ABSTRACT

The optimal soil management is dependent on rapid and frequent monitoring of key soil properties, which are conventionally measured in the laboratory using laborious wet-chemistry protocols. This research focused on developing soil spectral, elemental, and color index libraries using diffuse reflectance spectroscopy (DRS), portable x-ray fluorescence spectrometry (PXRF), and Nix color sensor for soils collected from three major soil types of West Bengal. Moreover, the relationship between Nix and Munsell soil color chart (MSCC) variables and their capability to predict soil organic carbon (OC) and classify soil types were explored using multiple data mining tools. Additionally, the relationship between the MSCC soil color values for dry soils to those reported by the Nix color sensor with and without MSCC standardization was tested. For the first time, this research has explored the sensor fusion approach involving Nix, PXRF, and DRS for predicting a host of soil physicochemical parameters. Finally, the combination of smartphone-captured images and a custom-made dark chamber was explored to predict soil texture and OC via random forest (RF) and convolutional neural network models. The variability among PXRF measured elements, DRS spectra, and Nix color indices indicated inherent pedological and geochemical variability among soil samples collected from three agroclimatic zones. A good match was observed between the MSCC and the standardized Nix data while comparing RGB values from both datasets. The combination of the MSCC and the non-standardized Nix datasets produced the best OC prediction (R^2=0.66). Combining Nix sensor color data with soil texture data improved OC prediction accuracy (R^2=0.81) than using them independently. For sand, silt, and clay, the combination of (Nix+PXRF+DRS) produced the best model performance, producing optimal RPD values ranging from 2.00 to 2.71. The best prediction model varied from one property to another, implying no universal optimal fusion approach for predicting all soil properties. RF models using image-derived features produced excellent prediction for clay (R^2=0.98) and sand (R^2=0.97). More research is necessary, incorporating more soil samples representing all soil textural classes, showing all possible soil colors in the pedogenic environment.

Keywords: PXRF; Nix; DRS; smartphone; organic carbon; random forest