ABSTRACT

Rapid assessment of soil characteristics is pre-requisite for the management of agricultural resources. Over the last two decades, diffuse reflectance spectroscopy (DRS) is emerging as a promising technology for the rapid assessment of several soil properties. A prerequisite in the DRS approach is the availability of robust relationships between soil properties and corresponding reflectance spectra. Generally, large databases on soil properties and soil reflectance spectra are required to develop such spectral algorithms. Review of the DRS studies revealed that only a limited effort has been made to apply the DRS approach to Indian soils and the performance of the DRS approach is often not satisfactory especially in low carbon soils. In this study, spectral algorithms were developed for estimating both chromophores (organic carbon; texture; iron content; aggregate size distribution, ASD characteristics) and non-chromophores (pH, electrical conductivity, phosphorus, potassium, sulfur, boron, zinc, aluminum) in two major soil orders Alfisols and Vertisols of Karnataka state in India. Partial least squares regression models were used to develop spectral algorithms. Model accuracy was evaluated using residual prediction deviation (RPD). The DRS approach yielded mixed results in predicting basic soil properties and nutrient contents. The first derivative-based DRS models yielded accurate prediction of most of ASD characteristics in both the soil types. The co-variation assumption was also evaluated using three dependency measures (Pearson correlation coefficient, *r*; biweight midcorrelation, *bicor*; and adjacency values of mutual information, AMI) by generating an average dependency index (ADI) for each of the three measures (ADI_r, ADI_{bicor} and ADI_{AMI}). The relationships between RPD values of non-chromophores and the ADI values were ascertained for different chromophore groups (physical, chemical and combined). The ADI_{AMI} outperformed ADI_r and ADI_{bicor}. The ADI_{AMI} computed using chemical chromophores showed strong linear relationships ($R^2 = 0.93$) between ADI_{AMI} and RPD of chemical non-chromophores suggesting that the AMI may be used as a robust dependency measure to assess the co-variation of non-chromophores with chromophores. The study demonstrated the use of DRS approach in the characterization of low carbon soils, prediction of ASD characteristics and a MI based dependency measure for 'co-variation' assessment.

Keywords: diffuse reflectance spectroscopy, aggregate size distribution, chromophores, non-chromophores, organic carbon, partial least squares regression, residual prediction deviation, Pearson correlation coefficient, biweight midcorrelation, mutual information.