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Biochar addition has contrasting effects on aggregate stability dynamics of clay and sandy-loam soils

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The aim of this work was to investigate to what extent soil type affects organic compound-mediated dynamics of aggregation. Indeed, it is still unclear how the physicochemical composition of organic amendments, and their quantity, can interact with soil particles, leading to soil aggregation/disaggregation.
Crop residues (R) and biochar input at two different doses (BC20, 20 Mg ha-1; BC40, 40 Mg ha-1) were used as carbon management treatments. Physicochemical (e.g., hydrophobicity, organic carbon content) and structure-related (e.g., pore size distribution, aggregate morphology, wet aggregate stability) parameters were measured in clay and sandy-loam aggregates, sieved at 1-2 mm, in a 2-year experiment. After benzene and ethanol pre-treatments, standard measurements of wet aggregates stability were coupled with laser diffraction analysis to disentangle the factors influencing disaggregation dynamics. Electrochemical properties of the colloidal suspension were also analyzed to identify changes in soil chemistry as affected by organic inputs.
Results showed that short-term soil organic carbon (SOC) accumulation due to crop residues was low (+6%), minimizing SOC-mediated effects on aggregate stability. By contrast, the increase of SOC was significant in BC20 (+39%) and BC40 (+58%). Biochar acted differently on aggregate stability, depending on distribution amounts and soil type. In clay-rich soils, BC40 increased repulsive forces between like-charged particles and excess of monovalent cations, that favored aggregate breakdown. An increase of micropores due to biochar likely minimized clay soil dispersability, reducing a rapid entry of water that would cause a build-up of internal air pressure and consequent disruption of aggregates. Conversely, sandy-loam soils with low clay content benefited from biochar addition at both doses (20 and 40 Mg ha-1) by increasing soil surfaces and inter-particles bonding, and in turn promoting SOC-driven aggregation.
The use of biochar in agricultural soils seems advisable to improve soil fertility, although specific quali-quantitative information is still needed to define specific guidelines that aim to increase SOC and enhance aggregate stability of contrasting soils.