ABSTRACT

Rapid soil testing and soil quality assessment are essential to address soil degradation and low farm incomes in smallholder farms. This study aims to evaluate the potential of diffuse reflectance spectroscopy (DRS) approach in the proximal and remote sensing mode as a complement to conventional wet chemistry-based soil testing and soil quality assessment. Two distinctly different datasets were used in this study: the DRS approach was calibrated using farmers' field data in a proximal mode for the Bundelkhand region of Central India and for the remote sensing mode of operation, a second dataset was compiled in the eastern Indian state of Odisha. For the proximal mode of operation, results of chemometric modelling showed that the DRS approach could yield the coefficient of determination (R^2) values ranging from 0.79 to 0.94 for exchangeable Ca followed by 0.67 to 0.88 for exchangeable K, 0.52 to 0.86 for SOC and 0.53 to 0.81 for available B content in the validation datasets. Except for one district, the DRS approach could be used to estimate SQI values with R^2 values in the range of 0.63 to 0.81. For the remote sensing mode of operation, a nonlinear unmixing and two different chemometric models were examined for estimating soil and crop residue parameters along with SQI. Estimated R^2 values in the validation datasets varied from 0.51 for soil base saturation to 0.91 for exchangeable Mg^{+2} using soil spectra obtained through linear polynomial unmixing of AVIRIS-NG spectra. We also estimated the three-tier soil test crop response (STCR) ratings to compare DRS and wet chemistry-based soil testing approaches. Both the approaches showed similar STCR ratings in more than 86% of the samples, indicating the potential of DRS to replace the traditional soil testing methods. With the availability of unmixed spectra both for the soil and vegetation endmembers from the AVIRIS-NG imagery, high spatial resolution maps for soil and CR parameters were generated. Extensive soil property data allowed us to evaluate soil carbon sequestration capability of different land use systems within the studied landscape. A critical value of 1/25 for the SOC/Clay ratio was observed for most of our agricultural land uses. Thus, the current HRS results show that soil and crop residue parameters may be accurately assessed for large areas with multiple land use and soil cover conditions. Assessment of both the modes of operations clearly showed that the DRS approach may be used as an efficient complement to conventional soil testing approaches.

Keywords: Soil testing, diffuse reflectance spectroscopy, AVIRIS-NG, soil test crop response