Geophysical Research Abstracts
Vol. 16, EGU2014-14798, 2014
EGU General Assembly 2014

Use of photoacoustic mid-infrared spectroscopy to characterize soil properties and soil organic matter stability

Clement Peltre (1), Sander Bruun (1), Changwen Du (2), and Lars Stoumann Jensen (1)

(1) University of Copenhagen, Department of Plant and Environmental Sciences, Copenhagen, Denmark, (2) Institute of Soil Science, Chinese Academy of Science, Nanjing, China

The persistence of soil organic matter (SOM) is recognized as a major ecosystem property due to its key role in earth carbon cycling, soil quality and ecosystem services. SOM stability is typically studied using biological methods such as measuring CO_2-C evolution from microbial decomposition of SOM during laboratory incubation or by physical or chemical fractionation methods, allowing the separation of a labile fraction of SOM. However these methods are time consuming and there is still a need for developing reliable techniques to characterize SOM stability, providing both quantitative measurements and qualitative information, in order to improve our understanding of the mechanisms controlling SOM persistence.

Several spectroscopic techniques have been used to characterize and predict SOM stability, such as near infrared reflectance spectroscopy (NIRS) and diffuse reflectance mid-infrared spectroscopy (DRIFT). The latter allows a proper identification of spectral regions corresponding to vibrations of specific molecular or functional groups associated with SOM lability. However, reflectance spectroscopy for soil analyses raises some difficulties related to the low reflectance of soils, and to the high influence of particle size.

In the last three decades, the progresses in microphone sensitivity dramatically increased the performance of photoacoustic Fourier transform mid-infrared spectroscopy (FTIR-PAS). This technique offers benefits over reflectance spectroscopy techniques, because particle size and the level of sample reflectance have little effect of on the PAS signal, since FTIR-PAS is a direct absorption technique. Despite its high potential for soil analysis, only a limited number of studies have so far applied FTIR-PAS for soil characterization and its potential for determining SOM degradability still needs to be investigated.

The objective of this study was to assess the potential of FTIR-PAS for the characterization of SOM decomposability during laboratory incubation and more classical soil parameters such as carbon and clay content for a range of 36 soils collected from various field experiments in Denmark. Partial least square (PLS) regression was used to correlate the collected FTIR-PAS spectra with the proportion of soil organic carbon mineralized after 34 weeks of incubation at 15˚C and pF 2, taken as an indicator of the labile fraction of SOM.

Results showed that it is possible to predict the labile fraction of SOM with FTIR PAS with similar accuracy as with NIRS (assessed in a previous study on the same soil set). FTIR-PAS offered the advantage over NIRS to allow identification of the chemical compounds positively or negatively correlated with the labile fraction of SOM. The band at 1612 cm^{-1} corresponding to polysaccharides, pectin and aromatic C=C was the band most positively correlated with labile SOM, which we attributed to the relative lability of fresh plant debris rich in polysaccharide and aromatic lignin. The band at 1560-1590 cm^{-1} assigned to N=H, C=N and aromatic C=C vibration was the band most negatively correlated with the labile fraction of SOM, confirming the abundance of nitrogenous and aromatic compounds in stabilized SOM. In conclusion, FTIR-PAS has proved to be a powerful tool to characterize the labile fraction of SOM, offering several benefits over reflectance spectroscopy techniques.