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Three-dimensional fluorescence as a tool to characterize dissolved organic matters in the rhizosphere of plants cropped in soil amended with organic wastes.

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Three-dimensional fluorescence is well known to be a powerful technique for the chemical characterization of dissolved organic matters (DOM). The qualification of the DOM by fluorescence intensity could then be connected to the complexation properties toward trace metals. To characterize DOM in the context of agricultural recycling of organic wastes, it is necessary to measure concomitantly the fluorescence properties of DOM in organic wastes, in the bulk-soil and in the soil affected by root activities, i.e. in the rhizosphere. Our study aimed at evaluating the specific fluorescence fingerprint of the different pools of DOM above-cited, as well as the consequences of their interactions on the evolution of the three-dimensional fluorescence of the initial soil DOM.

An in-situ experiment was conducted in Reunion Island (Indian Ocean). Two plant species, i.e. a graminaceous species the fescue (Festuca rubra) and a dicotyledonous species the tomato (Lycopersicon esculentum), were grown on a soil where we applied two types of organic wastes (pig manure compost and poultry manure compost) at three rates and a mineral fertilizer. Following this experiment, the soil either adhering to the roots (i.e. rhizosphere) or not (i.e. bulk-soil) was sampled and the soil solution was recovered by chemical extraction. Three-dimensional fluorescence spectra as excitation-emission matrix (EEM) plots were recorded with a spectrofluorometer (Hitachi F4500) and the obtained 3D spectra were processed with PARAFAC decomposition software, leading to 3 fluorescent components (terrestrial humic-type). Emission and excitation slits were set at 2.5 nm and a scan rate of 2400 nm.min-1 was selected for the emission monochromator. The wavelength emission range was increased sequentially from 200 to 600 nm and the excitation wavelength from 300 to 550 nm by 5-nm steps.

Root activities and organic wastes induced variations of DOM quality. Three fluorescent components of terrestrial humic-type were identified. An increase in fluorescence intensity (normalized to DOC) was observed for the three components identified in the bulk-soil amended with organic wastes and especially for soils that have received the highest application rate. An increase in fluorescence intensity was also noticed in the rhizosphere compared to the bulk-soil and even more so in soil amended with the organic wastes.

3D fluorescence spectra support relevantly this first investigation showing the modification of the bulk-soil and the rhizosphere DOM following the application of organic wastes. Further characterization of DOM properties and composition will be necessary to understand the mechanisms underlying the changes in bulk-soil DOM. These first results support the need to consider the influence of DOM quality to better evaluate the bioavailability of trace metals in soils.