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Impact of biochar addition on thermal properties of a sandy soil: modelling approach

Boguslaw Usowicz (1), Jerzy Lipiec (1), Mateusz Lukowski (1), Zbigniew Bis (2), Wojciech Marczewski (3), and Jerzy Usowicz (4)

(1) Institute of Agrophysics, Polish Academy of Sciences, Lublin, Poland (b.usowicz@ipan.lublin.pl), (2) Department of Energy Engineering, Faculty of Environmental Engineering and Biotechnology, Częstochowa University of Technology, 42-200 Częstochowa, Poland, (3) Space Research Centre, Polish Academy of Sciences, Warsaw, Poland, (4) Torun Centre of Astronomy of the Nicolaus Copernicus University, Torun, Poland

Adding biochar can alter soil thermal properties and increase the water holding capacity and reduce the mineral soil fertilization. Biochar in the soil can determine the heat balance on the soil surface and the temperature distribution in the soil profile through changes in albedo and the thermal properties. Besides, amendment of soil with biochar results in improvement of water retention, fertility and pH that are of importance in sandy and acid soils, widely used in agriculture. In this study we evaluated the effects of wood-derived biochar (0, 10, 20, and 40 Mg ha-1) incorporated to a depth of 0–15 cm on the thermal conductivity, heat capacity, thermal diffusivity and porosity in sandy soil under field conditions. In addition, soil-biochar mixtures of various percentages of biochar were prepared to determine the thermal properties in function of soil water status and density in laboratory. It was shown that a small quantity of biochar added to the soil does not significantly affect all the thermal properties of the soil. Increasing biochar concentration significantly enhanced porosity and decreased thermal conductivity and diffusivity with different rate depending on soil water status. The soil thermal conductivity and diffusivity varied widely and non-linearly with water content for different biochar content and soil bulk density. However, the heat capacity increased with biochar addition and water content linearly and was greater at higher than lower soil water contents. The measured and literature thermal data were compared with those obtained from the analytic model of Zhang et al. (2013) and statistical-physical model (Usowicz et al., 2016) based on soil texture, biochar content, bulk density and water content.