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Modification of hydrological properties in a fine textured soil following field application of pelletized biochar: investigation of the mechanism involved.

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The application of pelletized biochar is seldom employed in field, and its effect on soil hydrological behaviour scarcely investigated. Biochar is usually added in powdered or granular form to improve the homogeneity of distribution, meanwhile favouring its interaction with soil matrix. In this study we evaluated the possibility of applying pelletized biochar as soil conditioner to enhance, during a single cropping season, the hydrological behaviour of a silty clay loam soil prone to structure degradation. For that purpose, the water retention curves (WRCs) were determined on undisturbed soil samples (0-15 cm) three months after the addition, at the rate of 14 Mg ha^{-1}, of two differently pyrolyzed biochars (B1 and B2). Starting from the WRCs the pore size distribution was determined. The gravimetric water content at both field capacity (-10 kPa) and wilting point (-1,500 kPa) was also measured on biochar samples to assess their available water capacity (AWC).
In both the treatments, soil bulk density (BD) was significantly lower compared to control, apparently as direct consequence of the addition of low density pellets. Actually, excluding the intrinsic biochar porosity from soil bulk density calculation, BD values of the treated soils remain lower of around 10% over control. Such findings suggest that a modification of soil structural characteristics might have been induced by pellet addition. Data of the WRCs indicate a significant increase of transmission (500-50 micron), storage (50-0.5 micron) and AWC pores (30-0.2 micron) in the amended soils.
The two biochars affected the AWC by direct pore contribution, but the extent of such effect was related to the biochar type: the tested pelletized biomass seems to have positive effects provided that the pyrolysis temperature does not exceed 800°C, as in the case of B1. The overall hydrological improvement might be correlated to both the inherent biochar retention capacity and a merely mechanical process of rearrangement of soil aggregates/particles with pellets.
This field trial demonstrated that the application of pelletized biochar was particularly effective as soil conditioner in a fine-textured soil, even in the short term. In fact, such amendment was able to increase soil macroporosity (> 50 micron) by the creation of new accommodation pores, within the range of transmission pores, particularly important for improving water and air movement in fine-textured soils.
Nevertheless, given the recalcitrant nature of the biochars and their coarse size, longer term research should be carried out to assess i) the dynamics of the accommodation pores and the persistency of their hydraulic efficiency, and ii) the temporal trend of AWC pores in the amended soils. Actually, the fate of both pore classes is strictly related to the physico-chemical and biological interactions which can occur only in the long term between biochar surface and aggregates/mineral particles.