

# Science sorts the magic from the mystery

“We’re getting right back to the basic science to understand the fundamentals here.”

## Technical Agri-Intelligence update

With dozens of new bio-solutions appearing on the market every year, how do growers evaluate which offer a credible return? *CPM* joins Agrii for a deep delve into the science behind them.

By Tom Allen-Stevens

Think of Brazil, and maybe you think of Copacabana beach, Rio’s famous Carnival, or Sugarloaf Mountain. Agrii’s head of technical Clare Bend, however, pulls up pictures of the team and facilities of a laboratory exploring an interesting development in plant science.

“They’re looking specifically at anti-oxidant levels,” she explains. “It really is fascinating and quite unique research, and the work they’re doing opens your eyes to the science behind biostimulants.”

The lab is operated by Fortgreen, a company in which a controlling interest was acquired by Origin Enterprises, Agrii’s parent company, two years ago. It’s one of a number of R&D resources Agrii now draws on in its quest to evaluate the potential for bio-solutions.

“Every Tom, Dick and Harry is pitching into the market with their product and making wild claims. Our approach is that we want real evidence of a positive benefit and we want to be reassured about the chemistry,” continues Clare.

“We’re getting right back to the basic science to understand the fundamentals here, but it’s not science for science’s sake. As growers come to rely less on conventional crop inputs, we believe crop production programmes will increasingly be bolstered by bio-solutions. But expectations of these products are currently unrealistic — if you evaluate them under the same criteria as conventional chemistry, that’s setting the bar too high.”

### What works

So Agrii has adopted a “what works” approach that starts with a lab-based screening system, to refine priorities for field trials. The company’s working with universities, such as Imperial College and University College Dublin (UCD), as well as R&D facilities offered through its sister companies. This brings a deep delve into plant functions and how they interact with novel as well as established bio-solutions, which informs how they are evaluated in the field.

Agrii has already amassed a vast wealth of data, having researched these products for 20+ years, and Clare’s pulled out for *CPM* some of the highlights of tests and trials conducted on three key groups of these bio-solutions:

- **Endophytes** – a new appearance on the UK market and relatively little is known about them.
- **Elicitors** – some products have been around for some time, and a number of organisations, such as James Hutton Institute, have researched them.

- **Biostimulants** – fairly established in the UK market with the number of products and pathways growing every year. Agrii’s approach with bio-solutions builds on its traditional field trials, she explains.

We aim to start with laboratory screening to establish positive effects — at the last count we’ve taken 130 biostimulants through field trials, for example, which represents a massive investment. We have to be sure there’s something in a product before it’s taken into trials.”

Ideally the close scrutiny also allows the R&D team to truly understand the mechanism employed by the bio-solution (see panel on p27), and this comes back to the need, she notes. “Knowing when to use these products is really important.”



Clare Bend is searching for real evidence of a positive benefit from bio-solutions and wants to be reassured about the chemistry.

## Biostimulants on the UK market

	Product type	Description (and examples)
<b>Non-microbial</b>	Seaweed extract	Extracted from seaweed (Rooter, GA142, P and K)
	Humic substances (eg humic or fulvic acids)	Extracted from decayed plant or animal material (Mensa and Human products, Mitra)
	Phosphites and other inorganic compounds	Phosphites have the most evidence behind them, which also includes bicarbonates, phosphates, silicates and chlorides. (Nutri-Phite PGA*, Phyte P Plus)
	Chitin and chitosan derivatives	Chitin is a natural polysaccharide obtained from crustaceans. Chitosan is derived from chitin.
	Anti-transpirants (eg abscisic acid and waxes)	Products which reduce transpiration by plants (Desikote)
	Protein hydrolysates and free amino acids	Most protein hydrolysates used in agriculture are produced from plant residues. Free amino acids are obtained by the enzymatic breakdown of agro-industrial by-products. (Zonda, Bridgeway, Naturamin)
	Complex organic materials	Broad range of products (Atonik, nitrophenols)
<b>Microbial</b>	Non-essential chemical elements	Broad range of elements that are not essential nutrients but can promote plant growth. (Titanit; Biosilicate)
	Plant growth-promoting bacteria	Bacteria that potentially benefit plant growth ( <i>Bacillus/Rhizobia</i> spp)
	Non-pathogenic fungi	Wide range of fungal spp that have no direct pathogenic effects on plants ( <i>Trichoderma</i> )
	Arbuscular mycorrhizal	Common type of endomycorrhizal fungus that forms a symbiotic association with plant roots ( <i>Rhizophagus irregularis</i> )
	Protozoa/nematodes	

\* Nutri-Phite PGA also contains amino acids

Often the need comes from replacing a loss of chemistry, but it's not a simple substitution."

So a key requirement is to measure the

indicators of activity a bio-solution has.

"That may be a direct effect, such as activity on a disease, or it can be indirect, such as thickening of cell walls or stress



The Fortgreen lab in Brazil is one of a number of R&D resources Agrii now draws on in its quest to evaluate the potential for bio-solutions.

mitigation. If we can understand these mechanisms and ideally measure them, we can understand what they're doing in the field."

Clare's insight into endophytes comes through Origin's involvement with the CONSUS project. This is a €17.6M five-year collaborative research partnership with University College Dublin (UCD), supported through the Science Foundation Ireland (SFI) Strategic Partnership Programme. It aims for crop optimisation through sensing, understanding and visualisation using digital, precision agriculture and crop science.

"One of its six work packages is investigating the role of bio-solutions," explains Clare. "Researchers have isolated endophytes from wild wheat relatives growing in a diverse range of sites and subject to biotic and abiotic stress conditions. Hundreds of organisms have been extracted and DNA-profiled and then ▶

## What do bio-solutions do?

Bio-solutions also include bio-fungicides and bio-pesticides, bio-adjuvants and water conditions. The ones detailed here have distinct interactions with the crop plant itself.

### Endophytes

These are bacteria or fungi that live within a plant without causing apparent disease. Endophytes may enhance host growth, nutrient uptake and improve the plant's ability to tolerate abiotic stresses such as drought. They can also decrease biotic stresses by enhancing plant resistance to pests and pathogens.

### Elicitors

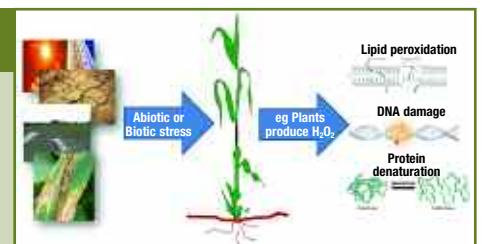
These extrinsic or foreign molecules are often associated with plant pests and diseases. They attach to special receptor proteins located on a plant cell and trigger intracellular defence

signalling. This induces (elicits) a plant's own defence mechanisms, a process known as systemic acquired resistance, which works in a similar way to a vaccine. The result can be reduced damage and increased resistance to pest, disease or environmental stress, but there are questions over whether this comes at a cost in terms of energy needed to acquire resistance.

### Biostimulants

The European Biostimulants Industry Council (EBIC) defines these as "a material that contains substance(s) and/or microorganisms whose function, when applied to plants or their rhizosphere, is to stimulate natural processes to benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, and/or crop quality, independent of its nutrient content".

When crops are under stress they produce



When crops are under stress they produce damaging, reactive, oxidative free radicals.

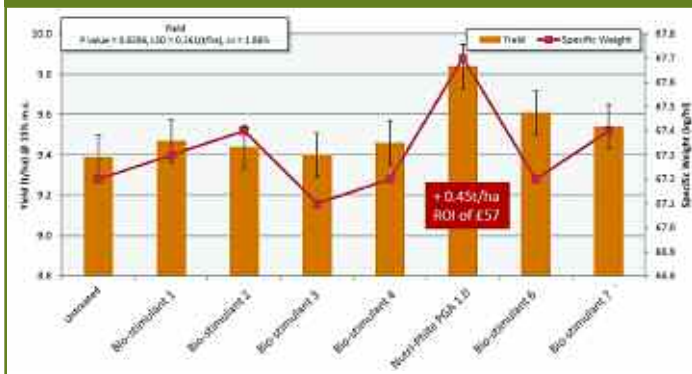
reactive, oxidative free radicals, such as hydrogen peroxide. These can cause damage to plant tissue, ranging from breaking down lipids to protein denaturation, right down to damaging the DNA itself. A crop can use enzymes such as hydrogen peroxidase, carotenoids or chlorophylls a or b, to break down these harmful free radicals into benign molecules. Biostimulants, and particularly amino acids, can encourage this process which can be measured in the lab.

## The effect of Iodus in a T0 fungicide trial, 2018



Source: Agrii, 2018 and 2020; Vareon contains prochloraz+ proquinazid+ tebuconazole.

## Performance of biostimulants on winter wheat, 2018



Source: Agrii, Langley, Berks, 2018.

► put into laboratory and glasshouse trials to assess what they do. The team also has access to an x-ray CT scanner to measure biostimulant effects on rooting.”

What’s building up is a library of bacterial and fungal endophytes. “Many remain a complete mystery — 37% of the fungal endophytes couldn’t even be classified into known species groups, for example.

“But many of the bacterial isolates tested show control of take all or fusarium. A number demonstrate strong inhibition of both *Fusarium graminearum* and *Gaeumannomyces graminis*. Some of the fungal endophytes have also shown positive control of take all.” Agrii field trials on some of the more promising finds start this autumn.

When it comes to elicitors, Agrii has been looking at one in particular — Iodus, a product registered as a fungicide by UPL that contains laminarin, a polysaccharide of glucose

found in brown algae.

“Iodus has a label recommendation for the control of *Septoria tritici* and powdery mildew in wheat, while some barley diseases are set to be added,” says Clare. “It increases cell wall lignification through protein and phytoalexin production, which stops the movement and progress of pathogens. What’s interesting about it is that you can apply it up to the end of GS30, which is when most fungicide use starts, and it has annex 1 listing until 2033, so it has a long life span.”

A trial in 2018 showed Iodus performed as well as chlorothalonil (CTL) in a T0 fungicide trial (see chart above).

Although we had some conflicting results, it’s clearly doing something, which warrants a closer look at how best to use it. With the loss of CTL, we’re scratching around for anything that’ll take the pressure off conventional

## The effect of Curative on winter OSR, 2020



chemistry,” she notes.

Agrii’s work with biostimulants is where the input from labs, such as the one in Brazil, pays off. “It’s really helped us narrow down those we select for field trials. Even then, of the 130 we’ve trialled to date, only around 30 have properties we believe are useful.”

One of the techniques developed by the lab is to extract out and measure levels of chlorophyll b, a key anti-oxidant produced by plants to combat the damaging effects of stress, she explains. “The various biostimulants available differ considerably in their ability to help a plant generate this enzyme.”

## Track record

Clare picks out a few, some tried and tested while others are new, that have delivered results both in the lab and the field — all are plant-based and Agrii avoids any animal-based biostimulants, she notes. “The humic acid range (see table on p27) is an example of a group of products with a proven track record that’s backed up by the science for a number of products we’ve tested.

“They enhance levels of chlorophyll, offering improved plant metabolism and resilience against drought, returning about £2-3 for every £1 invested.” To put this into context, nitrogen fertiliser delivers £9.54, fungicides £3.78 and micro nutrition £2.88 for every £1 spent with wheat at £180/t, she adds.

Nutri-Phite PGA is an

example of another “tried and tested” product that stands up to scientific scrutiny, says Clare. “It combines amino acids with a stabilised phosphite fertiliser supplement and has the effect of improving plant health, vigour, and uptake of nutrition at emergence as well as enhanced maturation. This reduces phytotoxicity and makes the plant more resilient to disease.

“The big test for these products came in the drought conditions of 2018 — if there was any situation that should show a return for biostimulants it was that long, hot summer. Yet in our field evaluation of eight products, Nutri-Phite PGA was the only one that gave a statistically significant benefit.” (see chart above).

A new product for 2021 is Curative, another stabilised phosphite with a number of key nutrients found to induce peroxidase production, resulting in increased cell wall thickness. “A trial on winter oilseed rape in 2019/20 showed treating with Curative at two autumn timings improved the crop’s resistance to light leaf spot, although the yield benefit wasn’t statistically significant (see chart above). With tebuconazole under threat, it could be a useful alternative,” notes Clare.

Tytanit is another recent introduction that’s going through the Agrii programme. Containing titanium, along with magnesium and sulphur, research literature suggests it increases chlorophyll content and stimulates nitrate reductase

activity, she says.

"We've included it with some other products in two years of trials aimed at investigating whether we can use it to bolster a weak fungicide programme to the same level as one of today's stronger chemical-based strategies. The conclusion is that you can't — it doesn't currently perform to the level of SDHIs. But you can get a significant uplift in yield of 0.2-0.3t/ha, which can help claw back yield as the efficacy of fungicide chemistry wanes."

And finally Zonda. Clare notes that trials and grower experiences have brought mixed results, and the Agrii trials are no different. "But we have found positions in management programmes that deliver a reliable result," she reveals.

"In winter and spring barley, the dilemma is whether to apply a late ethephon-based PGR, such as Cerone. An application in hot, stressful conditions may result in a yield penalty, but without it, you can suffer terrible brackling if hot, dry conditions are followed by a wet spell. We've found including Zonda helps further reduce crop height with no yield penalty even in adverse conditions."

## Agri-Intelligence update

Through the country's most extensive agronomy research and development network, Agrii is focussed on delivering the extra value growers need in a fast-changing and increasingly challenging crop production world; value which keeps them firmly ahead in a future where overall cropping sustainability is at least as important as individual crop performance.

Following on from the series of articles developed from 2013, the company's R&D team have provided *CPM* with exclusive insights into findings from some of today's most practical crop improvement work.

This includes taking advantage of the best available variety intelligence; tailoring nutrition for winter and spring crops; employing new technologies and approaches to sustainable agronomy; and making the most of modern spring cropping.

We hope you find these insights valuable in helping you optimise your production costs; minimise your risk; take advantage of your best new opportunities; maximise your performance; simplify your management; and, above all, secure a more sustainable farming future.

Clare believes the secret to getting the best out of these products is having the right product in the right situation. Often the best way to establish this is through growers performing their own on-farm trials, although she cautions these should be carried out to a level of scientific robustness that will bring a reliable, repeatable result.

"If I had a farm, I'd bring bio-solutions into my programmes and explore where to put them. The difficulty is that there's so much coming on the market that has not been properly evaluated. That's why we're putting in the fundamental lab work, alongside the field trials, to drill down through what's available to find the real gems and the situations they bring a credible return," she concludes. ■



One of the techniques developed by the Fortgreen lab is to extract out and measure levels of chlorophyll b, a key anti-oxidant produced by plants.



**Zypar<sup>®</sup>**  
Arylex<sup>™</sup> active  
HERBICIDE

Keep in the know  
@CortevaUK  
#CortevaUK

Zypar<sup>®</sup> controls broad-leaved weeds in winter and spring cereals.

Combining the remarkable Arylex<sup>™</sup> active and trusted Florasulam, it sets the new benchmark in cereal weed control. The power of Zypar<sup>®</sup> working whatever the weed growth or the weather.

So if you can get on, Zypar<sup>®</sup> lets you get on, allowing you complete flexibility.

Always keep your cereals in great shape, talk to your advisor or find out more at [corteva.co.uk](http://corteva.co.uk)



Discover more at [corteva.co.uk](http://corteva.co.uk)  
Technical Hotline: 0800 689 8899 E-mail: [ukhotline@corteva.com](mailto:ukhotline@corteva.com)

USE PLANT PROTECTION PRODUCTS SAFELY. Always read the label and product literature before use. For further information including warning phrases and symbols refer to label.  
Corteva Agriscience, 6931 Capital Park, Potters Bar, Herts, SG9 6ND, UK. Tel: 01438 413273  
\* Trade names of DuPont, Dow Agrosciences or Bayer and their affiliated companies or their respective owners.  
Zypar<sup>®</sup> contains florasulam-methyl (Arylex<sup>™</sup> active) and florasulam.

CORTEVA  
agriscience