Elemental Analysis of Inorganic Fertilizers using Portable X-ray Fluorescence (pXRF)

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Inorganic fertilizers are important agricultural inputs worldwide. Commonly used are straight, binary and compound fertilizers. Furthermore, these fertilizers can also be blended with micronutrients to produce crop or region/soil specific mixtures. Knowledge about fertilizer composition is critical for two main reasons. Firstly, users need to be sure about the quality of the product, i.e. the nutrient concentrations, given the widespread occurrence of low quality fertilizers due to poor blending or fraudulent practices. Secondly, there is the possible contamination of fertilizers with heavy metals which can endanger the environment and human health.

Conventional methods used for the elemental analysis of inorganic fertilizers are however labor intensive, time-consuming and expensive. Therefore, alternative techniques or tools that could be used to rapidly characterize inorganic fertilizers in a cost-effective manner will be invaluable to stakeholders.

To address these issues, the objectives of this study were to (i) develop calibrations for a portable X-Ray Fluorescence tool using a wide range of standard and spiked fertilizers, (ii) determine the reliability of the pXRF measurements for all macro and micro elements (except nitrogen) and (iii) evaluate the use of the pXRF for the detection of contaminants (i.e. As, Cd and Pb) in inorganic fertilizers.

XRF assays collected with different sets of conditions (i.e. energy, current, time and replication), together with ICP-OES data were used in the calibration of empirical quantification models based on the Lucas-Tooth and Price algorithm. R^2 values of the three calibrations for the macro and micro nutrients ranged from 0.6 to 0.99. The performance of these models were validated with an independent test-set comprising of 25 fertilizers.