Clarity on biostimulant effect

> *A significant helper to the plant's own natural defences.*

Technical Research Briefing

New research is shedding light on how exactly *Ascophyllum* seaweed products are affecting natural plant processes so that the potential of these biostimulants can be unlocked in modern crop production systems. *CPM* reviews the results.

By Lucy de la Pasture

Seaweed products aren't something new, they've been applied to crops for millennia because of their well-known beneficial effects. In the modern era of farming, seaweeds have been lumped into the category of biostimulants which is just 'muck and mystery' to many growers. That's all changing as research begins to identify the specific effects these products can have.

One of the big problems with farmer acceptance of the biostimulants concept at present is a fundamental lack of understanding about what they actually are, believes Charlie Bannister, technical manager for crop nutrition at FMC.

"There's some really good science attached to the concept of biostimulation now, and we've just carried out a large study on our *Ascophyllum* seaweed products, but before we can review the results it's necessary to define what biostimulants are. We're hamstrung by the lack of clarity on this," he says.

Since the EU adopted the European Fertilising Products Regulation (EFPR) last year, which will unify regulation on biostimulant products across Europe, there's been some debate on the precise definition of a biostimulant.

Natural processes

"Unfortunately the definition I liked is, it appears to me, being side-lined. This was proposed by Prof Patrick Du Jardin, in concert with the European Biostimulant Industry Council, and said 'Plant biostimulants contain substance(s) and/or micro-organisms whose function when applied to plants or the rhizosphere is to stimulate natural processes to enhance/benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, and crop quality.'

"The new wording and phrases being suggested takes the very succinct definition that Du Jardin proposed and is being usurped by a more complex form of words which does nothing to enhance understanding," he says.

Charlie believes it's the words 'abiotic stress' that set biostimulants apart from pesticides or bio-pesticides. "Pesticides and biopesticides (the latter is a pesticide or compound with pesticide properties produced from a biological starting point) control biotic stress, which comes from a living entity like weeds, insects or diseases.

"Biostimulants, on the other hand, reduce the effects of abiotic stress, which is caused by non-living factors like drought, high levels of sunshine or freezing conditions. In terms of crop loss, abiotic stress potentially causes more damage than biotic stress," he says.

The definition is important because at the moment there are grey areas, believes Charlie. "Some organisations lump biopesticides and biostimulants under the banner of biologicals, which clouds clear understanding. If we're going to get across the message about the benefits of biostimulant use, we need clarity of definition before we talk about the good science."

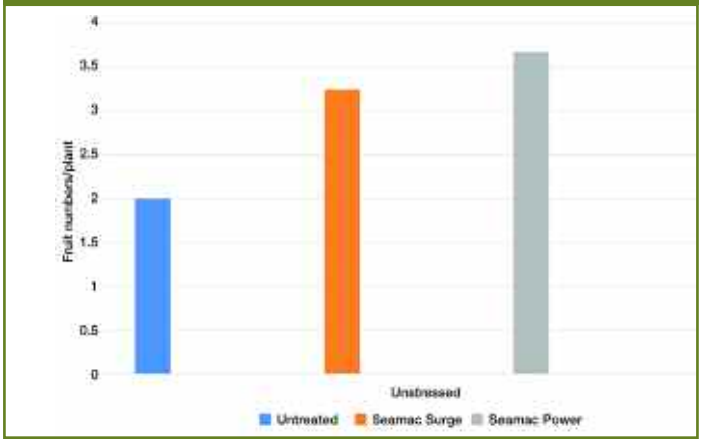
Having clarified the true meaning of biostimulants, Charlie describes some of the research FMC has carried out to quantify the effects of its Ascophyllum-based biostimulants products on abiotic stress.

"We set up a very detailed study to see how two of our biostimulant products worked in the plant. The products are based on straight *Ascophyllum*, which is a seaweed species common on the Atlantic coast of Northern Europe, with no added nutrition.

"There's already a good amount of work in

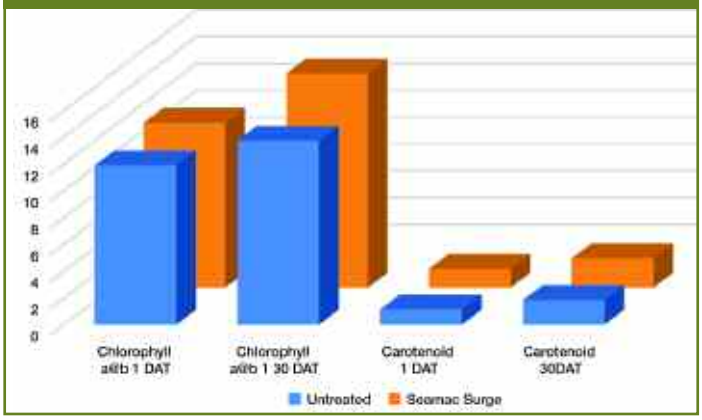
Results of a new study show that applying an Ascophyllum *biostimulant causes the expression of genes that involves the production of defensive compounds in the plants, explains Charlie Bannister.*

Effect of *Ascophyllum* application on fruit number



Source: FMC work at Shannon Applied Biotechnology Centre, 2020.

Effect of *Ascophyllum* application on photosynthetic pigments



Source: FMC work at Shannon Applied Biotechnology Centre, 2020.

the public domain on the effects of *Ascophyllum* on reducing various forms of abiotic stress, and also some on enhancing nutrient uptake and efficiency, but we thought it was important to have our own information to get a clearer understanding of the mechanisms and effects involved," he explains.

The new study builds on previous FMC biostimulant work carried out by Shannon Applied Biotechnology Centre (SABC) at the Institute of Technology, situated in Tralee, Ireland. The idea was to establish general first principles rather than look at trials in broadacre arable crops, explains Charlie.

"Dr Shane O'Connell at SABC has worked closely with *Ascophyllum* and has methodologies to establish its effects on treated plants. He's well respected in his field and has published a number of peer-reviewed scientific papers on *Ascophyllum*, presenting his work at global conferences on biostimulants."

Shane was tasked with applying two seaweed products to tomato plants and assessing changes in habit, genetic response, chlorophyll levels or nutrient levels. Tomatoes were chosen because of the ease of work and experience of using the plant in the past.

"In the study some *Ascophyllum*-treated plants were subjected to significant levels of abiotic stress in comparison with treated plants under no stress and control plants (nothing applied). Measurements were taken of responses at both the genetic level and ▸

Understanding how the biochemical mechanisms within the plant are affected by biostimulant products has to be carried out using pot experiments.

Putting research into practice

The result of the work at Tralee is causing Charlie to question his own understanding and thinking about biostimulants. "There's plenty of information, our own and more widely in the public domain, about the beneficial effects of biostimulants against abiotic stress. What I'm questioning is the general perception of abiotic stress itself.

"Because biostimulants are largely prophylactic in nature — generally the plant has to be primed before the event. The problem is predicting the event," he says.

"Chronic or severe abiotic stress, be it drought or excess rainfall as we experienced in February 2020, is obvious to most people. Far less obvious is what I would call low-level or hidden abiotic stress.

"My view is that this low-level stress is a constant and there's never a time when everything is in perfect harmony for the plant to thrive. In some respects that's why plants have developed systems to deal with this permanent imbalance. So somewhere along the line between hidden stress and the severe obvious stress that hits you in the eye is where biostimulants fit in," he comments.

Somewhere along the line between hidden abiotic stress and obvious stress is where biostimulants fit in.

In Charlie's opinion it means looking for benefits from biostimulants in severe long-term stress situation is probably asking the wrong question.

"Viewing biostimulants as a significant helper to the plant's own natural defences would fully explain why we got such significant results with our treated but non-stressed plants," he adds.

Chris Johnson, FMC's global lead in crop nutrition also believes that amount of abiotic stress is constantly under is probably underestimated and describes abiotic stress as a natural and on-going factor in the environment.

"Abiotic stress can too easily be seen as some definite and clearly perceived event in the crop's growth timeline. In fact, to a greater or lesser extent, the crop is 'fighting' aspects of abiotic stress at every point in its life cycle.

"That's why, for example, the growers in places such as California regard the use of biostimulants as a necessity, rate than as a specific intervention."

Chris also points to the effect climate change is already having on the growth cycle of crops and emphasises that it's something that will need to be factored in to crop production systems.

"In the climate situation we're currently experiencing, weather patterns are far from conducive to regular seasonal growth. So Charlie's point that a biostimulant could be viewed as more of a helper to the plant's own natural defences has an even greater resonance," he says. "Climate change also makes predictive modelling, which some look to in order to effect timely interventions (as the application must be in advance), rather more tricky."

The great scientist Albert Einstein once said. "The more I learn, the more I realise how much I don't know." It's a sentiment Chris empathises with as he's starting to question whether the whole approach to crop nutrition is wrong.

"We should be utilising tech to a far greater degree. All aspects of it, using the tech and analysis techniques that are now increasingly available — GPS, NIR spectroscopy, other remote monitoring methods (such as drones) and make baseline applications of key nutrients and biostimulants — coupled to specific applications in key geographies/field spaces."

While all crops could potentially benefit from strategic use of biostimulants, Charlie believes that in the UK typically vegetable crops, potatoes, sugar beet and pulses are the most likely targets, but not exclusively.

Chris Johnson says the crop is 'fighting' aspects of abiotic stress at every point in its life cycle.

"We had a very good trial on spring barley carried out by an independent company in Scotland under their auspices last season. Application of the FMC *Ascophyllum* programme resulted in some significant benefits.

"In the past we've had positive results on potatoes in the UK, vegetables in trials in Hungary and on tomatoes, potatoes and grapes in the United States."

While biostimulants can be a useful resource for growers, Charlie emphasises that they're not a complete answer to the problems a crop may encounter during its life. "Growing crops needs to have an holistic approach to be successful and there are just so many influencing factors that need to be considered. There is no silver bullet and while biostimulants have a part to play, they're only one of many tools in an integrated approach."

▸ physical level.

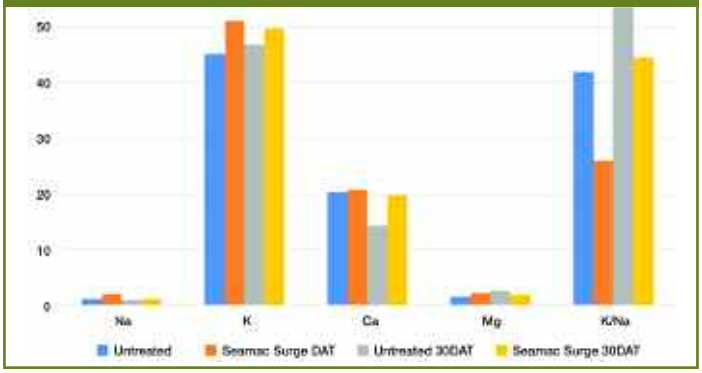
"While we fully expected to see benefits in the stressed plants, what actually struck me were the benefits we got in the unstressed but sprayed plants over the untreated plants," comments Charlie.

The beneficial changes in the unstressed plants included — more flowers per plant, up to one month after application; more vigorous growth; an increase in biomass in plants at 144 days old; statistically significant increases in levels of chlorophyll A and B one month after treatment; and statistically significant increase in carotenoid levels one month after treatment.

"The work also found a statistically significant increase in levels of sodium, potassium and magnesium compared with the untreated control and a trend for increased calcium levels at 24 hours after spraying. Some of these increases were still evident one month after spraying and very notable was the increase in calcium levels at the later timing," he explains.

At the genetic level, changes were noted in the expression of a large number of genes in both stressed and non-stressed

Effect of *Ascophyllum* application on nutrient uptake



Source: FMC work at Shannon Applied Biotechnology Centre, 2020.

plants, explains Charlie.

"Of particular interest was the expression of genes that involve the production of defensive compounds in the plants. Genes that encoded for the production of phytoalexins (plant compounds involved in reducing the effects of stress) and for the production of lignin (involved in cell wall strength and the ability to reduce external stress) were expressed, which gives a strong indication of how *Ascophyllum* works as a biostimulant to benefit overall plant health."

One of criticisms frequently levelled is that research on biostimulants is often carried out using pot experiments rather than field trials, but Charlie explains the reasons why this is.

"As far as pot trials are concerned, I'm a great advocate for this method rather than field trials for biostimulants. I've been closely involved with a lot of successful field trials over the years and been a great supporter of them, but always on pesticides where it's relatively easy to obtain results. For example, when assessing weed control — dead or not dead is a binary issue and not many factors can therefore impact on the assessed result.

"In my view it's completely different when you're dealing with the influence of a biostimulant. This is especially the case now, when we're trying to demonstrate some detailed and, at times, complex science behind the activity of the biostimulants within the plant where a controlled environment is essential.

"I'm fully confident that what we see in the pot trials — the basic mechanism of activity — will be replicated in the field but the effects may well be masked by other factors, so we need the detailed laboratory work," he comments. ■

Research Briefing

To help growers get the best out of technology used in the field, manufacturers continue to invest in R&D at every level, from the lab to extensive field trials. *CPM* Research Briefings provide not only the findings of recent research, but also an insight into the technology, to ensure a full understanding of how to optimise its use.

CPM would like to thank FMC for sponsoring this Research Briefing and for providing privileged access to staff and material used to help bring it together.

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