

# Biochar in fertile clay soil: impact on carbon mineralization, microbial biomass and GHG emissions

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## The project

The recently started PhD-project is an integrated part of the project: "Sustainable Co-Production of Pyrolysis Bio-Oil for Fuel and Biochar for Carbon Sequestration from Bioresidues".

**Aim:** Investigation of the short-term effects related to flash pyrolysis biochar amendments on soil fertility, nutrient dynamics, plant growth and green house gas (GHG) emissions. Further more it is planned to determine biochar characteristics in terms of environmental properties especially the biodegradability, the porosity and the cation exchange capacity (CEC).

## 4 key questions...

- 1 **Does biochar increase the decomposition rate of soil organic matter (SOM) on a short-term basis?**  
Motivation: Wardle *et al* 2008 ref 1) showed that biochar increases the decomposition rate of soil humus on a long-term basis.
- 2 **Is the decomposition of flash pyrolysis biochar mainly biotic or abiotic?**  
Motivation: Steiner *et al* 2008 ref 2), Sander *et al* 2008 ref 3) and Hamer *et al* 2004 ref 4) have shown that biochar increases the CO<sub>2</sub> flux from soil (on a short-term basis). What is the mechanism behind this?
- 3 **New and aged flash pyrolysis biochar - is there a difference?**  
Is there a difference in soil improving properties (CEC, porosity etc.) between new and aged biochar? And if so – how long does it take to develop these characteristics?
- 4 **Is biochar with time transported vertically deeper in the soil and if so to what extent?**

## ...and the planned experiments:

Setup: 13C-labelled biochar will be mixed with clay soil. The difference between the non-labeled CO<sub>2</sub> evolution in the two treatments will show if biochar speeds up the decomposition of SOM.

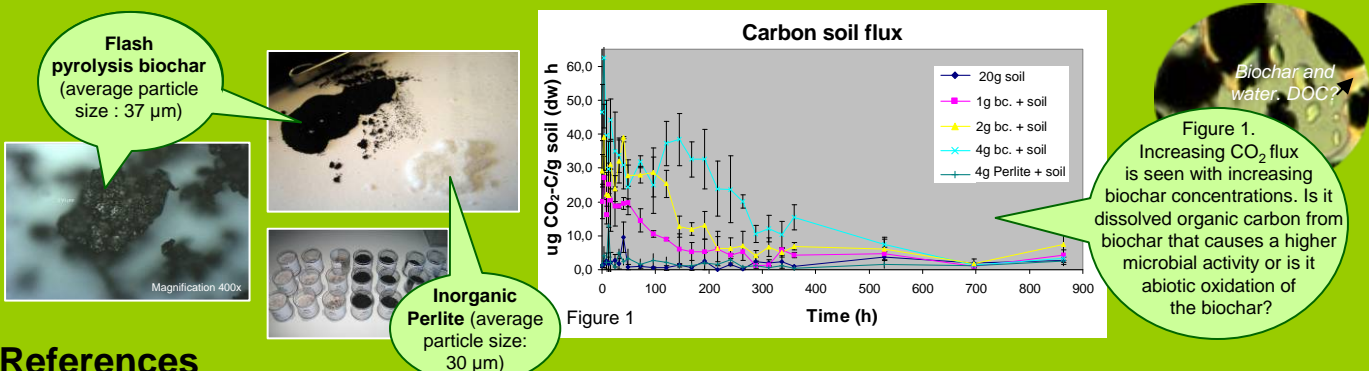
Setup: 13C-labelled biochar will be mixed with clay soil and one treatment sterilized. The difference in the CO<sub>2</sub> evolution between sterilized and non-sterilized samples will give the biotic degradation.

Biochar aged in the soil for 1 and 2 years will be compared with new char in an incubation study with plants. Key parameters will be porosity, CEC, microbial biomass, GHG emissions and plant growth.

13C-labelled biochar will be placed in the upper 10 cm soil layer and the following year soil from 0-50 cm's depth will be analyzed for the content of 13C.

## Preliminary results: Biochar increases the CO<sub>2</sub> flux from the soil

To determine the **short-term** effects of biochar additions to clay soil 1, 2 and 4g biochar was mixed with 20g soil and the CO<sub>2</sub> soil flux was measured repeatedly for 20 days and thereafter once a week. Inorganic perlite was used as a reference material for biochar to test if physical/structural changes of the soil (e.g. increased aeration-effect) would result in a higher CO<sub>2</sub>-flux. **RESULT:** Fig.1 shows that samples with biochar increases the CO<sub>2</sub> flux, while Perlite did not. This indicates that the higher flux observed with biochar additions was not due to a structural change of the soil, but more related to special biochar characteristics (e.g. labile hydro-carbons and increased porosity).



## References

- Ref 1) Wardle *et al* (2008). "Fire-derived charcoal causes loss of forest humus". *Science* vol 230; Ref 2) Steiner *et al* (2008). "Charcoal and smoke extract stimulate the soil microbial community in a highly weathered xanthic Ferralsol". *Pedobiologia* 51, 359-366. Ref 3) Hamer *et al* (2004). "Interactive priming black carbon and glucose mineralization". *Org. Geochemistry* 35, 823-830; Ref 4) Bruun S. *et al* (2008). "Microbial mineralization and assimilation of black carbon: Dependency on degree of thermal alteration". *Organic Geochemistry*, Article in press.