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Prediction of soil organic carbon stock using visible and near infrared reflectance spectroscopy (VNIRS) in the field

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Abstract :
Due to the role of soils in the global carbon cycle, there is increasing demand for data on soil organic carbon (SOC) stock, but the conventional determination of SOC stock (SSOC) is tedious and hardly allows meeting this demand. Visible and near infrared diffuse reflectance spectroscopy (VNIRS) is a time- and cost-effective approach that has been successfully used for characterizing SOC concentration, even in the field. The present study aimed at testing the potential of VNIRS for characterizing SSOC in the field, from spectra acquired on partially disturbed cores collected using a manual auger (thus not using cylinder sampling except for calibration), at 0–10, 10–20 and 20–30 cm depth in two agroforestry fields in France. Both fields were on silty Luvisols under temperate climate and included tree rows with grass cover, plowed interrows with cereals, and a conventional agricultural plot without trees. Conventional determination of SSOC involved bulk density measurement (cylinder method) and SOC concentration analysis (dry combustion) on the same samples, and was calculated as their product. VNIR spectra were acquired using an ASD LabSpec 2500 spectrophotometer, on the outer side of cores collected using a manual auger, at three points around the place where SSOC was determined. In total, 288 samples were studied (144 per field). Calibration with partial least squares regression was carried out on the 200 most spectrally representative samples, and validation was performed on the remaining samples. Considering the determination coefficient for validation (R2val), standard error of prediction corrected for bias (SEPc) and ratio of standard deviation of the validation subset to SEPc (denoted RPDval), the VNIRS prediction of SOC concentration was accurate (R2val = 0.75; SEPc = 1.6 gC kg− 1 soil < 2 mm, i.e. 13% of the mean; RPDval = 2.0). The prediction of SSOC was acceptable (R2val = 0.70; SEPc = 2.0 gC dm−3, representing 13% of the mean; RPDval = 1.8). Part of the VNIRS prediction error could be attributed to the fact that conventional and spectral measurements were not made on the same samples. Scanning the cylinder cores would probably result in better VNIRS predictions but is not consistent with the objective of determining SSOC without tedious cylinder sampling (except for calibration). However, conventional determination of SOC concentration on auger cores (rather than on cylinder cores) could be a valuable solution for improving calibration, with the perspective to develop a rapid procedure for accurate VNIRS prediction of SOC stock in the field.

Keywords:
Bulk density ; Agroforestry ; Proximal soil sensing ; In situ measurements

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