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Influence of feedstock and production conditions on the stability of biochar in soils

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Biochar is increasingly being recognised as a viable tool for climate change mitigation through long term biological carbon sequestration. However, in order for it to realise its full potential it is important that both the production (usually pyrolysis) and sequestration processes are effectively designed. Of particular importance is the fact that biochar produced from a particular feedstock by a given technology has no detrimental environmental effects, is produced to maximise beneficial agronomic effects (e.g. enhanced soil nutrient and structural qualities), and most importantly is highly stable in soils. The stability of biochar over a timescale of centuries to millennia, if it is to be used as a large-scale carbon mitigation option, is essential to its effectiveness and has to be demonstrated to some level of certainty. Biochar also contains a fraction of relatively labile carbon, which suggests that it is more chemically heterogeneous than previously assumed. Given the reactions that occur during pyrolysis, it is likely that production parameters are key determinant of the size of the labile fraction, and overall stability. The labile fraction is not eligible for carbon credit, and therefore optimisation of production parameters for maximum carbon retention may potentially be counter-productive.

The main objective of this work has been to quantify the labile carbon fraction of biochar, and relate this to the biochar production process (i.e. feedstock and operating conditions). To achieve this we used lab-based incubations of biochar in a “model” soil (a sterilised size-graded quartz sand inoculated with soil microbes and maintained at optimal conditions for microbial respiration). This approach was necessary in order to increase confidence in comparisons by removing any interference from other soil processes, as well as removing the potential for any priming effect of biochar on mineralization of soil organic matter. Furthermore, in order to assess the long-term stability of biochar, we subjected the same biochar products to accelerated ageing techniques. The results gave information on the expected short-term release of the labile carbon fraction of biochar, as well as information on the long term stability of biochar, allowing different biochar products to be ranked by their relative short and long-term stability.

Due to the lack of information on what proportion of biochar will remain “permanently” sequestered, and how much could be released back into the atmosphere, this information is of crucial importance for the assessment of biochar as a meaningful method of climate change mitigation. The results of this work will be used to assess whether biochar production conditions can be optimised, in order to produce biochar with the well defined properties that provide the most useful function relevant under different circumstances.