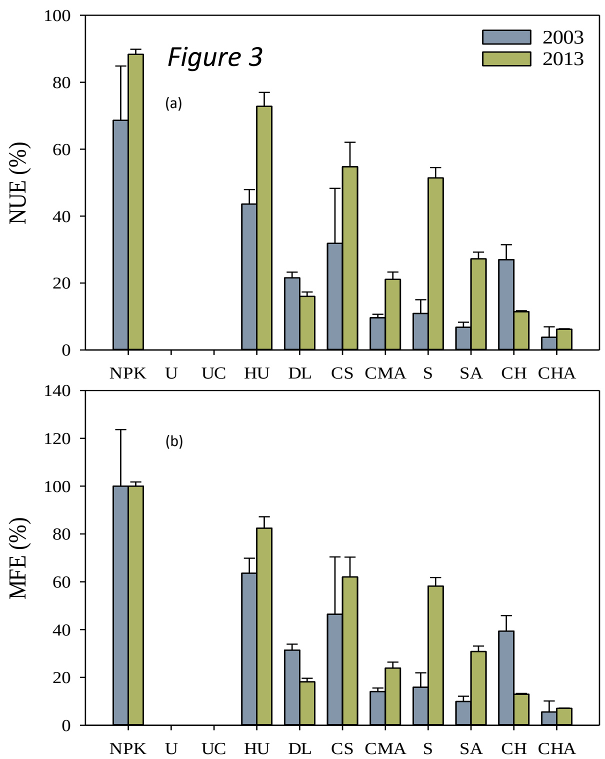


Figure 3

Beginning of trial (2003, Spring Oats):

- N uptake efficiency (NUE, Fig. 3a) and Mineral fertiliser equivalent (MFE, Fig. 3b) value (HU>CS>CH=DL>S=CM) was most correlated to OW mineral-N.
- Accelerated OW application (CMA, SA and CHA) naturally resulted in the lowest NUE and MFE.

After 11 years of OW application (2013, Spring Oats):

- The increase in soil TN and residual N availability enhanced overall NUE and MFE value for HU, CS, CM and S, for which the 10-y MFE ranged 60-85%.
- Low and decreasing MFE was found for the C-rich and relative stabilised OW products DL and CH; though they enhance soil fertility significantly, the crop has difficulties utilising the increased avail-N
- **Long-term application of OW improves soil fertility significantly and relatively high long-term MFE is achievable for most OW products**

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