Influence of feedstock and production conditions on biochar stability (short and long-term) and soil functional attributes

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Abstract

Biochar is receiving much attention as a potential tool for mitigating climate change through long-term biological carbon sequestration. However, before this potential can be recognised, it is essential that the production (usually pyrolysis) and sequestration processes are effectively designed and tested. It is important that biochar produced from different feedstocks under different processes is shown to have no detrimental effects on the environment. The beneficial agronomic benefits of biochar additions to soils, as well as short and long-term stability of biochar in soils also need to be demonstrated before biochar is widely implemented. If biochar is to be effectively used for carbon sequestration on a large-scale, its long-term stability (i.e. centuries to millennia) needs to be proven. It has also been shown that biochar contains a fraction of relatively labile carbon, which will affect the short-term stability of biochar in soil (as well as not being eligible for carbon credit under current schemes). Depending on the size of this labile fraction, optimisation of biochar production parameters to enable maximum carbon retention may therefore be counter-productive.

The main objective of this work has been to develop a toolkit which provides a means for rapid screening of different biochar products. The toolkit took the form of five different assays designed to test the stability of biochar in soil, the effect of biochar additions on pre-existing soil carbon, and the agronomic value of biochar products. Short-term stability (i.e. quantification of the labile carbon fraction of biochar) was assessed using controlled incubations of biochar in sterilised sand. Long-term stability was tested by subjecting biochar to a novel accelerated ageing technique. Any priming (and its magnitude) for the loss of pre-existing soil carbon was determined by incubating biochar in a range of different soils, using standard stable isotope techniques. The nutrient value of biochar was determined using a procedure to extract mineral ions determined to be ultimately crop available, whilst the soil structural value of biochar products was evaluated using an approach that assessed the addition of biochar to abiotic and biotic aggregation processes in soil.

The results of this work will be used to assess how biochar production conditions can be optimised, in order to produce biochar with properties that provide the most useful functions, relevant to the situation in which it is used.

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