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Measuring plant available phosphorus using diffusive gradients in thin films and x-ray fluorescence spectrometry

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Global concerns of phosphorus (P) deficiency limiting crop yields, and finite supplies of mineral P reserves, suggest a need to maximise P use efficiency in agriculture. To accurately predict the availability of soil P to crops, and subsequent P fertiliser recommendations, soil P tests must determine only the P that will be accessed and utilised by a crop. However, there is growing doubt regarding the ability of current extraction techniques (water, bicarbonate, resin) to accurately determine plant-available P across a range of soils. Indeed, the most widely-used test (Olsen P) across all soil types was only designed for alkaline soils and therefore it is inappropriate as a national standard soil test. Thus, there is an urgent need to develop a standard approach to measuring P availability applicable across a range of soil types. Diffusive Gradients in Thin Films (DGT) may be a more accurate technique for measuring the P available to plants than P measured using current extraction techniques because the measurement responds to both soil solution P and the P rapidly resupplied from the solid phase. However, elution by acid extraction of P retained within the resin gel of a DGT device, followed by analysis via inductively coupled plasma-based techniques, typically results in a delay of several days between DGT deployment and reporting of P concentrations. This is currently a significant constraint on the adoption of DGT to determine plant-available P in agricultural soils. Our research seeks to develop a novel combination of two existing techniques, DGT with portable x-ray fluorescence spectrometry (pXRF) to achieve rapid, non-destructive analysis of P within a DGT device, thus significantly reducing the length of time between DGT deployment and the final determination of plant-available P in agricultural soils. We aim to develop DGT-pXRF as a robust routine analytical procedure suitable for analysis of plant available P in a wide range of agricultural soil types.