Chasing the RB209 phosphate target index of 2: A fool's dream?

RB209 recommends building soil phosphate banks – does this fit modern farming practice?

THE importance of phosphorous for plant growth is well-documented and understood. The lack of it at any stage of plant development can leave the plant's engine room lacking fuel for growth.

It is, therefore, perhaps understandable that the thinking behind RB209 – The AHDB Nutrient Management Guide - for phosphate and potash management is to maintain the soil at a target Index of 2 or above.

John Sarup, Managing Director of Spud Agronomy, and Simon Fox, a Soil Scientist and Managing Director of Emerald Research Ltd discussed the fundamental flaws in this practice and how, in light of high fertiliser prices, environmental management and the drive for sustainability, this thinking is leading to excessive input use and cost.

The original thinking behind this was to build up reserves to maintain available nutrient sources throughout the crop rotation, a principle driven by the desire to "level up" agricultural soils for food production in the post-war era.

Under this scenario soils have often been likened to banks, where nutrients are added to the soil (current account), crops withdraw what they need to grow, anything left over is stored within your soil and can be used when needed (savings account).

However, John and Simon believe this to be a very simplistic view. A more apt housekeeping analogy of this approach would be that of someone while ensuring the children are fed (the current crop's needs are met) then wildly invests in the stock market. They may get lucky, they may break even, but more often they have squandered it for no return. →

Features of phosphate

Phosphate is present in soils in two forms: Organic (dead plant/animal residues and soil micro-organisms) and inorganic, which exists in three categories: -

- **Plant-available (soil solution):** This is inorganic phosphate that has dissolved in soil water, this is the smallest pool and the most readily available.
- **Sorbed:** A pool of inorganic phosphate that is attached to the surface of soil minerals such as clay, iron, aluminium and calcium.
- **Mineral:** The largest pool of phosphate and the most 'unavailable' for plant uptake, it consists of primary minerals and organic compounds that do not mineralize easily.

Unlike nitrogen and potash, phosphate is immobile within the soil, moving at most 1 mm a season, compared to 200 – 230 mm for potash and potentially metres for nitrogen (as nitrate), both of which are highly soluble and can flow through the soil structure with the flow of soil water.

Simon Fox

John Sarup

For phosphorous to be taken up by a crop and used, its roots must grow into the localised zones where phosphate exists, or can be easily solubilised, into the soil solution.

This is where the addition of phosphate fertilisers come in – but there are issues:

- Phosphate fertilisers are increasingly expensive.
- The World sources of phosphate are finite and diminishing.
- For the current crop broadcast phosphate fertilisers are often only 10 – 20% efficient.

Should farmers really try to achieve and maintain a Soil Index of 2?

In a 2016 report published by AHDB which looked at improving the sustainability of phosphorus use, several conclusions were drawn when considering phosphate fertiliser strategy.

It stated that strong environmental imperatives should drive further intensive research into feeding the crop, rather than the soil, and a transition to this new strategy should be planned. Crop yield effects demonstrated high sensitivity of outcomes to the P buffering capacity (= fixation capacity) of the soil, according to the report.

This AHDB review indicated significant potential to target P applications for more immediate crop uptake, rather than with the current philosophy of broadcasting simple P fertilisers on the soil, sufficient to maintain a large soil store of fixed P.

As it stands, RB209 recommends phosphate not only for the current crop's needs, but also to compensate reserves for offtake by the crop and to further build up the soil Index to 2 or above.

Simon and John believe that this approach is no longer fit for the modern agricultural world and state that over-application of phosphate leads to run-off, water pollution, wasted fertiliser and wasted cash, as well as mid/long term unavailability of the phosphate that remains, in the majority of UK soils.

"Unfortunately, RB209 does not account for phosphate sorption onto soil particles and minerals, where such sorption can lead to phosphorus becoming either completely or partially unavailable. This does little towards building up reserves and a lot towards building up unnecessary costs," Simon said.

He said the two main factors controlling the availability of soil P to plant roots are the concentration of phosphate ions in the soil solution and the ability of the soil to replenish these ions when plant roots remove them, ie the P-buffer capacity of the soil.

The level of soil-available phosphate is what is freely available within the soil for the crop to use and not what is held in reserve in either the sorbed form or in mineral pools – most of which is too slowly available to the plant, leading to deficiency and yield loss.

Because of this, Simon has spent much of the past 30 years researching and developing techniques to measure and predict the availability and fate of phosphate in the soil. As a result, new soil analysis laboratory techniques and computer algorithms have been developed to accurately predict the Phosphorus Sorption Index (PSI) of all soil samples processed by Emerald Research.

The soil's phosphate sorption index (PSI) is what determines the fate of any soil applied phosphate, it provides a percentage measurement of the soil's capability to retain or release phosphate to the soil for the crop to use.

The PSI allows better prediction of the soil's true P Index and more effective and efficient recommendations for the use and application of phosphate nutrition for the farmer, Simon said.

The higher the percentage, the more available the phosphate is and conversely the lower the figure the less that is available. The sorption figure should not be looked at in isolation because it will also be influenced by factors like pH, soil texture, types of organic matter and levels of iron, calcium, aluminium and clay that are present. In high concentrations, these factors can 'mop up' phosphorus, removing it from the plant availability pool.

If soils have a strong PSI, by trying to build up the soil reserves, you are locking up a resource and putting concentrated, useful fertiliser into a dilute, unavailable space where it cannot be recovered, Simon said.

Managing soils with strong phosphate sorption for potatoes & root crops

For potatoes and root crops, managing soils with a strong phosphate sorption index (PSI) is quite simple when a targeted test and application approach is taken. The to-do list is as follows:

- Use only the phosphate you need to feed the crop adequately.
- Avoid using ANY broadcast phosphate.
- Place fertiliser in high concentration bands, below the growing root system where it will be accessed and used efficiently.
- Apply low-dose, high availability P next to the seed at planting.
- Use foliar phosphates as a supplement

as this is at least 10 times more efficient than soil-applied.

- Apply foliar phosphates that are specially formulated for foliar application.
- Apply foliar phosphates at the correct dose and timing to promote desired aspects of growth (e.g. tuber numbers or bulking).
- Use tissue analysis at critical times to check leaf tissue phosphorous levels.
- Ensure micronutrients are also supplied (especially zinc) as phosphate applications can depress zinc uptake – both are necessary in Krebs cycle and protein synthesis.

By taking this direct application approach, the crop receives all it needs to achieve the target tonnage and quality, while reducing wasted phosphate, which is not used by the crop, that in the past has either been:

- Leached or lost as run-off.
- Used by competing weeds for their growth.
- Locked up within the soil never to be seen again.

John and Simon believe one of the overriding thoughts to be borne in mind with phosphates, and in fact many nutrients, is that they come from a finite resource and as such, should be applied in the most efficient ways and at the optimum amounts to gain the desired results.

By reducing the amount of phosphate lost to the environment, not only is a farm's environmental sustainability improved but also its financial sustainability. PR