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The influence of biochar on substrate erodibility: An experimental approach with simulated rainfall

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Biochar is charcoal made from biomass by pyrolysis and used as a soil amendment. The addition of biochar to topsoils can lead to significant changes in soil characteristics. Nevertheless, the impact of biochar on soil functions is a controversial subject. It generally results from specific influences of substrates and biochar on the equilibrium between release (e.g. desorption) and fixation (e.g. adsorption) mechanisms. Furthermore, physical effects between soil and biochar are reported, which affect soil texture and thus mostly the transport and storage of water in substrates. It seems likely that while biochar influences biochemical and –physical processes, it can also affect soil erodibility.

To investigate this assumption, an experimental rainfall simulation with splash cups was conducted. Different types (“HTC”, “Pyrochar”; Delinat, Switzerland), sizes (<1 mm, 1-2 mm, 2-5 mm) and percentages of biochar (2 %, 6 %, 10 %) were used in two substrates (sand and silt). Rainfall was induced with a single-nozzle rainfall simulator (Tübingen Rainfall Simulator) under a portable light frame tent (16 m3). The simulator was equipped with a Lechler 460.788.30 nozzle and adjusted to a drop falling height of 3.5 m (pressure at nozzle: 150 hPa). The sprinkle area was 1 m2 and rainfall was applied for 10 min with an intensity of 50 mm h-1 for all simulation runs (KE=5.13 J m-2 mm-1). The drop size spectrum and intensity of the simulator were calibrated and continuously checked using a “Laser Precipitation Monitor” (Thies GmbH) to ensure homogeneous rain characteristics.

Results showed that the erodibility of both sand (p=0.006) and silt (p=0.094) decreased with biochar addition compared to treatments without biochar addition. The erodibility of sand was lower with HTC-char than with Pyrochar, but in silt it was lower with Pyrochar than with HTC-char. Nevertheless, the biochar type did not affect erodibility significantly. Sediment detachment was three-times higher in silt than in sand, both with and without biochar addition. Differences in erodibility occurred due to biochar sizes, as sand showed smallest sediment losses with 1-2 mm biochar size and silt showed smallest losses with 2-5 mm biochar size. The percentage of biochar addition did not show any effect. A main reason for the reduction of substrate erodibility with biochar addition is the larger size and higher weight of biochar particles compared to substrate particles. Further effects can be explained by the formation of soil-biochar-complexes. In conclusion, it could be shown that the addition of biochar generally reduces the erodibility of soil substrates. Moreover, the practical use of rainfall simulations in combination with a splash cup system to compare different substrates could be demonstrated. Further long-term examinations are required to expand our understanding on the influence of biochar addition on soil erodibility.