

Nutrient availability unearthed

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Innovation Crop nutrition

One of the hardest things to predict in crop nutrition is the quantity of nutrients in the soil available for uptake by the crop. *CPM* talks to a soil scientist who believes he's developed a system which enables a more finely-tuned approach to feeding the crop's potential.

By Lucy de la Pasture

As the major R&D institutes concentrate more and more on molecular research programmes, much of the applied research is being carried out by innovative growers and entrepreneurial scientists in on-farm trials.

It marks a sea change from the way things used to be done, with trials data obtained from real commercial situations which enables fast transfer of technology into actual practice, says Simon Fox, soil scientist and founder of Emerald Research, based in Glos.

One of the puzzles facing agronomists is how to meet the crop's nutritional needs and get the most benefit from using biostimulant products. While their potential is exciting,

deciding how and when to use them is proving to be a huge learning curve and there is a relationship between the two factors, he explains.

Refined approach

Simon has been developing a more refined approach to plant nutrition for the past 30 years and has developed a system tailoring the needs of the plant to the availability of nutrients in the soil. On top of that, he's incorporated new biostimulant products into a programmed approach to nutrition, which he says takes the guesswork away from deciding what and when they will provide a tangible benefit.

He describes the bible of nutrient recommendations RB209 as 'insufficient to meet current and future demands, especially where greater yields need to be achieved.' So what exactly does he mean by this?

"In my opinion, the analyses behind RB209 aren't sufficient to predict accurate fertiliser needs, particularly for phosphate. Analysis of the data shows that across the range of soil types, there's generally a poor relationship between the amount of phosphate in the soil, determined using the usual extractant methods, and the amount of phosphate in leaf tissues.

"But there is a meaningful relationship between the amount of phosphate in the roots of plants and in their leaves. This tells us that when it comes to predicting the amount of phosphate that's actually

available for plant roots to take up, current single-extraction soil analysis is just not up to the job," he says.

Although the relationship between soil analysis and leaf tissue levels is more positive for potassium and magnesium, Simon explains that statistically the correlation isn't generally that high (often $R^2 \leq 0.4$), so there's a high degree of variation from the mean.

"This is important because, not only are we not meeting crop potential, but in hitting a yield 'glass ceiling', we're also potentially wasting valuable and finite fertiliser resources, such as phosphates.



Simon Fox says the system uses RB209 as a guide to the amount of base fertiliser, but overlays this with output from the OptiYield model.

Phosphate deficiency in rye grass

Crop nutrition

"There's a significant lack of multi-variate, multi-disciplinary approaches to the advancement of agricultural systems. The majority of experimental trials research still appears to rely upon testing either single or a very small number of variables. If these don't show significant effects, then they're habitually excluded from future work and the focus moves on to other trials," he comments.

"It may be these inputs would play a significant part in increasing performance if combined with other inputs (e.g. two nutrients plus two biostimulants), but these types of trials are seldom conducted."

Simon has made it his mission to develop a better way of predicting the availability of P, K and Mg to plants in order to supply the plant with what it needs, when it most needs it. That was the motivation behind Emerald's OptiYield system, which provides growers

with an advanced soil analysis. This employs new laboratory methods he's developed alongside the existing methods, and a programme of foliar supplementation with nutrients and biostimulants. It's based on the output of the OptiYield model and tailored to the needs of individual varieties and their markets, explains Simon.

To further complicate phosphate applications, recent research funded by AHDB indicates that on average, only 4% of phosphate applied as triple super phosphate fertiliser becomes available to the crop in the year it's applied, and the range of availability is also wide across different soils and conditions

"We still use the standards set by RB209 as a guide to the amount of base fertiliser, but overlay this with the output from the OptiYield model, which gives a more accurate prediction of the availability of



Enhanced methods of analysis and an innovative P-Sorption Index have been instrumental in developing a more accurate prediction of nutrient availability.

P, K Mg and other nutrients for the crop.

"We can then adjust recommendations and ameliorate any shortfall with foliar

More refined approach to nutrition pays



According to Patrick and Tess Elliott, last year their crops under the OptiYield system exhibited greater crop vigour and disease resistance, as well as being less stressed.

Ian and Fiona Elliott, together with son and daughter Patrick and Tess, grow around 170ha of potatoes on the silty clay loams at Cresswell Barn Farm next to the Cleddau Estuary in Pembrokeshire.

They bought the farm in 1977, when they grew just 20ha, and embarked on a programme of expansion soon after.

"As well as growing more of the crop, it's always been our aim to increase yields and quality, but we wanted to achieve that without overly-depending on chemistry," says Patrick. "We wanted to aim towards greater sustainability while maintaining quality."

The team grow a range of maincrop varieties, including Desiree, Electra, Maris Piper and several salad varieties, such as Belana, Charlotte and Gemson. All are destined for supermarkets via Haverfordwest-based Puffin Produce.

Patrick first became interested in the OptiYield system at a Puffin Produce meeting in early 2016. "We conducted some replicated plot trials in 2016 as well as a range of field-scale trials, mainly on maincrop varieties, and continued these in 2017 and 2018.

"The trials normally involve treating adjacent beds or beds between standard treatments. Where possible, we've alternated beds across a field in order to give some replication."

OptiYield programmes were applied with crop protection products such as blight sprays to reflect commercial practice. Results were measured using boxes per block, test digs and quality inspection. Plants in the treated areas had healthier canopies and a bigger root mass, he notes.

This translated into higher tuber counts, producing a very significant increase in yields. "Overall maincrop yield rose by 20-25% on average," says Patrick. "Crops exhibited greater crop vigour and disease resistance, as well as being less stressed.

"We also observed better skin quality and more even distribution of tuber size, which has helped our saleable yields go up by around 25% on average over the past 3 years.

"The effect on the bottom line was staggering, particularly last season which was very dry. We have little or no access to irrigation, and OptiYield greatly improved crop growth and maintained vigour and canopy.

"Overall, following on from previous years, for 2018 we estimate our net margin increases around 320% for maincrop and 150% for salads in what was a very low rainfall, high-stress year."

OptiYield's range of biostimulants and microbials are now standard inputs across much of the Elliott's potato area.

"All maincrop will be treated with OptiYield Complete and we'll probably use OptiYield Bioactive on most salad crops this season," says Patrick.

"The strength of OptiYield is the customised programmed approach tailored to our needs, and those of each variety. The soil analysis system is definitely better than others we've used. Rather than simple analysis values, the availability interpretation has proved to be significantly more valuable, not only for major nutrients but also for minor and micronutrients," he comments.

"We also like the fact that Emerald is involved closely with a variety of research centres including Bangor and Aberystwyth Universities, as well as other organisations overseas, which ensures the programme is updated as necessary to reflect current thinking."

The Elliots found that by refining their approach to nutrition they achieved a 20-25% increase in marketable yield.





Emerald Research are working with over 15 institutions in the UK and overseas to help growers overcome the yield barrier.

nutrition, which — for many nutrients, but not all — has a much higher level of efficiency than soil-applied fertilisers,” he explains.

The groundbreaking feature of the OptiYield system is its available phosphate predictor, which utilises a novel Phosphorus Sorption Index that Simon has developed. “This calculates the capability of the soil for

adsorbing phosphate, making it unavailable for uptake by plants. This then tells us how much phosphate may be locked up in the soil and how much is likely to be available to the crop.”

Unique algorithms

The unique algorithms within the programme also take into account the effect of other soil factors on adsorption; including organic matter content, cation exchange capacity, clay content/type, pH and a number of other soil factors included in the soil analysis. Simon’s found his more advanced methods of analysis and the interpretation he’s developed, has a much more accurate correlation with the availability of P, K and Mg — statistically having a typical R² of 0.8 or 80% confidence in the prediction of the soil’s ability to adsorp.

As with most new technologies, it’s the higher value crops where OptiYield has been met by keen interest from growers and packers, he says.

“Even though potatoes don’t have a particularly high requirement for phosphate, they’re a poor rooting crop which means they have a poor capability to scavenge phosphate from the soil,” he explains.

“We have growers in some parts of the UK who have very high P-indices of 5-8, yet some potato crops show phosphate deficiency. This demonstrates the inadequacy of the standard methods of analysis as they stand and shows how powerful the adsorption capacity of a soil can be,” he adds.

Having worked out the amount of nutrient available to the crop, the next big challenge is to make sure the nutrients or biostimulants



A more accurate prediction of nutrient availability is a step forward to matching the crop’s need to its yield potential.

applied actually work, he says.

“Some foliar products can have a counterproductive effect, depending on the way they’re formulated. In trials, some commonly available forms of manganese applied as straight salts have been shown to reduce yields as they can be slightly phytotoxic. In this form the manganese doesn’t translocate well to the growing points, where it’s needed, it sits in and on the older leaves which may be already ‘shocked’ by its application.”

Emerald has also developed a range of microbial products, which were demonstrated in a replicated trial at Potatoes in Practice (PiP) last year, and Simon explains the thinking behind them.

“We’ve found multi-species and strains of microbes that are highly effective in the field and work together, so are beneficial to the crop in parallel. For potatoes it’s applied in-furrow at planting, in addition with a biostimulant which acts as a bug food to stimulate microbial growth. The microbes provide a beneficial environment, increase the hormones that encourage rooting and fix phosphate, sulphur and nitrogen,” he explains.

“Our PiP trial in Scotland mirrored the results we’ve had commercially across the UK. Plots treated with microbial mixtures emerged much faster than those where tubers had no such application. In commercial trials in Scotland, England and Wales, microbial treatments gave an overall yield benefit of 15-20%, with very clean tuber samples.

“We can’t rest on our laurels, but I believe it’s possible for us to break through the 30% yield increase barrier reliably in the next few years by combining and refining these emerging technologies alongside more comprehensive soil analysis and bringing on board new bioactive products. We’re working hard on R&D as UK commercial lead in the Interreg NASPA project with over 15 European institutions to help bring this about,” he concludes.

OptiYield programmes

Bioactive

Down-the-furrow seed tuber treatment using beneficial microbes and biostimulants.

Foliar programme of organic biostimulants designed to improve vigour, nutrient redistribution, enhance photosynthesis and reduce stresses. Designed for application with blight sprays.

Core

OptiYield Bioactive plus critical growth stage nutrition. Addition of high concentrate nutrition to bioactive foliar programme.

Suited to short-season crops where focus is on securing vigorous growth and early-to-market benefits.

Uses major and micronutrients specific to crop and field applied at two or three crucial growth stage timings. Designed for application with blight sprays.

Complete

Combines Bioactive and Core programmes with further applications of biostimulants and nutrients.

Typically delivers marketable yield increases of 15-30%.

Designed for application with blight sprays.



Trials have shown potato emergence is quicker where an in-furrow microbial treatment has been applied.