Green use of black gasification biochar

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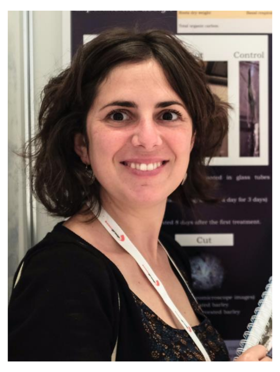


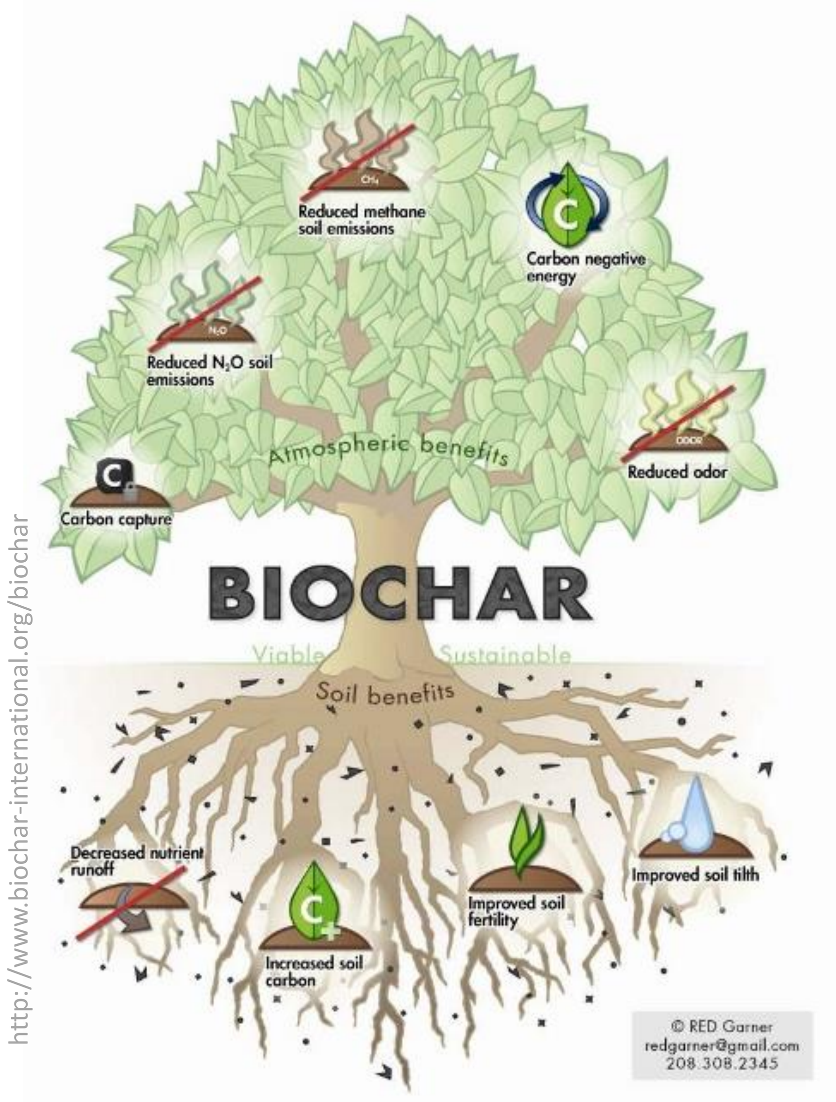
Valentina Imparato
vim@envs.au.dk

Green use of black gasification biochar:

microbial community diversity and function in a Danish sandy loam soil amended with straw gasification biochar – a field study

Valentina Imparato[1], Veronika Hansen[2], Susana Santos[1], Henrik-Haugaard Nielsen[3], Anders Johansen[1], Laura Giagnoni[4], Giancarlo Renella[4], Anne Winding[1]

1 Department of Environmental Science, Aarhus University, Roskilde, Denmark
2 Department of Plant & Environmental Sciences, University of Copenhagen, Denmark
3 Department of Environmental, Social and Spatial Change, Roskilde University, Denmark
4 Dipartimento di Scienze Produzioni Agroalimentari e dell'Ambiente, UNiFi, Firenze, Italy



http://www.biochar-international.org/biochar

INTRODUCTION

Biochar is *char* made from *bio*mass during the production of bioenergy via pyrolysis.
The chemical properties of the biochar strongly depends on the feedstock and the process.

Despite the numerous proposed benefits of biochar (2), fundamental knowledge on environmental risks of adding biochar to agricultural soil is lacking (5).

Knowledge gaps include biochar effects on:

- ✓ native soil microorganisms abundance, ecology and community composition
- ✓ soil functions and activity of microorganisms

Concern regarding the impact of bio-energy residues in soil leads to exclusion of biochar from current agricultural practice (1). Especially further investigations, at field conditions, on both short and long term, considering specific biochars quality, and original feedstock and soil type are needed (3).

Here, we present a field study using ***wheat straw gasification-biochar*** **(SGB)** from DONG Energy in Denmark.

Aim and Design

Study the effect of *wheat straw gasification-biochar* (SGB) on soil bacterial and protist communities at field conditions, with particular emphasis on soil function, soil catabolic potential and toxicity. SGB was applied at two levels (H; L) and compared with application of fresh wheat straw (S) and no application (C).

RESULTS

1 SGB had a liming effect and is not toxic

Treatments	pH mean (±SEM, n=3)	Soil toxicity [inhibition (%)]
(H) High SGB (10 tons ha^{-1})	7.42 (± 0.01)^a	-30.5 (±6)
(L) Low SGB (2.6 tons ha^{-1})	7.26 (± 0.07)^a	-46.4 (±2)
(S) Fresh straw	7.17 (± 0.01)^b	-58.4 (±5)
(C) No SGB No straw	6.95 (± 0.06)^b	-56.7 (±3)

Fig.1 Field treatments, soil pH and BioTox® test

Effect of the four treatments on pH and toxicity in soil.
Significant differences are indicated with different letters within each column (p<0.05; Tukey).

2 SGB did not alter cultivable protist

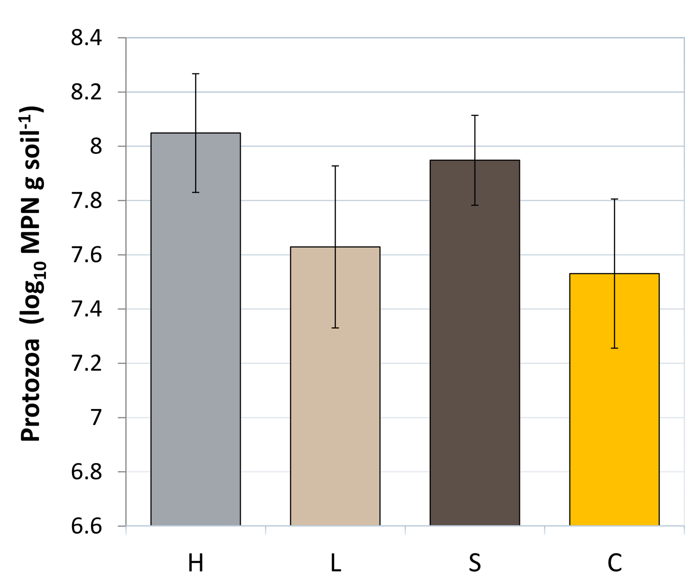


Fig. 2 Most-probable numbers of protists (MPN)

Effect of the four treatments on soil protist community size. MPN were counted 3 weeks after incubation in growth substrate. Flagellates are evenly present at all conditions tested (data not shown). No significant effect was observed. Error bars indicate SEM (n=3).

3 SGB did not alter catabolic potential of microbiota

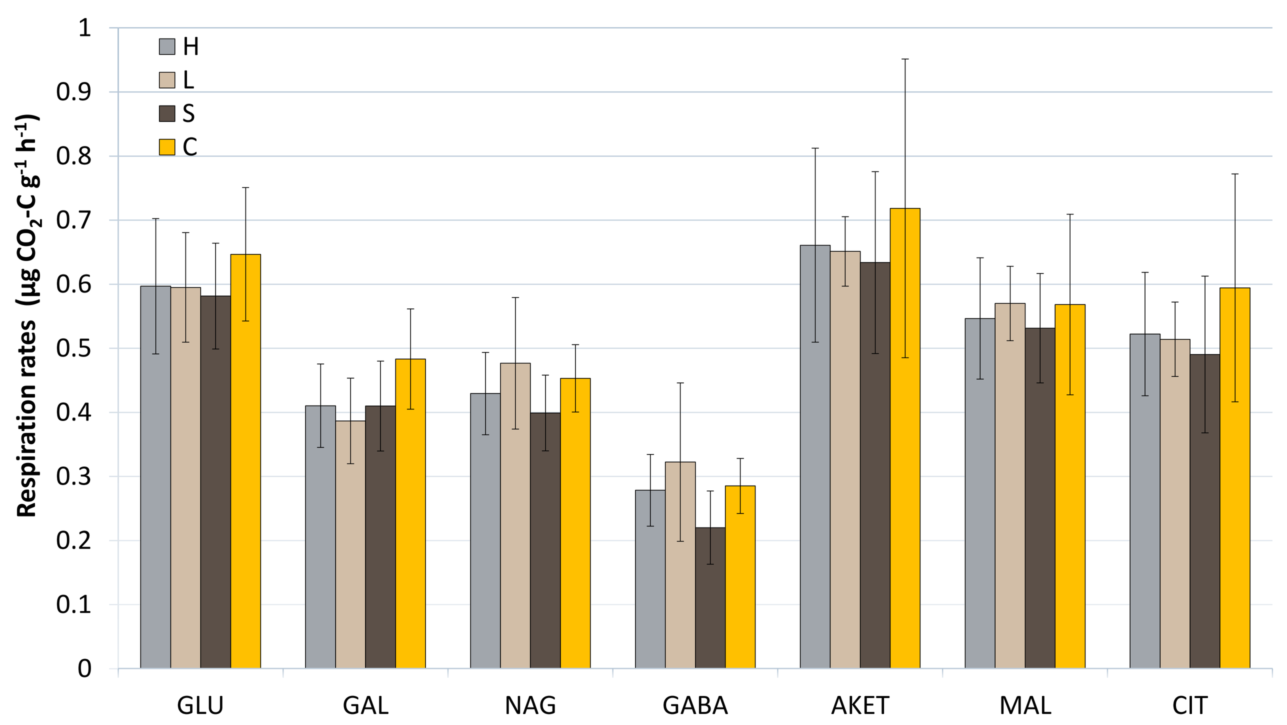


Fig. 3 Catabolic profile of soil community

Respiration rates (0-6 hours) after addition of different substrates. (GLU: glucose, GAL: galactose, NAG: n-acetyl glucosamine, GABA: γ-amino butyric acid, AKET: α-ketoglutarate, MAL: malic acid and CIT: citric acid).
No significant effect was observed.
Error bars indicate SEM (n=3).

4 SGB did not alter soil bacterial community structure

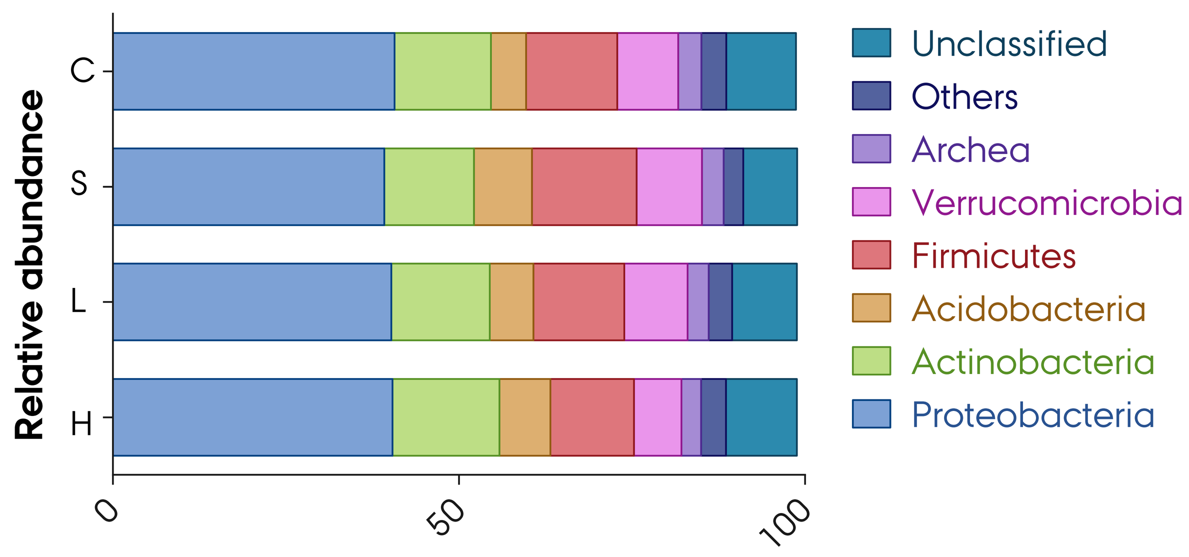


Fig. 4 16S rDNA sequencing: bacterial community structure

Effect of the four treatments on relative abundances of the dominant phyla in soil bacterial community.
Construction of V3-V4 amplicons library via Nextera XT, AMPure XP beads, and sequencing (spiking 5% phiX DNA) via Illumina Miseq. Analysis via 16S Metagenomics App in Illumina Basespace.

5 SGB enhanced dioxygenase and reduced cellulase activities

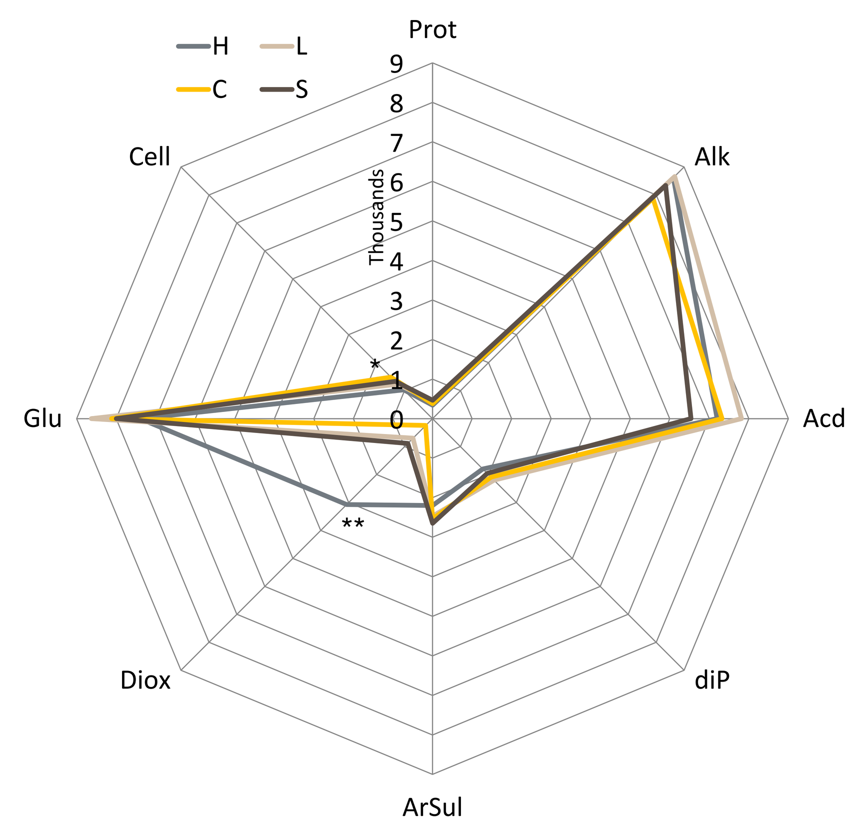


Fig. 5 Enzymes activity assay

Effect of the four treatments on alkaline phospho-monoesterase (Alk), acid phospho-monoesterase (Acd), phospho-diesterase (diP), arylsulfatase (ArSul), β-glucosidase (Glu), protease (Prot), cellulase (Cell) and dioxygenase (Diox).
Enzymatic activities are expressed as mg PNP g^{-1}h^{-1}, except for Diox (Unit enzyme g^{-1}) and Prot (µg Tyr g^{-1}h^{-1}).
* , ** indicate significant differences with p<0.05 and p<0.01, respectively; Tukey). For Cell: H vs C; for Diox: H vs all treatments.

CONCLUSIONS

High levels of *gasification-biochar (SGB)* in Danish agricultural soil:

- ✓ has a significant liming effect
- ✓ is a microbiologically benign amendment
- ✓ does not alter the number of cultivable protists
- ✓ maintain bacterial community structure largely unaltered
- ✓ does not alter soil catabolic potential for the 7 substrates tested
- ✓ does not alter most of the enzymatic activities measured
- ✓ enhances dioxygenase and reduce cellulase activities which might indicate a shift in soil functions

wheat straw gasification-biochar (SGB) has no detrimental effects on soil microorganisms and their functions

KNOWLEDGEMENTS

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