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## Coupling Pyrolysis with Mid-infrared Spectroscopy (Py-MIRS) to Fingerprint Biochemical Quality of Soil Organic Matter

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### Abstract

A novel method coupling pyrolysis with mid-infrared spectroscopy (Py-MIRS) was developed to characterise soil organic matter (SOM) quality in soils with different management and land use types while overcoming acknowledged constraints of analytical techniques such as mineral interferences and associated secondary reactions. The set-up generates pyrolysis fingerprint spectra from which individual pyrolysis products can be related to biochemical SOM quality. For method development, pyrolysis temperature, heating rate and pyrolysis time were optimised using pure organic substances (e.g., glucose, xylan, quebracho). The preferred experimental conditions were 700 °C, 20 °C ms<sup>-1</sup> and 30 s, respectively, ensuring maximum pyrolysis yield efficiency, while reducing the formation of secondary compounds. Soil test samples were taken from (i) the Static Fertilisation Experiment, Bad Lauchstädt, Germany (Chernozem), (ii) the Frame Experiment Ultuna, Sweden (Cambisol) and (iii) the Observatory for Environmental Research (ORE-ACBB) Experiment, Lusignan, France (Cambisol). The results were used to evaluate the changes in SOM biochemical characteristics due to management practices and land use type. The pyrolysis products consisted mainly of organic compounds with aliphatic and aromatic structures, polysaccharides and carboxyl groups, alkenes as well as methane, carbon dioxide, carbon monoxide. Differences in peak areas of the different SOM compounds were observed providing insights into management and land use type related biochemical SOM quality. Py-MIRS results indicated that the SOM quality in soils receiving organic and mineral fertiliser inputs differed from that in samples of bare fallow and control soils. However, there were no distinct effects of

fertilisation and land use on aromatic compounds evolved in the soils. Notwithstanding, the coupling of pyrolysis with mid-infrared spectroscopy allowed via semi-quantification of pyrolysis products a rapid monitoring of SOM biochemical quality changes due to management and land use type with high degree of reproducibility. The proposed technique has considerable potential for the initialisation of SOM pools in dynamic SOM models. It was concluded that Py-MIRS represents an effective and reproducible technique to characterise SOM biochemical quality changes as a result of differing management practices and land use change.

**Keywords:** Fertilisation, land use, mid-infrared spectroscopy, pyrolysis, soil organic matter