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Extending the Knowledge of Soil Organic Matter Stabilisation through Fractionation and Mid-infrared Spectroscopy

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Abstract

Soil organic matter (SOM) is important in agricultural systems for improving soil fertility and maintaining a source of plant available nutrients, especially in highly weathered tropical soils. Traditionally, investigating SOM has involved time consuming fractionation procedures. This study examined SOM dynamics under long term management through the use of SOM fractionations in combination with diffuse reflectance Fourier transform mid-infrared spectroscopy (DRIFT-MIRS) to gain information on SOM stabilisation and provide a more cost effective way to analyse samples. It was proposed to use DRIFT-MIRS on soil samples in order to identify different stabilities of SOM by specific absorbance ranges in the mid-infrared wavelengths. Soil samples were from the long term experiment Bad Lauchstädt treatments of farmyard manure (FYM), mineral fertiliser, combination, and no fertiliser inputs. Bulk soil was extracted with hot water and fractionated by size and density methods. Bulk soil and fractions were additionally analysed by mid-infrared spectroscopy with the selection of wavelengths for peak area integration. These included 2930 cm^{-1} (aliphatic C), 1620 cm^{-1} (aromatic C and –COO), 1530 cm^{-1} (aromatic C), and 1159 cm^{-1} (C-O). DRIFT-MIRS peaks were found to differ significantly with treatment. The relative peak area (rA) of 2930 cm^{-1} was highest in FYM and mineral fertiliser treatment (36.5 % relative area) and lowest under no fertiliser inputs (17.6 % relative absorbance). Conversely the peaks at 1620 cm^{-1} had the opposite trend with a rA of 53.0 % in the manure and mineral fertiliser treatment compared with 69.8 % in the no inputs. Positive correlations were found between SOM fraction C contents (<1.8 g cm^{-3} C r=0.86 and hot water extractable C r=0.93) and 2930 cm^{-1} and negative correlations between the same fractions (<1.8 g cm^{-3} C r= -0.95, and hot water extractable C r= -0.79) and 1620 cm^{-1}. After 29 years, 2930 cm^{-1} peak areas increased in the FYM treatments, but declined in the non-FYM treatments, indicating a continual buildup of labile organic compounds under manure inputs, but a decline in non-manure treatments. These results showed the utility of combining DRIFT-MIRS with fractionation procedures for studying SOM of different stabilities under long term management.

Keywords: Fractionation, long term experiment, mid-infrared spectroscopy, soil organic matter, stabilisation

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