Geophysical Research Abstracts
Vol. 18, EGU2016-18063, 2016
EGU General Assembly 2016

Assessing plant residue decomposition in soil using DRIFT spectroscopy

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Assessment of the decomposition of plant residues typically involves the use of tracer techniques combined with measurements of soil respiration. This laboratory study evaluated use of Diffuse Reflectance Fourier Transform (DRIFT) spectroscopy for its potential to assess plant residue decomposition in soil. A sandy loam soil (Orthic Humic Gleysol) obtained from a field research plot was passed through a 4.75 mm sieve moist (∼70% of field capacity) to remove larger crop residues. The experimental design consisted of a randomized complete block with four replicates of ten above-ground cover crop residue-corn stover combinations, where sampling time was blocked. Two incubations were set up for 1) Drift analysis: field moist soil (250 g ODW) was placed in 500 mL glass jars, and 2) CO_2 evolution: 100 g (ODW) was placed in 2 L jars. Soils were amended with the plant residues (oven-dried at 60°C and ground to <2 mm) at rates equivalent to field mean above-ground biomass yields, then moistened to 60% water holding capacity and incubated in the dark at 22±3°C. Measurements for DRIFT and CO_2-C evolved were taken after 0.5, 2, 4, 7, 10, 15, 22, 29, 36, 43, 50 64 and 72 d. DRIFT spectral data (100co-added scans per sample) were recorded with a Varian Cary 660 FT-IR Spectrometer equipped with an EasiDiff Diffuse Reflectance accessory operated at a resolution of 4 cm-1 over the mid-infrared spectrum from 4000 to 400 cm-1. DRIFT spectra of amended soils indicated peak areas of aliphatics at 2930 cm^{-1}, of aromatics at 1620, and 1530 cm^{-1} and of polysaccharides at 1106 and 1036 cm-1. Evolved CO_2 was measured by the alkali trap method (1 M NaOH); the amount of plant residue-C remaining in soil was calculated from the difference in the quantity of plant residue C added and the additional CO_2-C evolved from the amended soil. First-order model parameters of the change in polysaccharide peak area over the incubation were related to those generated from the plant residue C decay curves obtained from respiration measurements. The DRIFT method demonstrated that spectral areas consistent with labile aliphatic-C bands (2930 cm-1) can also be used to describe residue C decomposition. This is the first study to demonstrate the usefulness of DRIFT spectroscopy to characterize plant decomposition in soil.