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Role of organic matter on trace metal availability in contaminated soils: case of high biomass perennial crops vs annual crops

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Soils of contaminated agrosystems are still potential arable surfaces for the production of non-alimentary crops provided that such cropping systems do not increase risks for the environment in order to integrate them in a sustainable agriculture development. Effects of changing land management from annual to perennial on soil properties have been widely studied over the last decades, but the case of contaminated agricultural soils remains little documented in particular concerning the effects on the dynamic of soil trace elements.

Among the non-alimentary crops, the use of energy crops like miscanthus, a C4 perennial plant, must be studied in particular to evaluate their environmental impacts as they are known to modify the soil organic matter pools. In this work we aimed at assessing changes in soil trace metal availability when annual crops are replaced by a perennial cropping system in a metal contaminated soil, with the hypothesis that exogenous organic carbon originating from the plant induced changes in the soil metal speciation. For this, we used the soil surface horizons of a smelter impacted parcel in the North of France, whose one part was cultivated in miscanthus three years ago and the other part was left with the previous land use i.e. cropping rotations. We quantified the carbon fluxes originating from miscanthus in the various granulo-densimetric fractions of the soil under miscanthus by C13 measurements, and compared the chemical extraction and the physical localisation of both organic carbon and of two trace metal, Cu and Zn in the various soil size fractions of both soils under miscanthus and under annual crops. Results showed an incorporation of organic carbon from miscanthus in the coarse organic fractions which was related to an increase in the metal localisation in the coarse grain fractions observed for Cu but not for Zn. Comparison of metal availabilities between the two cropping systems showed no difference for Zn availability while copper availability was shown to decrease. This decrease in copper availability was related to an incresae in Cu localisation towards finest soil fractions between soil under annual system and miscanthus soil, while results for Zn localisation showed no changes.

Our results show that soil particulate organic matter is first impacted by the new perennial crop system and that depending on the trace metal, this impact can involve or not a change in metal localisation in the soil granulometric fractions related to changes in metal availability.