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"Competing pathways for equitable food systems transformation: Trade-offs and synergies"

Visible and near-infrared spectroscopy for agricultural soil analysis using alternative data preprocessing and wavelength selection

Natchanon Santasup[1], Parichat Theanjumpol[2], Nuttapon Khongdee[3]

[1] *Chiang Mai University, Dept. of Plant and Soil Sciences Faculty of Agriculture, Thailand*
[2] *Chiang Mai University, Postharvest Technology Research Center, Thailand*
[3] *Chiang Mai University, Dept. of Highland Agric. and Natural Resources, Thailand*

Abstract

Visible and near-infrared (VIS/NIR) spectroscopy has been widely utilised to predict soil properties due to its rapidity, affordability, and environmental friendliness. However, the accuracy of predictions varied due to the regions, soil pedological characteristics, and particularly site-specific practices. Therefore, soil-specific predictive models should be developed to increase the accuracy of the model. This study aimed to evaluate the effect of data preprocessing and wavelength selection on the prediction of organic matter (OM), total carbon (TC), and total nitrogen (TN) in agricultural soil using NIRs. A total of 148 soil samples were randomly collected from different agricultural areas in northern Thailand for soil chemical components i.e. OM, TC, and TN analysis. The Walkley-Black method was used to analyse OM, while TC, and TN were analysed by dry combustion technique. Soil samples were then scanned for VIS-NIR (400–2500 nm of wavelength), NIR (700–2500 nm of wavelength), and long-wave near-infrared (LWNIR) (1100–2500 nm of wavelength). Five data preprocessing techniques were tested, including smoothing (SMO), Saviizki-Golay derivatives (SGD), multiplicative scatter correction (MSC), mean centering (MC), and standard normal variate (SNV). Data preprocessing techniques were combined with partial least squares regression (PLSR) and principal component regression (PCR). The performance of the prediction was evaluated by the coefficient of determination (R^2) and the root mean square (RMSE). For a result, the best prediction was obtained with the combination of SMO preprocessing and the PLSR model in 400–2500 nm of wavelength. The R^2P values of OM, TC, and TN were 0.83, 0.81, and 0.84 and RMSEp were 0.76, 0.47, and 0.04, respectively. This study demonstrated that the model could be used as an alternative method for determining OM, TC and TN in agricultural soil. However, large-sample populations and improved model algorithms could further improve prediction.

Keywords: Chemometrics, model, prediction, soil property

Contact Address: Natchanon Santasup, Chiang Mai University, Dept. of Plant and Soil Sciences Faculty of Agriculture, Division of soil science department of plant and soil sciences faculty of agriculture chiang mai university., 50200 Chiang mai, Thailand, e-mail: natchanon.s@cmu.ac.th