Effects of biochar addition to soil on nitrogen fluxes in a winter wheat lysimeter experiment

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Introduction

Biochar, a pyrolysis product of organic residues, is considered to improve soil fertility[1], sequester CO_2[2] and to reduce greenhouse gas (GHG) emissions[3] from arable soils. Biochar has the ability to alter the rates of N-cycling in soil systems[4].

Yet, neither the magnitude nor the mechanisms of these effects are understood. Our experiments have shown reduction of N_2O emissions from temperate soils of about 20 % in the field and from 20 to 90 % in the laboratory following biochar application[5].

Aims of the project

- Understand how biochar application influences crop productivity and N-cycling to improve the use of biochar in agriculture (↑ productivity and ↑ N-use efficiency).
- Quantify the effect of biochar on N_2O emissions and yield in two temperate soils.

Experimental

Soil A (sandy loam):
- sand, silt, clay: 57;25;18 %
- C/N: 8.5, pH: 5.3

Soil B (silt loam):
- sand, silt, clay: 27;54;19 %
- C/N: 9.3, pH: 6.3

Climate:
- mean precip.: 1042 mm
- mean air temp.: 8.5 °C

Lysimeter system:
- 0.6 m diameter
- n = 4, soil depth: 0.8 m

Biochar

Green waste biochar pyrolysed at ~750°C for 25 min

C [%]	N [%]	H [%]	O [%]	pH	SSA[m^2 g^{-2}]
67.8	0.7	1.1	8.3	13.1	226.4

- Sieved < 3 mm
- 20 t dry weight per ha
- ~ 10 cm deep incorporation by hand

Ammonium nitrate ($^{15}NO_3{}^{15}NH_4$) was applied (total rate of 170 kg-N/ha) in 3 applications. This allows N-cycling to be traced through the measurement of ^{15}N in soil, air, leachate and plants.

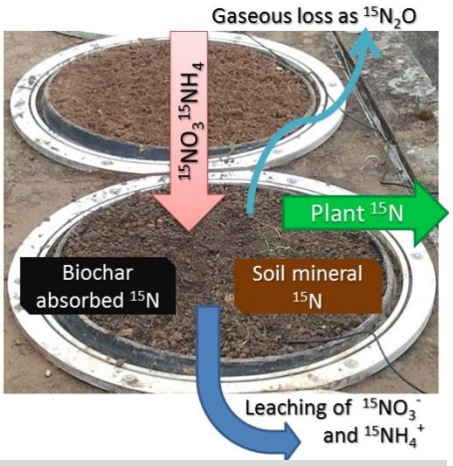

Fig 1: ^{15}N fluxes traced in the lysimeter system

Results

Results from first year of winter wheat (*Triticum aestivum*) cropping.

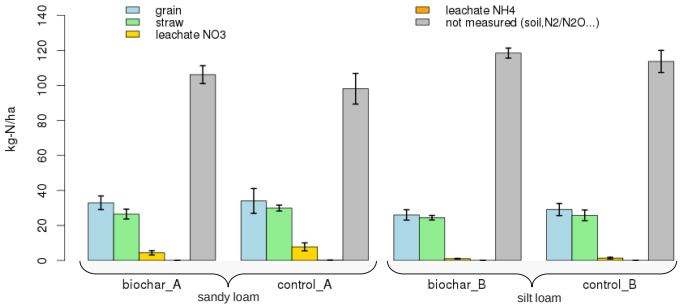

Fig 2: N-balance of applied 170 kg-N/ha measured in different compartments, error bars indicate standard errors from 4 replicates of each soil type * biochar/control treatment

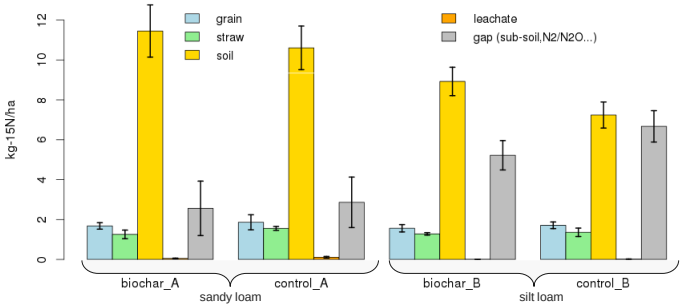

Fig 3: ^{15}N-balance of the applied 17 kg^{15}N/ha. Soil N is estimated from ^{15}N measurement of the first 10 cm depth and a expected bulk density of 1.1 and 1.3 t/m^3 for sandy resp. silt loam soil.

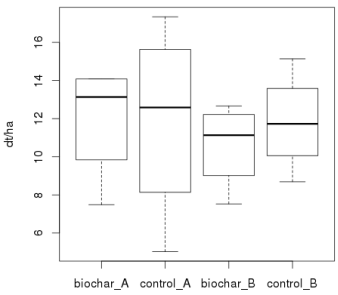

Fig 4: Grain yield in dt/ha from the first year. No significant differences among treatments, but high variability and in general low yield.

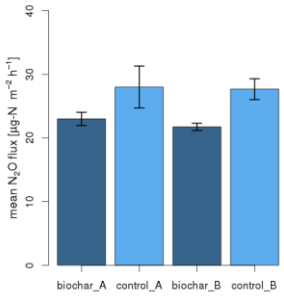

Fig 5: Mean N_2O emissions from 17 measurements between May and November 2013. Significant reduction in both soils of about 20 % by biochar

Conclusions

- No significant biochar effect on grain and straw yield, leachate-N, soil-N content or fertilizer uptake
- N-use efficiency was not increased by biochar
- 20 % reduced N_2O emissions by biochar
- Mid term biochar effects will be studied in 2014

References: [1] Jeffery et al. 2011. [2] Lehmann et al. 2006. [3] Singh et al. 2010. [4] Clough et al. 2010 [5] Felber et al.2013.

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