OPTIMUM BIOCHAR APPLICATION RATE FOR IMPROVING SOIL MOISTURE CHARACTERISTICS

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Water movement and storage in soils are crucial for successful intensification of agriculture and maintaining productivity in the face of changing climate. Previous studies have shown biochar to be a natural porous material with potential to be used in maintaining soil moisture. Its application, especially in sandy soils can improve total soil porosity, pore size distribution and soil aggregation thereby increasing total water retained as well as maintain this water in the soil for a long time. However, there is little known about the optimum rate of biochar application in sandy soils for moisture improvement. The cost of biochar production varies from US$300 to $7000 per tonne and most studies to date used relatively high application rates of biochar. At such high application rates, the cost may not lead to a return on investment. This study aims to assess the optimum rate of biochar application as well as to evaluate the potential of biochar particle size in affecting this rate. An extensive meta-analysis was performed on published literature data to quantify the relationship between biochar characteristics and soil moisture properties. The literature data spans across a wide range of feedstock, pyrolysis condition, soil texture and experimental conditions. Out of a total of 150 published studies, 42 articles providing sufficient amount of reliable data on biochar-soil moisture effects were selected. These studies covered; 51 feedstock, 16 pyrolysis temperatures, 20 particle size ranges, 12 soil textural classes and 45 rates of biochar application. The meta-analysis results confirmed that biochar particle size, surface area, feedstock, porosity and carbon content are important factors to consider when using biochar as a material for improving soil moisture content and identified relative importance of different parameters.

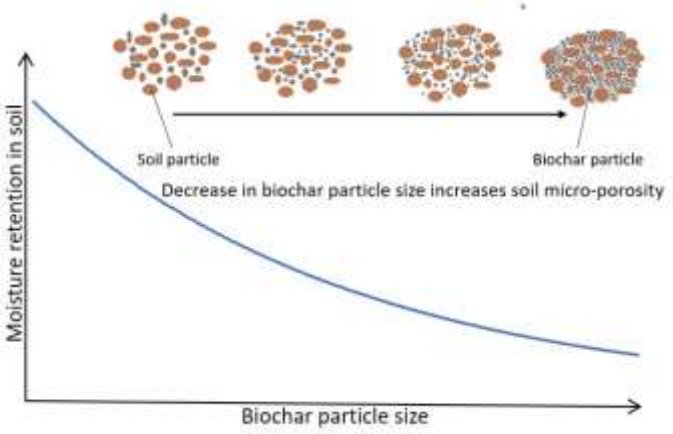

Figure 1 – Schematic diagram of the effect of biochar particle size on soil moisture retention

Based on the outputs of the meta-analysis we designed a laboratory study aimed at providing further insights on the role of biochar type and range of biochar particle sizes (PS) on water content at saturation, field capacity, and permanent wilting point, available water content, saturated and unsaturated hydraulic conductivity. Standard biochar – softwood pellet and wheat straw both produced at 700 ^{0}C – were selected because of their high carbon content and the fact that they represent both woody and crop residue-based feedstock. Biochar particle sizes of 2 – 0.5 mm, 0.5 – 0.25 mm, 0.25 – 0.063 mm and <0.063mm were used. The study hypothesis was that smaller PS will have large surface area, can easily fit into the large pores of sandy soils and increase micro-porosity probably giving rise to higher benefits at lower rates of application (Fig 1). Different rates of biochar (1, 2, 4 and 8wt%) were tested using 3 standard LUFA soil (sandy loam, loam and clay textures). Soil moisture characteristics/curve, water content at saturation, field capacity, permanent wilting point, and available water content were determined using Wp4 and Hyprop. Saturated hydraulic conductivity was also determined using KSAT device. Findings from this study will be important in developing engineered biochar tailored for enhancing water use efficiency and provide low-dose, high efficiency benefits.