Effect of biochar on the water holding capacity of the Brazilian soils exemplified by sandy Northeast soil

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Abstract

The northeastern of Brazil is a semi-arid region has with a dry and warm climate with rains that are concentrated between February and May. This bad distribution of rainfall over time, combined with intense insolation, results in: a lower soil water retention capacity; water infiltration to a deeper soil levels; rapid evaporation; and deficiency of water during the main part rest of the year. In this work, we propose the use of soil organic conditioners, derived from agricultural and industrial biomass wastes, in order to improve soil water holding capacity (WHC). Five biochars, prepared by slow pyrolysis at low temperature (heating to 350 °C at 5 °C min^{-1}), were produced from green coconut shells (CS), orange peel (OP), palm oil bunch (PO), sugarcane bagasse (SB), and water hyacinth plants (WH). Charcoal fines, known as coal residue (CR), obtained from the metallurgical industry was another studied sample. The soil investigated was dystrophic podzols, denoted as PD, collected in the Reserva do Caju – Campus Experimental Embrapa Itaporanga, Sergipe, Brazil. The treatments were 5% (w/w, equivalent to a biochar rate of 120 Mg ha^{-1}) of each biochar and a control without biochar. The WHC was determined by wetting/drying cycles (Case et al., 2012). This application rate was calculated assuming 12 cm of soil depth and bulk density of 1.2 g cm^3. The soil-biochar mixtures were placed in PVC tubes (W = 50 mm; H = 75 mm). Then the mixtures were saturated with water for one hour, allowed to drain for three hours in a sealed plastic buckets and subsequently dried in an oven (~60 °C). All the biochars increased the WHC, compared to the control. The biochars that provided the best water retention were CS, PO, WH e SB (increases of 41, 41, 41 and 47 %, respectively). These results could be explained by the polarity of the biochars, as shown by their hydrophilicity, measured by ^{13}C NMR spectroscopy, as well as by the increased presence of micropores that could physically retain water (revealed by SEM analyses). The use of biochars could therefore contribute to alleviating hydric stress in semi-arid regions of Brazil.

Keywords: biochar, drying-wetting cycles, WHC, semi-arid