

SOIL PHOSPHORUS: AVAILABILITY, UPTAKE AND MANAGEMENT

Phosphorus (P) is the second most applied nutrient globally after nitrogen (N), and is essential for plant growth. Crops often respond well to both mineral and organic P applications maintained at optimal levels, However, P management is complex:

- Most phosphate fertilisers are derived from phosphate rock – a finite global resource, raising long-term supply concerns and contributing to price volatility.
- Over-application or inefficient use can lead to P loss into water bodies, reducing water quality and harming biodiversity through eutrophication.
- Soil processes affecting P availability and plant uptake are complex, influenced by factors such as pH, soil texture, organic matter, and root access.

Phosphorus in soil

P availability in soil is controlled by three key factors:

- The concentration of P in the soil solution
- The rate at which P is replenished from soil reserves
- The extent and surface area of the plant root system.

Only a small proportion of applied P is immediately available. The rest becomes part of less soluble pools and is gradually released over time. Although initial uptake efficiency from P additions can be low, long-term phosphorus use efficiency can exceed 90% – if losses are minimised and crops have good root access across multiple seasons.

Figure 1. Conceptual diagram showing mineral phosphorus pools in arable soils. There is P in organic matter which is released by mineralisation



Maintaining Soil P

- For arable rotations, maintain 16-25 mg/l Olsen P (Index 2) – based on extensive UK trial data.
- Soil pH matters:
 - Low pH: P binds with iron and aluminium → less available
 - High pH: P forms insoluble calcium compounds
 - Keep soil pH around 6.5 on mineral soils for optimal availability
- Organic matter helps: Higher organic matter improves soil structure and may lower the critical Olsen P level needed for good yields.

Grain P

- Monitoring grain P can be useful allowing more accurate offtake estimates allowing for targeted nutrient replacement
- It can be used as a guide for P uptake efficiency – guidelines currently recommend that P concentrations of 0.32% are optimum in wheat, although recent Rothamsted analysis suggests this could be lower, potentially closer to 0.24%.

