Prediction of carbon mineralization rates from different soil physical fractions using diffuse reflectance spectroscopy

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Abstract

Soil carbon (C) mineralization rate is a key indicator of soil functional capacity but it is time consuming to measure using conventional laboratory incubation methods. Recent studies have demonstrated the ability of visible-near infrared spectroscopy (NIRS) for rapid nondestructive determination of soil organic carbon (SOC) and nitrogen (N) concentration. We investigated whether NIRS (350–2500 nm) can predict C mineralization rates in physically fractionated soil aggregates (bulk soil and 6 size fractions, n = 108) and free organic matter (2 size fractions, n = 27) in aerobically incubated samples from a clayey soil (Ferralsol) and a sandy soil (Arenosol). Incubation reference values were calibrated to first derivative reflectance spectra using partial least-squares regression. Prediction accuracy was assessed by comparing laboratory reference values with NIRS values predicted using full hold-out-one cross-validation. Cross-validated prediction for C respired (500 days) in soil aggregate fractions had an R^2 of 0.82 while that of C mineralized (300 days) in organic matter fractions was 0.71. Major soil aggregate fractions could be perfectly spectrally discriminated using a 50% random holdout validation sample. NIRS is a promising technique for rapid characterization of potential C mineralization in soils and aggregate fractions. Further work should test the robustness of NIRS prediction of mineralization rates of aggregate fractions across a wide range of soils and spectral mixture models for predicting mass fractions of aggregate size classes.

Keywords: Diffuse reflectance spectroscopy; Mineralization rate; Organic carbon; Soil physical fractions

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