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Biochar carbon sequestration and downward translocation in contrasting soils under field conditions in Australia

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Carbon (C) sequestration potential of biochar depends on its stability and stabilisation of native or added organic C in soil. However, the processes of biochar degradation, fate in soil organic matter pools, and downward translocation in the soil profile, and the influence of biochar on emissions or stabilisation of native organic C sources are poorly understood under field conditions. An *Eucalyptus saligna* green-waste biochar (δ^{13}C -36.6‰; total C 66.8%) produced by slow pyrolysis at 450° C was applied at 29.2 t ha^{-1} to 10-cm depth in circular (0.66-m diameter) micro-plots, encompassing three soils [Tenosol, Dermosol and Ferrosol (Australian Soil Classification); Arenosol, Planosol, Ferralsol (approximate WRB Classification] under contrasting pasture systems across New South Wales and Tasmania (Australia). The aims of this study were to (i) monitor the fate of biochar C in respired CO_2 and quantify biochar stability and stabilisation under field conditions, (ii) determine the influence of biochar on native soil C emissions, and (iii) track downward migration of the surface (0-10 cm) applied biochar over a 1-year period. We also periodically monitored the impact of biochar on microbial biomass carbon (MBC) and aboveground biomass production. The soils were separated into light and heavy C fractions and the C recovery of applied biochar C was calculated at 0-8, 8-12, 12-20 and 20-30 cm depths.

Biochar C mineralisation rates were generally higher, albeit fluctuated widely, in the first 3 to 4 months. Over the first 7 months, the proportion of added biochar C mineralised in soils ranged between 1.4 and 5.5% and followed the sequence: Tenosol < Dermosol < Ferrosol. The mean residence time (MRT) of biochar ranged from 29 and 70 years. These values of MRT should be treated as highly conservative values, as they mainly reflect the MRT of relatively labile C components in biochar. The cumulative CO_2-C emission over the 7-month period from native soil and plant sources was larger in the biochar-amended Tenosol, whereas lower in the biochar-amended Dermosol and Ferrosol, relative to the corresponding controls. As the aboveground biomass production was similar between the biochar-amended and control micro-plots during the first 7 months, the higher cumulative CO_2-C emission in the biochar versus control Tenosol may be related to positive priming of native SOC mineralisation by biochar, and/or greater belowground allocation of plant-assimilated C, or possibly alternative effects (i.e. negative priming or lower belowground plant C allocation) in the Dermosol and Ferrosol. At 4 months, most of the applied biochar was recovered in the top 12 cm depth, with the total recovery of 72.1% in the Tenosol, 103.7% in the Dermosol and 79.2% in the Ferrosol. Biochar C was clearly migrated downward from the application depth ($0-10$ cm) within 4 months, particularly in Tenosol and Ferrosol, with the recovery of 4.8%, 2.7% and 12.7% in the $12-20$ cm profile, and 6.0%, 1.1% and 9.1% at the $20-30$ cm profile, across the Tenosol, Dermosol and Ferrosol, respectively. At 4 months, MBC was higher in the biochar-amended Tenosol and Dermosol than the corresponding controls, whereas, biochar had no effect on MBC in the Ferrosol, possibly due to its higher native organic C content *cf.* the other soil types. The updated results will be presented at the conference.