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Making better use of nutrients

Bioscience in practice

A greater percentage of soil-applied phosphate (90-95%) and potash fertilisers (60%) remains in an unavailable form than is actually used by the crop. CPM explores how growers can rely less on solid fertiliser as well as improve nutrient uptake, assimilation and utilisation, while maintaining yields.

By Lucy de la Pasture

In the words of Socrates: ‘change is to focus all your energy not on fighting the old, but on building the new’.

It’s fair to say that the world has changed significantly, even within the current cropping year. Tomorrow’s problems have very much become the pressing issues of the day, particularly when it comes to crop nutrition.

Change that has been coming has accelerated in the topsy-turvy economics which follow a pandemic and have been further distorted by Putin’s war. For many reasons it’s a good time to think differently about how to ‘build the new’ and still meet the needs of crops, believes Mark Hemmant, technical manager at Agrovista.

The agronomy company has been challenging itself to think differently for several years now and part of that process has involved better understanding how

plants take up nutrients and ways of making the process more efficient. To that end it has been looking at product innovations, with several of those coming from specialist bioscience company Unium.

“Part of Unium’s ethos is to formulate and manufacture products which are not only rooted in science, but they’re also proven to work. Just as importantly they’re affordable to use,” he adds.

The same problem

Although much of the discussion is about nitrogen and improving nitrogen-use efficiency, the other major elements shouldn’t be forgotten, believes Mark. Improving phosphate and potassium-use efficiency is all part of the same problem, particularly as growers also face challenges with escalating prices for straight and compound products, not just ammonium nitrate and urea-based fertilisers.

John Haywood, director of Unium Bioscience, agrees. “Research shows that nitrogen-use efficiency and phosphate-use efficiency are intrinsically linked, a small change in one can give a big change in the other.

“Historically, the conversation around plant nutrition has been all about meeting the crop’s needs and not depleting soil supplies. That has to change to include how much of the applied nutrient is taken up, as well as how well it’s assimilated and utilised by the plant.”

Phosphate-use efficiency is an area which John believes has been largely ignored. “It’s been generally accepted as okay that a crop only utilises 5-10% of the phosphate applied. Because of this inefficiency, traditional forms of phosphate are over-applied in an effort to

meet plant needs, with implications for the environment.”

One of the problems with soil applied phosphate is that it only moves very slowly in the profile, he adds. “P is very immobile in the soil, so spring application doesn’t have enough time to get it into the root zone of crops — you’re actually fertilising for the next crop.”

Other limiting factors for P availability include high calcium and high pH soils. “If you put TSP on an alkaline soil, 50% of the P will be locked up within seven days and 90% within three weeks. So you’ve moved rock phosphate from Tunisia/Morocco put it on a calcareous soil in the UK and effectively turned it back into rock phosphate.”

John acknowledges that MAP or DAP are more suitable forms of P for a calcareous



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soil but he believes, because TSP is the cheaper form, the importance of soil pH is sometimes overlooked when making buying decisions.

When considering phosphate, it exists in three pools in the soil. Only the inorganic phosphate that has dissolved in soil water, which is the smallest pool of phosphate in the soil, is readily available to the plant, he explains.

“Some is adsorbed onto the surface of soil minerals (such as clay, iron, aluminium, magnesium and calcium) and slowly becomes available to plants (active pool). The majority exists as primary minerals (such as apatite, strengite, and variscite) and organic compounds that don’t mineralize easily (fixed pool) — and are therefore very unavailable to plants. These pools are in a state of equilibrium with one another,” explains John.

“Between 30-65% of the total phosphate in the soil is organic, and within this fraction soil biology plays a crucial role in releasing phosphate into the active pool by mineralising the insoluble P held in organic forms and solubilising the P held in inorganic substances.”

Using biology in the form of endophytes is one way that growers can help the plant take up nutrients more effectively, says John.

Unium endophytes can be applied as a seed treatment (Tiros) or as a foliar spray (Tarbis), which is new this season.

“Both products contain two strains of endophyte — one targets N-fixation from the atmosphere and the other P solubilisation and sequestration from the soil,” he explains.

Secondary adsorption

As well as considering the effect of Ca in the soil, it’s not the only place where it can limit P uptake, says John. He explains that nutrition within a root is primarily driven by calcium. So when the root brings P into the plant the Ca bonds to it, causing a secondary adsorption to the root.

“Biology has freed up the P where it was adsorbed onto soil particles but then it can become bound again in the root, and that’s where endophytes have a secondary application. They’re able to free P from the root to allow it to be translocated around the plant to wherever it’s required — often either the root tips or shoot tips because these are actively growing.

“So not only can you improve the pull of P from the soil, it’s also possible to improve the pull away from the roots. Both these attributes help improve phosphate-use efficiency.”

Having first trialled Tiros and seen it in



Once applied to the seed or as a foliar spray, endophytes work throughout the plant’s life to improve nutrient-use efficiency, says Mark Hemmant.

commercial use for the past two seasons, Mark has been impressed with its consistent performance, particularly getting crops off to a good start in the autumn. But it’s also working like this in the plant for life, he highlights.

“Tarbis fits where Tiros hasn’t been used and looks a useful way to boost nutrient uptake when the crop has a high demand, particularly for P and K in the spring.”

Agrovista’s John Murrie echoes Mark’s ►

Feeding the plant, not the soil

At Topcrop Farming the emphasis is very much on looking at ways to increase nutrient-use efficiency. Based at Whittlesey, near Peterborough in Cambridgeshire, Roger Hunt-Pain says the fenland farm has complex and varied soils and being high in organic matter brings its own set of challenges.

“A lot of our black land is low in P but very high in K. I’ve been working with John (Haywood) because we’re very conscious that a lot of applied fertiliser gets locked up, so we want to make sure that what we put on is best used by the plant.”

It’s a working relationship that goes back a number of years, when Roger and John were both members of Crop Management Information (now Green Crop Information).

“CMI always highlighted that credible biostimulant products require good data from replicated trials. John’s products have a good science base, are well tested and we’re trialling some on the farm as well,” he says.

Roger grows 130ha of onions — with some ground rented to help extend the rotation — and 80ha of potatoes in rotation with winter wheat, sugar beet and maize on the farm’s 400ha. With

high-value crops forming a fair proportion of his cropping, the rise in input costs has elevated risk to a whole new level, he says.

“The increase in costs and sale prices means more money is involved in the crop and that makes the cost of failure much higher. We’re really having to dot the ‘i’s and cross the ‘t’s on cashflow. It’s all new territory for us and many businesses and the last thing we need is for the wheat price to evaporate.”

It all reinforces Roger’s view that the farm has to make the best use of fertiliser from a financial point of view. He says that his aim is to make sure the plant’s nutrient use is most effective and valuable nutrients aren’t left in the soil, unavailable to the plant.

One of the products he trialled is Luxor and the results showed he was able to reduce soil-applied P205 application by 75% and saw an increase in potato yields. “The PGA within Luxor enhances the nutrient use efficiency, especially for P, and makes them more available to the crop. This will be even more important where we rent ground, as we don’t want to leave excess nutrients behind.”

Roger has also had good results using Calfite



His farm has to make the best use of fertiliser from a financial and environmental point of view, says Roger Hunt-Pain.

applied as powder to coat potato tubers and onion sets. “We found it helps maximise root growth and makes P more available.”

One of the things that’s important to Roger is the low salt-index of Calfite and other products from Unium, which are all formulated with both crop safety and the well-being of soil biology very much in mind, he says.



It's Calfite's ability to trick the plant into thinking it's short of P that can be utilised by growers to use P more effectively, says John Murrie.

► views, adding that both products also help plants withstand and recover from abiotic stress, such as droughty periods, which seem to happen more regularly in late spring just as the crop is growing rapidly.

Phosphites are another well-known stress busting biostimulant, with the low salt-index calcium phosphite (Calfite) the offering from the Unium stable. But it's Calfite's ability to trick the plant into thinking it's short of P that can be utilised by growers to use P more effectively, explains John Murrie.

"Because the plant thinks it's short of P, it pushes out more roots, increasing their depth and biomass and therefore their ability to scavenge for nutrients. And the PGA included in Calfite enhances nutrient uptake, further improving nutrient-use efficiency."

Phosphites also help nutrient-use efficiency in other ways, adds John Haywood. "Calfite activates root exudation, so roots produce more exudate which feeds the biology which bring P back to the crop. It's all part of a circle.

"So when you use phosphites early in the life of the crop, it improves root mass and elevates P into plant. It's a really efficient way of utilising the P that's found within the soil."

In a six-year rotational study (wheat/ barley/OSR), MAP

and TSP were applied at either 100Kg/ha P₂O₅ or at a reduced rate and supplemented with phosphite, explains John Haywood.

"The most cost-effective treatment was phosphite alone but over the duration of the study the soil P dropped from 14ppm to 12ppm. However, if 25% of the normal P was applied to the soil and topped up with phosphite this ameliorated the depletion."

Soil Biology

John Haywood notes that the low salt-index formulation of phosphite doesn't have a negative impact on soil biology, primarily on mycorrhizae, though phosphate does. "The challenge with high P fertilisers is that they have a negative impact on soil biology. For example, often there's a kick from starter fertiliser but as the P source depletes, or becomes adsorbed to the soil, the crop growth stutters as its forced to pause to form associations with the biology it needs to pull further P from the soil.

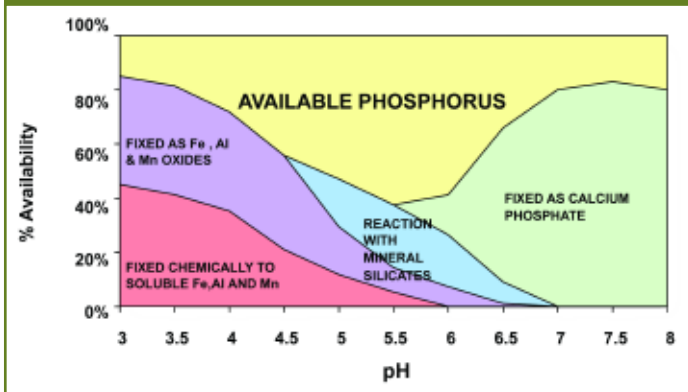
"However, if the P is in a low salt index source that supports biology, then the plant will form these associations from the very beginning and avoid the slump in growth."

And this is how Unium provides P in new product, Luxor. "Growers can now achieve the same result as seen in the six-year trial, with the same positive effect on soil biology, using a new innovation from Unium — Luxor — which contains two forms of P in a fulvic/humic complex," he says.

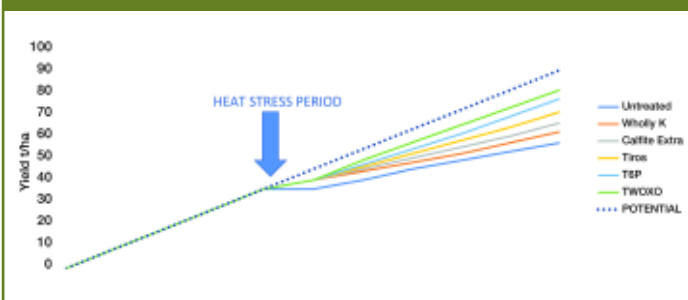
"Luxor enables growers to use some granular and top up with a foliar source of P. It provides an opportunity for potato growers on rented land to maintain soil reserves and deliver the P requirement of the crop at a much lower cost than if following conventional programmes."

In other crops, Luxor could be directed where it's still necessary to deliver P, either as a soil application or as a foliar in season if P-limiting, or where

Effect of soil pH on available phosphorus



Different nutrient/biostimulant treatments on potato yield



Mitigation of heat stress period in potatoes, where bulking rate changed from 9t/ha to 4t/ha in the untreated.

Source: Greencrop

there are availability problems in the soil, he adds.

While it's become normal to consider the supply of nutrients as individual elements, for many of the physiological functions of plants they're interdependent on each other, says Mark. For that reason, supplementing K levels with a foliar complex can increase the overall nutrient-use

efficiency of plants at a time when their requirement is high.

"Wholly K is a complex which delivers potassium efficiently through the leaf, while the 2-oxo metabolite drives nutrient use efficiency, especially nitrogen. This stimulates root production to allow better access to soil K to help overcome the deficiencies or lack of availability." ■

Bioscience in practice

As the chemistry toolbox continues to shrink, a mesmerising array of new bio-solutions are coming to market, offering a range of benefits and complementary additions. Evaluating just how effective they are, and where they're best placed can be tricky.

In 2021 CPM teamed up with Unium BioScience to open the science behind these innovations. In this second series of articles we explore how bioscience can be utilised in the field, building on our understanding of the physiological processes and trials data. Above

all, these articles give the grower an inside view on some of the exciting opportunities biosolutions offer in the field.

Nutrient-use efficiency is a hot topic at the moment, with prices rocketing and products becoming hard to find. At Unium we are combining many years of experience with tried and tested technologies to help farmers find affordable solutions that will maximise their yields and profits.

