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Reflectance spectroscopy: a tool for predicting the risk of iron chlorosis in soils

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Chlorosis due to iron (Fe) deficiency is the most important nutritional problem a plant can have in calcareous soils. The most characteristic symptom of Fe chlorosis is internervial yellowing in the youngest leaves due to a lack of chlorophyll caused by a disorder in Fe nutrition. Fe chlorosis is related with calcium carbonate equivalent (CCE), clay content and Fe extracted with oxalate (Feo). The conventional technique for determining these properties and others, based on laboratory analysis, are time-consuming and costly. Reflectance spectroscopy (RS) is a rapid, non-destructive, less expensive alternative tool that can be used to enhance or replace conventional methods of soil analysis. The aim of this work was to assess the usefulness of RS for the determination of some properties of Mediterranean soils including clay content, CCE, Feo, cation exchange capacity (CEC), organic matter (OM) and pHw, with emphasis on those with a specially marked influence on the risk of Fe chlorosis. To this end, we used partial least-squares regression (PLS) to construct calibration models, leave-one-out cross-validation and an independent validation set. Our results testify to the usefulness of qualitative soil interpretations based on the variable importance for projection (VIP) as derived by PLS decomposition. The accuracy of predictions in each of the Vis-NIR, MIR and combined spectral regions differed considerably between properties. The R2adj and root mean square error (RMSE) for the external validation predictions were as follows: 0.83 and 37 mg kg-1 for clay content in the Vis-NIR-MIR range; 0.99 and 25 mg kg-1 for CCE, 0.80 and 0.1 mg kg-1 for Feo in the MIR range; 0.93 and 3 cmolc kg-1 for CEC in the Vis-NIR range; 0.87 and 2 mg kg-1 for OM in the Vis-NIR-MIR range, 0.61 and 0.2 for pHw in the MIR range. These results testify to the potential of RS in the Vis, NIR and MIR ranges for efficient soil analysis, the acquisition of soil information and the assessment of the risk of Fe chlorosis in soils.