Geophysical Research Abstracts
Vol. 16, EGU2014-1633-4, 2014
EGU General Assembly 2014

EEM+PARAFAC analysis of water-soluble organic matter in soils with different irrigation history

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Water-soluble soil organic matter (WS-SOM) is well known to affect carbon and nitrogen cycling, biodegradability of organic matter, transport of nutrients and pollutants, and soil physical properties. Among other factors, the composition of WS-SOM may be affected by soil type and quality of water used for irrigation, especially in soils irrigated with treated wastewater (TWW) rich in dissolved organic matter. The aims of the study were to (1) establish whether the quality of irrigation water has an impact on the WS-SOM composition and (2) examine possible relations between the WS-SOM composition and some soil characteristics. Fluorescence spectroscopy of excitation-emission matrices (EEMs) combined with parallel factor analysis (PARAFAC) was applied to examine the composition of WS-SOM in various soils irrigated with fresh water (FW) and secondary TWW. In addition to the bulk WS-SOM samples, the EEM+PARAFAC analysis was applied also to the WS-SOM acid-soluble and acid-precipitated fractions. Fluorescent WS-SOM in the soils studied comprised of two humic components and one proteinaceous tryptophan-like component. The impact of the irrigation water quality was soil-dependent: in coarse-textured soils, irrigation with TWW generally increased the concentrations of fluorescent components in WS-SOM in comparison to irrigation with FW. In fine textured soils, TWW application led to a decrease or had no impact on the concentration of the fluorescent components in WS-SOM. Weak or no relations were found between concentrations of fluorescent components in WS-SOM and dissolved organic carbon (DOC) concentration or basic soil properties. Therefore, DOC concentration in aqueous soil extracts or SOM content are not suitable predictors for the concentration of fluorescent components in WS-SOM. Notably, a statistically significant relation was obtained between the ratio of the concentrations of two humic-like components in the WS-SOM (expressing the composition of water-soluble humic-like matter) and clay content of the soils. This relation suggests that smaller-size negatively charged humic components become enriched in WS-SOM compared with the larger-size humic components, in soils characterized by higher content of negatively charged clay surfaces. The detection of this relation illustrates the usefulness of the EEM+PARAFAC methodology for quantifying the composition of organic matter. The WS-SOM fractions differing by their solubility in acidic solutions were characterized by the same aforementioned humic-like components, but in a different proportion. This observation suggests that spectrally similar fluorescent components might possess different physico-chemical properties which may be a complicating factor in using the EEM fluorescence spectroscopy for correlating between composition and reactivity of organic matter.