



## Identification of long-term carbon sequestration in soils with historical inputs of biochar using novel stable isotope and spectroscopic techniques

Maria C. Hernandez-Soriano (1), Bart Kerré (1), Brieuc Hardy (2), Joseph Dufey (2), and Erik Smolders (1)

(1) Division of Soil and Water Management, KU Leuven, Kasteelpark Arenberg, Belgium (maria.HernandezSoriano@ees.kuleuven.be), (2) Earth and Life Institute, Université Catholique de Louvain, Louvain-la-Neuve, Belgium

Biochar is the collective term for organic matter (OM) that has been produced by pyrolysis of biomass, e.g. during production of charcoal or during natural processes such as bush fires. Biochar production and application is now suggested as one of the economically feasible options for global C-sequestration strategies. The C-sequestration in soil through application of biochar is not only related to its persistence (estimated lifetime exceeds 1000 year in soil), but also due to indirect effects such as its potential to adsorb and increase OM stability in soil.

Historical charcoal production sites that had been in use >200 years ago in beech/oak forests have been localized in the south of Belgium. Aerial photography identified black spots in arable land on former forest sites. Soil sampling was conducted in an arable field used for maize production near Mettet (Belgium) where charcoal production was intensive until late 18th century. Soils were sampled in a horizontal gradient across the 'black soils' that extend of few decametres, collecting soil from the spots (Biochar Amended, BA) as well as from the non-biochar amended (NBA).

Stable C isotope composition was used to estimate the long-term C-sequestration derived from crops in these soils where maize had been produced since about 15 years. Because C in the biochar originates in forest wood (C3 plants), its isotopic signature ( $\delta^{13}\text{C}$ ) differs from the maize (a C4 plant). The C and N content and the  $\delta^{13}\text{C}$  were determined for bulk soil samples and for microaggregate size fractions separated by wet sieving. Fourier Transform Infrared Spectroscopy (FTIR) coupled to optical microscopy was used to obtaining fingerprints of biochar and OM composition for soil microaggregates.

The total C content in the BA soil (5.5%) and the C/N ratio (16.9) were higher than for NBA (C content 2.7%; C/N ratio 12.6), which confirms the persistence of OM in the BA. The average isotopic signature of bulk soil from BA (-26.08) was slightly but significantly higher ( $p < 0.05$ ) than the  $\delta^{13}\text{C}$  obtained for NBA (-26.25) despite the overwhelming presence of char derived OM, suggesting higher build-up of crop derived OM ( $\delta^{13}\text{C} = -12.5$ ) on BA ( $\delta^{13}\text{C} = -27.66$ ). Analysis of isolated microaggregates revealed a stronger decrease in  $\delta^{13}\text{C}$  for C present in the microaggregates within macroaggregates (i-mic) of soil from BA (-25.46) compared to those isolated from NBA (-26.27), while for free microaggregates (f-mic) differences in  $\delta^{13}\text{C}$  were comparable to those obtained for the bulk soil analysis. Faster turnover of OM for i-mic has been previously reported. Thus, for NBA, f-mic and i-mic presented similar values of C content and C/N ratio, while for BA larger C content (11.0%) and C/N ratio (26.8) were determined for i-mic compared to f-mic (C content 7.3%; C/N ratio 21.0). Additionally, FTIR analysis of microaggregates suggested an inversion for BA and NBA in the distribution of polysaccharides and aromatic compounds in f-mic and i-mic.

This study has evaluated the long-term enhancement of C-sequestration caused by biochar addition in a field scenario. Overall, results positively contribute to confirm the potential of biochar to increase the bio(chemical) stability of new inputs of OM, suggesting also that adsorption and stabilization might occur within macroaggregates.