



Linking measurements of biodegradability, thermal stability and chemical composition to evaluate the effects of management on soil organic matter

Ed Gregorich (1), Adam Gillespie (2), Mike Beare (3), Denis Curtin (3), Hamed Sanei (4), and Sandra Yanni (1)
(1) Agriculture Canada, Ottawa, Canada (ed.gregorich@agr.gc.ca), (2) Canadian Light Source Inc., Saskatoon, Canada, (3) New Zealand Institute for Plant & Food Research Limited, Christchurch, New Zealand, (4) Geological Survey of Canada, Calgary, Canada

The stability of soil organic matter (SOM) as it relates to resistance to microbial degradation has important implications for nutrient cycling, emission of greenhouse gases, and C sequestration. Hence, there is interest in developing new ways to accurately quantify and characterise the labile and stable forms of soil organic C. Our objectives in this study were to evaluate and describe relationships among the biodegradability, thermal stability and chemistry of SOM in soil under widely contrasting management regimes. Samples from the same soil under permanent pasture, an arable cropping rotation, and chemical fallow were fractionated (sand: 2000-50 μm ; silt: 50-5 μm , and clay: < 5 μm). Biodegradability of the SOM in size fractions and whole soils was assessed in a laboratory mineralization study. The chemical composition of SOM was characterized by X-ray absorption near-edge structure (XANES) spectroscopy at the K-edge and its thermal stability was determined by analytical pyrolysis using a Rock-Eval pyrolyser.

The mineralization bioassay showed that whole soils and soil fractions under fallow were less susceptible to biodegradation than other managements and that sand-associated organic matter was significantly more susceptible than that in the silt or clay fractions. Analysis by XANES showed accumulation of carboxylates and strong depletion of amides (protein) and aromatics in the fallow whole soil. Moreover, protein depletion was most significant in the sand fraction of the fallow soil. Sand fractions in fallow and cropped soils were, however, enriched in plant-derived phenols, aromatics and carboxylates compared to the sand fraction of pasture soils. In contrast, ketones, which have been identified as products of microbially-processed organic matter, were slightly enriched in the silt fraction of the pasture soil. These data suggest reduced inputs and cropping restrict the decomposition of plant residues and, without supplemental N additions, protein-N in native SOM is significantly mineralized in fallow systems to meet microbial C mineralization demands.

Analytical pyrolysis showed distinct differences in the thermal stability of SOM among the size fractions and management treatments; it also showed that the loss of SOM generally involved dehydrogenation. The temperature at which half of the C was pyrolyzed showed strong correlation with mineralizable C and thus provides solid evidence for a link between the biological and thermal stability of SOM.