Assessing the ability of soil tests to estimate labile phosphorus in agricultural soils: evidence from isotopic exchange

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Phosphorus (P) fertilization management strategies are essential for effective crop production with minimal negative environmental impact. A key factor to asses the soil P budget, is the use of soil P tests, i.e. extractions, which need to be cheap, fast and reliable. This study investigated the two commonly used P tests, the Olsen extraction (sodium bicarbonate) and the ammonium acetate lactate extraction (AL), with the objectives to assess (1) which test is most suitable for quantifying the plant-available P pool, and (2) whether the P status of the soil affects the relevance of the test results. Soil samples were taken from the Swedish long-term soil fertility experiments and included soils with varied soil texture from six sites and two treatments, one with P fertilizer and one without.

The amount of P extracted by the Olsen and AL tests was compared with the isotopically available P after 6 days of reaction with ^{33}P (P-Ea), which was assumed to represent plant available P for one growth season. Further insight into the performance of different extraction methods was obtained by determining the recovery of added ^{33}P (after one week of incubation) by extraction with water, $CaCl_2$, Olsen, AL and ammoniumoxalate. The P-AL test quantitatively matched P-Ea in non-calcareous soils with low P content, but tended to overestimate P-Ea in calcareous soils or soils high in P. This combined with a low recovery of ^{33}P showed that the AL extraction mainly targeted non-isotopically available P. The Olsen method distinctly underestimated P-Ea for all soils, and the difference from P-Ea was more prominent for the unfertilized soils. Hence, the Olsen method appeared not to be useful for direct quantification of plant-available P, but it might be satisfactory as a calibrated soil test for classification, due to its even performance on calcareous and non-calcereous soils.