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Predicting key agronomic soil properties with fluorescence spectroscopy combined with reflectance spectroscopy: a farm-scale study in a Mediterranean viticultural agroecosystem

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For adequate crop and soil management, rapid, accurate techniques for monitoring soil properties are particularly decisive when a farmer starts up his activities and needs a diagnosis of his cultivated fields. This study aimed to evaluate the potential of fluorescence spectroscopy performed on whole soil solid samples, for predicting key soil properties at the scale of a Mediterranean 6 ha-wine estate with contrasted soils. Fluorescence measurements were carried out using the portable non-contact hand-held multiple excitation fluorescence sensor (Multiplex, FORCE-A, Orsay, France) in conjunction with reflectance measurements in the Vis-NIR-SWIR range.
Combining Vis-NIR-SWIR reflectance spectra and a set of fluorescence signals enabled to improve the power of prediction of a number of key agronomic soil properties including SOC, Ntot, $CaCO_3$, iron and particle-size contents (clay, fine silt, fine sand, coarse sand), CEC, pH and exchangeable Ca, K and Mg, with cross-validation RPD $\geq$2 and $R^2 \geq 0.75$.
Predictions of SOC, Ntot, $CaCO_3$, iron contents, pH, were still good (RPD $\geq$ 1.8, $R^2 \geq 0.68$) when using a single fluorescence signal such as SFR_R or FERARI indices, highlighting the unexpected importance of red excitations and indices derived from plant studies. The predictive ability of single fluorescence indices or original signals was very significant for topsoil: this is very important for a farmer who wishes to update information on soil nutrient for the purpose of fertility diagnosis and particularly nitrogen fertilization. These results open encouraging perspectives for using miniaturized fluorescence devices enabling red excitation coupled with red or far-red fluorescence emissions, directly in the field.

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