

Evaluation of the performance of field infrared instruments for the prediction of soil analytes

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Good soil management requires large amounts of soil data which are expensive to provide using traditional laboratory methods. Soil infrared spectroscopy offers a cost-effective solution. Further savings can be achieved by in-field assessment using portable/miniaturized infrared spectrometers. There is a need to compare the performance of in-field mid-infrared (MIR) and visible-near-infrared (Vis-NIR) spectrometers for the prediction of soil analytes across a range of soils. For this assessment, 458 soil samples from a wide range of soil groups in Australia were scanned by five Vis-NIR and MIR benchtop/portable/miniature spectrometers and partial least squares regressions (PLSR) applied for the prediction of 17 analytes in soils (dried at 40°C and sieved to <2 mm). Mid-infrared benchtop and handheld instruments provided the best performance, the Vis-NIR instrument the next most successful, and the miniature NIR instrument (950-1650 nm) being less successful. Providing we have a similar performance of handheld and benchtop MIR instruments, this also being true for the miniature and reference Vis-NIR instruments in the same spectral range (950-1650 nm), spectral quality was not decisive in determining prediction accuracy. In order to get optimum predictive results for a given analyte, a combination of appropriate spectral range and reliable reference analytical data with adequate distribution is required. The prediction potential of the analytes was classified as follows:

High: Total carbon (C) and nitrogen; organic C; pH; sand; silt; clay; cation exchange capacity; exchangeable Ca and Mg; and drained upper limit moisture.

Medium: Exchangeable sodium and exchangeable sodium percentage.

Low: Electrical conductivity; exchangeable K; bulk density; and saturated water content.

The results demonstrate the capability of portable infrared spectroscopy for the prediction of a range of soil analytes, with MIR being in general more accurate than Vis-NIR for a diverse set of soils.