Geophysical Research Abstracts
Vol. 16, EGU2014-12269, 2014
EGU General Assembly 2014

Impact of drying-rewetting events on the response of soil microbial functions to dairyfibre and Miscanthus biochars

Sam Bonnett (1), Stefanie Vink (2), Kate Baker (3), Muhammad Saghir (4), and Andreas Hornung (5)

(1) Department of Biomedical, Biological and Analytical Science, University of the West of England, Bristol, United Kingdom (sam.bonnett@uwe.ac.uk), (2) Department of Agronomy and Plant Genetics, University of Minnesota Twin Cities, Minneapolis, MN, United States, (vinksn@gmail.com) , (3) Crop and Environmental Sciences Department, Harper Adams University, Shropshire, United Kingdom (kbaker@harper-adams.ac.uk), (4) Engineering and Applied Sciences, Aston University, Birmingham, United Kingdom (m.saghir2@aston.ac.uk), (5) Engineering and Applied Sciences, Aston University, Birmingham, United Kingdom (a.hornung@aston.ac.uk)

Biochar application has been shown to positively affect soil microbial functions such as reducing greenhouse gas emissions, increasing water/nutrient availability and increasing crop yields in tropical regions (Lehmann & Joseph, 2009). Understanding the dynamics of biochar application to soil microbial processes is critical for ensuring that soil quality, integrity and sustainability of the soil sub-system are maintained for crop growth. The aim of this British Ecological Society (BES) funded study was to examine the effect of two types of biochar on soil physicochemistry, GHG production, soil enzyme activities and microbial biomass in typical agricultural soil types and whether the effects were altered by drying, rewetting and flooding events. Miscanthus and dairyfibre (a mixture of straw and manure) feedstocks from Harper Adams University were pyrolyzed by Aston University at 450 °C using 100 kg/hr pyroformer technology. Two sieved soil types (sandy loam and clay loam) were mixed with dry biochar to produce 2 and 10 % w/w treatments for comparison with controls and maintained at 15 °C in temperature controlled incubators. At 0, 22, 44, 80, 101, and 114 days, soil was collected for determination of heterotrophic respiration, and microbial biomass by substrate-induced respiration (SIR), by gas headspace incubation and analysis of carbon dioxide (CO_2) and nitrous oxide (N2O) by gas chromatography. Soil was sampled for the determination of water-extractable carbon, pH, and extracellular enzyme activities. Soil samples were maintained at field gravimetric water content between 0 and 44 days; air dried between 44 and 80 days; rewetted between 80 and 101 days; and flooded between 101 to 114 days. Results showed that the impact of biochar on soil microbial processes was dependent on biochar type and soil type, the level of biochar application and changes in soil moisture. Biochar affected soil pH particularly within the dairyfibre treatments, potentially due to the dissolution of alkaline minerals, high ash content (Lehmann et al. 2011) and solubility of DOC. Biochar treatments buffered changes in pH caused by drying and flooding but resulted in an increase in DOC. Biochar in general stabilised glucosidase activity whilst Miscanthus biochar stimulated chitinase and phosphatase activity that may have been due to adsorption of either enzyme or substrate as observed by Bailey et al. (2011). Surprisingly, alkaline phosphatase activity was not stimulated by the rise in pH in the diaryfibre treatment and was lower than the control along with the other hydrolase enzymes suggesting that deprotonation of soil phenols at higher pH inhibited activity via the enzyme-latch mechanism that in peatlands explains low rates of decomposition (Freeman et al., 2001; Sinsabaugh et al. 2010). This was supported by observation of higher phenol oxidase activity within the dairyfibre treatment that increased in response to greater availability of substrate and/or increases in pH. All biochars inhibited the production of N2O that was stimulated by the supply of labile carbon from SIR, suggesting that biochar decreased C-substrate availability through adsorption at its surface (Clough and Condron, 2010). Overall, this study has shown that specific feedstocks may be used to produce biochars to control microbial functions in soil such as inhibiting hydrolase enzymes for carbon sequestration as occurs naturally in peatlands or suppress the production of the potent greenhouse gas N2O.

References

Bailey, V., Fansler, S.J., Smith, J.L. Bolton, H. (2011) Reconciling apparent variability in effects of biochar amendment on soil enzyme activities by assay optimization. Soil Biology and Biochemistry 43, 296-301.

Clough, T. and Condron, L. (2010) Biochar and the nitrogen cycle: introduction. Journal of Environmental Quality, 39,1218–1223.

Freeman, C., Ostle, N. and Kang, H. (2001) An enzymic 'latch' on a global carbon store. Nature 409,

149.

Lehmann, J and Joseph, S (2009). Biochar for Environmental Management. Earthscan, London.

Lehmann, J., Rillig, M.C., Thies, J., Masiello, C.A., Hockaday, W.C. and Crowley, D. (2011) Biochar effects on soil biota – A review. Soil Biology and Biochemistry 43, 1812-1836.

Sinsabaugh, R.L. (2010) Phenol oxidase, peroxidase and organic matter dynamics of soil. Soil Biology and Biochemistry 42, 391-404.