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Studies on the water retention in arable sandy soil amended with fine size-fractionated sunflower husk biochar

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Biochar application has been reported for improving the physical, chemical, and hydrological properties of soil. However, biochar can be produced from different feedstocks and at different conditions having a direct impact on its properties. Furthermore, the overall effect of improvement depends on the type of soil. That makes biochar amendment difficult to optimize and creates the need for extensive studies of this issue for its better understanding. In these studies, we show that water holding capacity (by means of Available Water Content - AWC) can be significantly improved in arable sandy soil using fine-sized biochar particles.

For our studies, we have used sunflower husk biochar (pyrolyzed at 650^{o}C). Biochar samples were characterized using an elemental analyzer for C, H, N content studies, mercury porosimeter for porosity and specific pore volumes, and vibratory shaker with a stack of sieves for particle size distribution. The examined biochar was sieved in order to obtain four diameter size fractions: <50 µm, 50–100 µm, 100–250 µm and <2000 µm and mixed with arable sandy soil for 0.95, 2.24, 4.76 and 9.52 wt.%. The unamended soil sample served as a reference. At first, we have measured the bulk density of the air-dried samples. After then the pressure plate method was used to determine the water retention curves. The results were fitted using the van Genuchten equation. Finally, the AWC for all the measured samples was calculated from a difference between soil water contents for pF=2.2 and pF=4.2.

The bulk density studies have shown a nonlinear behavior as a function of dose for all fractions of the biochar. The clearest effect is observed for fractions below 100 µm for which the density vs dose characteristics of the samples revealed a maximum for 0.95 wt.% and a decreasing trend for higher biochar contents. The AWC studies shown that the particle size fractions of biochar below 100 µm in diameter cause also the most significant improvement in the water retention, almost doubling the reference level (0.078 m^3 m^{-3}) to approximately 0.155 m^3 m^{-3} after biochar amendment. The results are explained by the filling of the free volume in the sandy soil matrix by small biochar particles. That leads to a shift of the pore size distribution to smaller radiuses, which in consequence promotes an increase in AWC.

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