A helping hand

> *Like most things in nature, optimal metabolic function in plants is all about balance.*

Bioscience in practice

Fungicide chemistry, both new and old, is increasingly coming under pressure, with selection pressure in the field and regulatory hurdles thinning down azole and multi-site options. *CPM* finds out how plants can be given a bit of help with their own defences.

By Lucy de la Pasture

For millennia, signals — a puff of smoke, a wave of a flag or a flare lighting up the sky — have been used to draw attention to the fact there's danger or trouble ahead. Plants are no different, using chemicals to signal, not just to their own defences but to those around them, that something is amiss.

Land-based plants have evolved unique survival strategies, explains Unium director John Haywood, particularly as they are sedentary. "This makes them subject to intense biotic stress — such as herbivory and disease — as well as abiotic stresses such as drought, fire and climatic extremes.

"Part of their evolutionary success is due to the plant's ability to detect potential threats and defend themselves using physical (cell walls), chemical (phytoalexins) and protein/enzymatic defence systems (pathogenesis-related proteins)."

When the plant receives a chemical signal that it's coming under attack, says John, a hormone cascade is initiated which kicks its defence responses into action, "First there's a hypersensitivity response (HR). This is a type of programmed cell death at the site of a microbial invasion and is designed to stop the interloper from spreading to healthy plant tissues."

Plant defences

As the site of the invasion is being tackled, the troops are also being brought in to fight invaders that get beyond the first line of defence, or the HR response, he explains. "This is called systemic acquired resistance (SAR), which takes over from the plant's induced systemic response, which is akin to having troops which are continuously stationed on the battlements to tackle any mild skirmishes.

"When SAR is triggered, the plant produces more chemical defence compounds, such as phytoalexins and pathogenesis-related proteins to fight off the attack."

But it takes a lot of energy for the plant to keep its troops in this heavy fighting, prolonged attack mode, explains John. "The plant has to divert energy into its defences, so something has to give and that's its growth, which it shuts down temporarily."

For a crop, relying on its natural defences alone isn't enough, he adds. Shutting down growth so the plant can fight a disease means both yield and quality will suffer which is why crops are supported with fungicides.

But what if it were possible to support crop plants to help them maintain an enhanced and prolonged innate response to disease without having to shut down growth? In other words, to keep reinforcements piling into battle to maintain the line while life goes on as normal in the castle keep, says John.

"Plant metabolism has a multi-layered approach to defence, with both primary metabolism (metabolites required for growth, development and reproduction) and secondary metabolism (metabolites used in mechanisms such as defence) involved to different degrees."

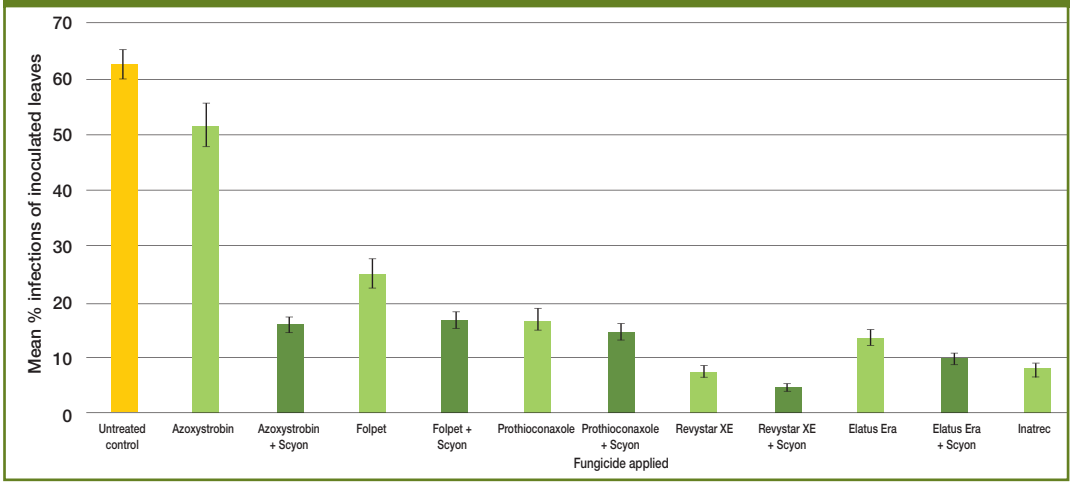
Unium screened many of these metabolites before finding six, that in combination did what they set out to do — which was to upregulate the plant's own defence mechanisms. But in order for this to have a useful effect, it was necessary to formulate the plant metabolites with a complex with supporting nutrients so that the plant didn't have to divert energy away from growth. The result of this R&D is the biostimulant-nutrient product, Scyon.

"It contains six metabolites that support 14 different pathways, all with key roles to play in nutrient balance, plant defence mechanisms or stress management."

The subject of nutritional balance is an interesting one, says John, and is something regenerative farmers in particular are paying a lot of attention to — learning how to help the plant help itself by optimising its health.

"Like most things in nature, optimal metabolic function in plants is all about ▸

Scyon use with fungicides



Foliar fungicide control (half recommended rate) of septoria in wheat -applications made one day before inoculation. Error bars = 95% confidence limits.

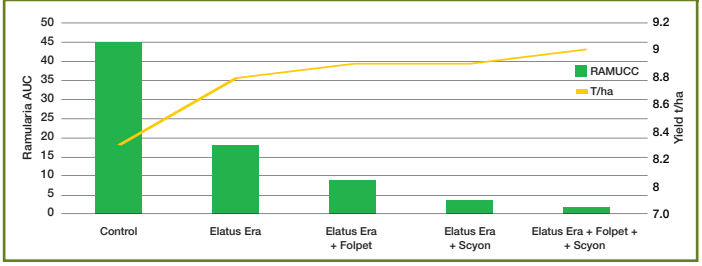
Source: University of Nottingham, 2021

Scyon trials summary

	OLD chemistry % control	NEW chemistry % control
	SEPTORIA	
Chemistry Alone	46%	76%
Chemistry Plus SCYON	65%	83%
Infection level 62.5%	+19%	+7%
	YELLOW RUST	
Chemistry Alone	54%	62%
Chemistry Plus SCYON	72%	78%
Infection level 36.3%	+18%	+16%
99% improvement over 72 assessments		
Average across all assessments 30.34% reduction for septoria		
Average across all assessments 36.71% reduction yellow rust		

Source: Unium, 2021

Effect on ramularia



Source: Germany, 2021

▸ balance. Maintaining nutritional balance is essential for the plant to keep its physiological balance — and maintaining a strong primary metabolism and an efficient secondary metabolism is essential for plant health.

"The complex works by enabling plants to optimise their nutrient-use efficiency and carbon:nitrogen metabolic ratio, creating a stronger healthier, plant. The combination of plant metabolites and nutrients also stimulates and supports the plant's natural SAR pathway, resulting in increased concentrations of innate immune compounds and the secondary metabolites used to fight diseases," he explains.

"Critically, in plants photosynthetic upregulation provides carbon flow to support host defence systems and this is one of the ways Scyon helps mitigate any negative effects on growth and accounts for the greening seen in the field."

But that's not all it does. Scyon also delivers potassium, manganese, zinc and an unusual foliar-acting form of sulphur, which supports the sulphur-induced resistance defence pathway, together with a balanced amount of nitrogen.

"Sulphur is the only inorganic compound ever identified in plant defence mechanisms. In the sulphur-induced resistance pathway, sulphur is produced specifically in response to pathogen attack (fungal and bacterial) and is localised at the site of the invasion," he explains.

But it's the role of potassium that's perhaps under-recognised in plant defences, notes John.

"Nutrients fall under two categories in plants — structural and regulatory. Some can function as both (such as calcium) but potassium is primarily a regulatory element and, as such, it's intricately linked with plant metabolic functions and growth."

What's more, its interactions with other nutrients, both within the plant and soil, provides an opportunity to use potassium to modify the plant's response to disease, he explains.

"One of the functions of potassium is to affect plant host defence mechanisms. Out of 165 peer reviewable cases which look at the effects of potassium on fungal, bacterial and nematode diseases, 71% resulted in a decrease in disease, explains John.

"Potassium deficiency has been shown to induce changes in gene expression, enzyme activities, metabolites and signalling within the plant. Because potassium modulates the metabolic and hormonal pathways involved in plant defence, insufficient supply makes plants more susceptible to pathogen attack."

Potassium isn't alone in helping plants fight disease, the other elements included in Scyon also perform vital roles in defence, he adds.

Buzz of excitement

The theory behind Scyon sounds good, but the proof of the pudding is in the eating. That's why Hutchinsons extensively screen nutritional and biostimulant products to see if they will bring any value to farmers, says Dick Neale, technical manager for the agronomy company.

"We've trialled Scyon pretty intensively for about five years now and it first came into our trials when it was a coded development product. It looked interesting because, at the time, we were looking for something as a replacement for chlorothalonil, knowing it would probably go."

When the results of trials with UBS007, as it was then known, was put in front of agronomists there was a buzz of excitement, says Dick. "At a time when the efficacy of the main fungicide groups was shifting and CTL looked like it wouldn't be with us much longer, the coded product was producing data that looked impressive alongside fungicide options. Then I told the team it was a biostimulant, not a fungicide," he smiles.

Although that fact somewhat dulled the collective enthusiasm of some of the agronomists at the time, Dick believes that was because of the stigma associated with biostimulants — that in some situations they perform yet in others they don't.

"That's something that's hard to explain to farmers when you've recommended that they spend money on a biostimulant, so agronomists tend to want the measurable, 'no question it's

worked', effect that fungicides bring. But in the case of Scyon, we're using it to help control disease but in a different way to a fungicide so it's an alternative way of thinking about disease control."

Having confidence that a product will reproduce its performance time after time is important and that's where trialling in a field situation and a statistical interpretation of the results comes in. Hutchinsons commissioned Dr Tom McCabe, from the University of Dublin, to take a closer look at Scyon in the trials programme he runs at Prime Crop Research in East Anglia.

Tom assessed Scyon within a fungicide programme and he found that in 95% of cases, the septoria control was as good when Scyon was included with a fungicide partner as it was where folpet was included instead, says Dick.

It's this supporting role to fungicide chemistry that makes Scyon particularly interesting as an added tool for disease management, he believes. "In many ways we're stuck in a hamster cage — we wait eagerly for new fungicide products, use them, break them and then hope there's another new one. It's not a sustainable model, we have to start thinking about fungicide longevity."

Dick sees the multi-faceted support from Scyon as a way to take some of the pressure off fungicide chemistry — by helping to kick-start plant defences but it's also reducing some of the heavy-lifting that has previously been left to the fungicides, without much help from the plant itself. The inclusion of Scyon changes that, so it can help protect other products because it's not a fungicide, making it a useful additional anti-resistance management tool, he says.

One of the concerns Dick has is the superior efficacy of new chemistry, such as Univoq (fenpixoxamid+ prothioconazole), could make growers throw thoughts of resistance management out of the window. That's partly because using new chemistry will be relatively expensive but also because it looks to be tremendously effective.

"We saw this when the strobilurins were introduced in the 1990s. We had chlorothalonil then but thought we didn't need to use it anymore because we'd never seen the level of disease control before that the strobilurins offered. Then quite quickly they stopped working completely and we went from near total disease control to zero in a season."

Protecting chemistry

Univoq is a QiI fungicide, which has the same effect on microbial respiration as the strobilurin QoI fungicides, albeit by acting on a different target site. In a QiI, the active binds to complex III at the Qi site on the cytochrome bc1 complex. The target site for strobilurins is also on complex III but at the outer binding site in the electron transport chain.

"That means there's also a high risk of resistance occurring, so Univoq needs to be protected."

So when is the best time to apply Scyon to crops? Dick is pretty emphatic that it should be before GS31, so he recommends inclusion at the T0 timing.

"We believe it's important to use Scyon before foliar diseases, septoria in particular, really get going in the crop — especially in advance of leaf three emerging or any leaves higher up the plant. So T0 is an ideal time to switch on the plant's own systemic acquired resistance to last the rest of the season," he says.

"Applying a T0 adds flexibility to the programme so that if you're delayed with the T1 application (leaf three emerged) then there's a bit more leeway. So much can go wrong, so quickly."

Last season, trials at Hutchinsons' regional technical centre at Banbury showed the T0 spray with Scyon had an unusually influential impact. "We don't normally expect a yield response from a fungicide at T0, but it was a demo site rather than a replicated trial," adds Dick.

So how long will the effects of Scyon last? That's something else Hutchinsons has looked at in its trials and has come to the conclusion that Scyon only requires one application. "You can't switch plant defences on twice. There's also no benefit from altering the rate from the recommended 1.0 l/ha," he says.

"I'd still use folpet at T1 and 2 as there's growing evidence that you need those two 1.0 l/ha applications as the benefit builds through the season."

In theory because Scyon boosts the plant's natural defences, it should help disease management on any crop, says Dick. "We've very much concentrated on septoria management in trials but we're also seeing an impact on other disease development, including mildew, yellow and brown rusts."

When used with folpet, Scyon looks like a useful addition to programmes targeting ramularia in barley crops, he adds.

Hutchinsons has also studied the nutrient balancing effects of Scyon in studies at the University of Nottingham and in the field. "We certainly see a measurable difference in nutrient uptake where Scyon is applied. In a hydroponic trial at Nottingham, we saw increases in uptake of up to 25% for all nutrients, with the exception of molybdenum."

Dick Neale says Scyon is being used to help control disease but in a different way to a fungicide, so it requires an alternative way of thinking about disease control."

Summing up, Dick says Scyon isn't another chlorothalonil, but that's gone. Instead he believes it's time to think differently and, in his book, Scyon has proven itself to be as effective as folpet at managing disease, but with the added advantage of being a biostimulant.

So by increasing nutrient-use efficiency and increasing chlorophyll — which makes crops greener and boosts photosynthesis — that's added value at a cost which isn't budget busting, he says. ■

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.

Unium's view is that optimising genetics and chemistry are essential but to produce healthy crop plants, strategies should include judicious use of balanced nutrition and biostimulants.Scyon is backed by over 10 years of trials experience and provides a robust and reliable support for crop health which can take some of the pressure off genetics and fungicides.