ABSTRACT

Diffuse reflectance spectroscopy (DRS) continues to emerge as a rapid approach for estimating several soil properties. Large database on soil properties and their reflectance spectra are prerequisite for developing robust chemometric models. To improve the accuracy of DRS approach for soil properties estimation, a new data fusion approach was tested in which the reflectance spectra over 350-2500 nm of bulk soil and its aggregate size fractions obtained by dry sieving approach were combined with three chemometric models such as partial-least-squares regression (PLSR), a locally-weighted PLSR ($PLSR_{LW}$) and PLSR with feature selection ($PLSR_{FS}$). This newly developed approach was tested using three different spectral libraries containing a total of 1013 soil samples each with 9 different aggregate size fractions. Correlation analysis suggested that soil properties were correlated to the respective mass fractions and average spectra of macro aggregates (aggregate size > 0.20 mm) while the adjacency analysis suggested that the micro aggregates (aggregate size <0.13 mm) mass fractions and average spectra might hold more information for estimating soil properties in the DRS approach. In general, the $PLSR_{LW}$ and $PLSR_{FS}$ approaches with micro aggregate spectra as the additional data source showed lower root-mean-squared errors (RMSE) than those obtained when bulk soil spectra were used alone. The newly developed data fusion approach improved the estimation of soil properties. The improvement in the RMSE ranged from 3% to 46 % for texture, 2% to 18 % for structure, 3% to 40% for chemical properties such as pH, and 1% to 24 % for nutrient contents. Hence, the results of improving the performance of spectral algorithm using aggregate size fraction spectra is a step forward in soil analysis through DRS approach. Although collecting soil aggregate spectra involves additional time, compared to bulk soil spectra alone, the analysis provides mean weight diameter property as well.

Keywords: Texture; Aggregate size distribution; Diffuse reflectance spectroscopy; Visible and near-infrared spectra; partial-least-squares regression; Locally-weighted partial-least-squares regression