NIR determination of Cation Exchange Capacity and Exchangeable Cations of Italian Corn Areas Soils

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The determinations of cation exchange capacity (CSC) and exchangeable cations of soils using conventional wet methods are time consuming and require skilled analysts in order to obtain both precise and accurate results. Aim of this work was to evaluate NIR reflectance spectroscopy in order to obtain a rapid estimate of these soil parameters.

A representative and heterogeneous set of 250 soil samples was selected from a population of soils sampled in all the northern Italy corn areas for which the organic carbon content and the texture were known. In order to maximize CSC variability the model of Courtin et al. (1979, CSC=23+3680*Organic Carbon+510*Clay) was used to estimate the CSC of selected samples. The true CSC was determined using the Barium Chloride-Triethanolamine at pH 8.1 method, and the the exchangeable cations were analyzed by atomic absorption spectroscopy. The results are summarized in table 1:

	Min	Max	mean	Standard deviation	Analytical error
CSC (meq(+)/kg)	3.5	90.9	20.6	14.3	0.75
Ca (mg/kg)	220	21593	3366	2689	97.5
Mg (mg/kg)	18	1483	300	240	7.8
K (mg/kg)	61	1058	273	169	7.9

The NIR spectra on dry soil ground at 0.5 mm were acquired using a FOSS 5000 spectrometer.

In order to maximize the calibration performances and to select the smallest calibration set were tested two multivariate design of experiment techniques: Kennard-Stone algorithm (KS) and Neighborhood Mahlanobis Distance (NMD). The regression model built with using NMD design and a Neighborhood distance of 0.5 gave a standard error of prediction of 4.6 cmol(+)/kg and a R^2 of 0.853 using 139 sample in calibration set and 111 samples in validation set. For exchangeable Ca, Mg and K the standard error of prediction were 738, 98 and 136 mg/kg and the R^2 were 0.837, 0.714 and 0.230 respectively.

These results demonstrated the usefulness of the NIR technique for rough determination of CSC and divalent exchangeable cations on heterogeneous soils.