

Effects of biochar addition on the sorption of polar herbicides in paddy soils

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Organic amendments, and their water soluble fraction, induce an important impact on pesticide dissipation in soils, affecting their adsorption and transport processes through various chemical interactions. Although in most cases addition of organic amendments increases sorption, leaching of the pesticides can be either reduced or promoted. Because of that, their effect on pesticide behavior must be assessed in order to optimize their use. The major objectives of this study were to investigate the impact of biochar and biochar water extractable substances (BWES) on the sorption behavior of two polar herbicides, azimsulfuron and penoxsulam, in two amended and unamended paddy soils under flooded conditions. The adsorption - desorption of these herbicides was studied in soils amended with fresh biochar and in soils amended with a washed version of the biochar, simulating the conditions of a soil recently amended and a soil where biochar was applied longer time before and most part of the BWES has been already removed because of the flooded conditions. Therefore, sorption on biochar was assessed before and after removing 80% of its water extractable substances, separately and in combination with each soil (at 2 and 5% w/w). BWES were analyzed by high resolution mass spectrometry. The most abundant fractions present in the high mass range were nitrogen-containing molecules. The aromatic character of the DOC-extracts of the unamended and amended soils, based on the specific UV absorbance at 280 nm (SUVA₂₈₀), was increased with the amendment in all the conditions tested. Adsorption data of both herbicides fitted very well to the Freundlich equation, with R² values higher than 0.9 in all the conditions tested. Sorption isotherms were in all cases nonlinear, with N_f values <1, resembling L-type isotherms. Biochar had a very different effect on the sorptive properties of each soil. The highest sorption affinity of azimsulfuron to amended soils was observed for the soils amended at the maximum dose of BC. For penoxsulam, the amendments had the opposite effect on each soil. The reduction of the amount of BWES in the soil solution had a significant effect on the behavior of the applied herbicides, enhancing their adsorption or reducing it depending on the characteristics of the soil. Results stress the importance of proper screening of biochar and soil characteristics before its application in combination with polar herbicides.