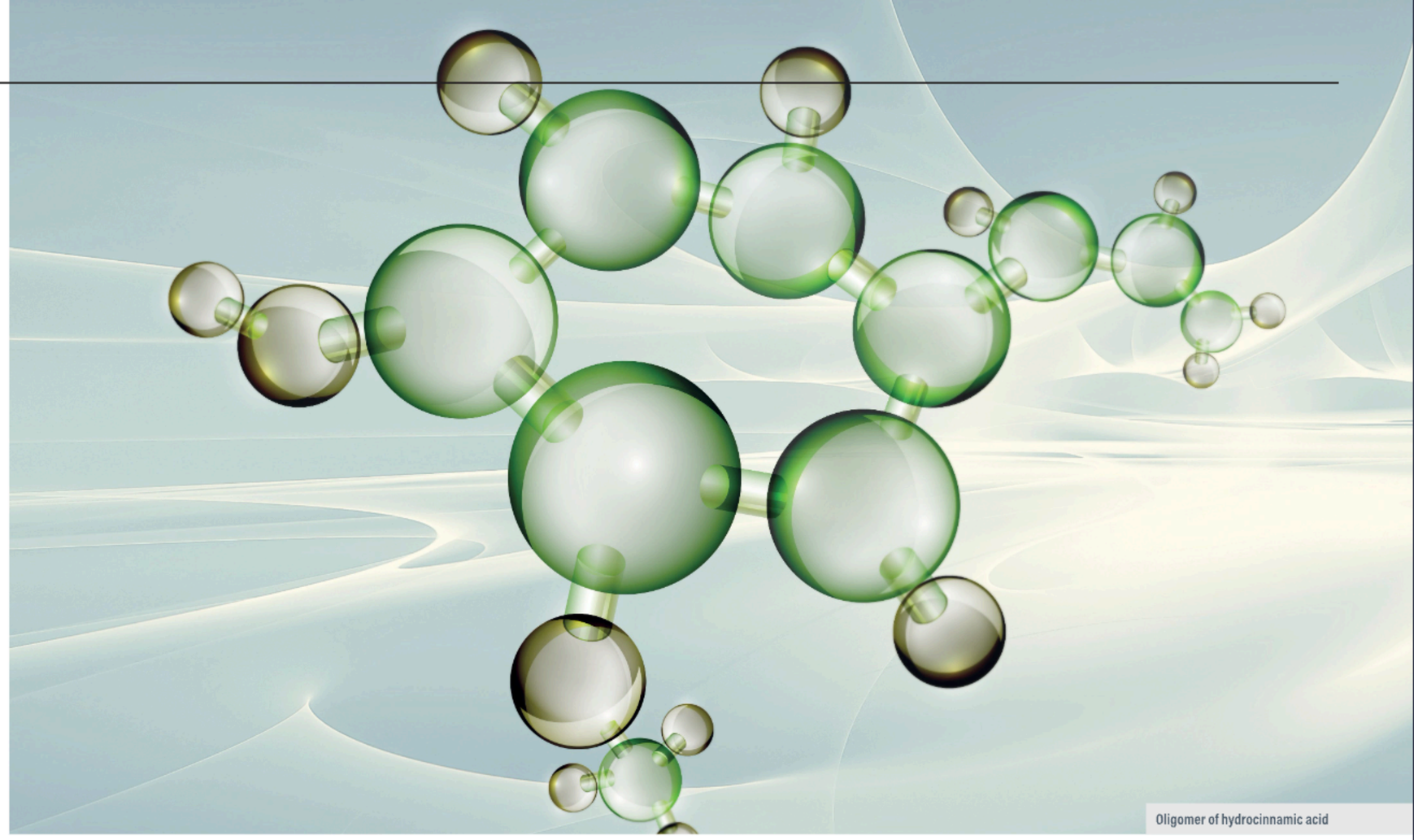
Crop problem? Turn to Mother Nature...

Fyteko has developed the first 'agri-biomolecule' based on a natural defence process, says **Adrian Bell** of **Agro Mavens**



Oligomer of hydrocinnamic acid

Agriculture often stands accused of being behind the curve when it comes to modernisation and adopting new practices. A 2015 report from McKinsey named it the world's least digitised industry, using 70% of the world's fresh water and contributing up to a quarter of global greenhouse gas emissions.

That said, we need to eat and, as the invasion of Ukraine has shown, this industry is highly susceptible to jitters and price shocks when supply is threatened. Now imagine a future where most of the world's crop-producing countries are also at risk. Agricultural climate scientists see climate change as one of the biggest threats facing agriculture in the next 50 years.

"Truth is, we don't know how serious climate change will be for agriculture. What we do know is that it's not going to be a walk in the park and growing crops is going to become more difficult," says Guillaume Wegria. Wegria co-founded sustainable agriculture company Fyteko with Dr Juan Carlos Cabrera in 2014, specifically to provide the answer to one question: what would nature do?

"Agriculture is in transition. It's abundantly clear that we need to move towards a lower-input, more sustainable model that delivers on the dual fronts of productivity and environmental performance. Such a philosophy will not only help us mitigate the effects of climate change, but we can also deal with resource-use efficiency for water and nitrogen, as well as addressing the loss of biodiversity attributed to intensive agriculture."

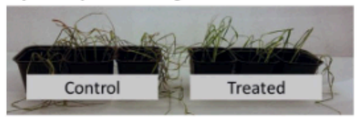
Don't stress it

Wegria's stated aim is to help forge a bio-based input economy for agriculture, using original research to identify and emulate solutions that already exist in nature.

Some scientists suggest that climate change may benefit agriculture. Warmer temperatures might extend growing seasons and expand the cultivation range for certain crops, while higher concentrations of CO_2 could improve the efficiency of photosynthesis.

Equally, climate change might shrink the world's available croplands, as more extreme weather events, new weather patterns and shifting seasons make cultivation less predictable and more challenging.

After 7 days under drought stress



One day after re-watering

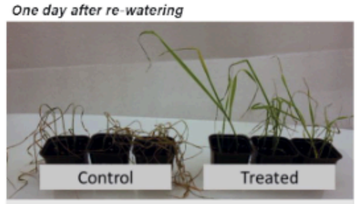


Figure 1 – Enhanced tolerance to a simulated drought stress of wheat plants growing from seed treated with signal molecule developed by Fyteko

"We're most concerned about the propensity for greater occurrence of drought events," Wegria explains. "Crops in parts of the world already struggle – and even fail – owing to inadequate rainfall and high temperatures. If this becomes the norm, we face a monumental challenge to global food security."

Such incidences of abiotic stress, as it is called, are not new, he observes. Plants have evolved to survive. Fyteko decided to go back to square one and discover how nature itself deals with these events.

"It's an unconventional approach," says Wegria. "For decades, the routine has been laboratory-led: to identify a suitable synthetic chemical that delivers the required outcome. But by going back to nature, we believe we can find safer, smarter and more sustainable solutions that will keep agriculture productive in a changing world."

Mother Nature, Fyteko found, had the answer all along: hydrocinnamic acid oligomers, which are a class of workaday plant compounds that make up part of the plant's cell wall structure. Cell walls surround all plant cells, providing structural integrity, water regulation and physical protection against damage and pathogenic attack. During periods of abiotic stress, the cell wall is one of the first plant organs to be affected.

Follow the signal

The structural function of hydrocinnamic acid oligomers was already well known, but Wegria and Cabrera discovered they harboured a hitherto unknown property: the ability to act as a 'signal' molecule within the plant.

Fyteko perfected and patented the biocatalytic modification of hydroxycinnamic acids, yielding what appeared to be a powerful crop biostimulant and potentially the first member in a new class of 'agri-biomolecules'. Further research revealed the true purpose of this molecule.

"When applied to an otherwise healthy crop – any of the common row crops, such as wheat or maize or soybeans, for example – it appears to 'prime' the plant against abiotic stresses, preparing it to 'fight' against drought, flood, high temperatures and so on," says Wegria. "You can essentially think of the signal molecule as firing up the plant's own defence systems to deliver better protection and speedier recovery."

In early trials across Europe, Africa and the Americas, the biomolecule demonstrated an average yield increase of more than 10%. Research has shown that plants respond to it when it is applied either in foliar form, or as a seed treatment.

Even in the absence of stress events, yield increases of up to 8% have been observed. Wegria believes that this

points to the existence of 'sub-clinical', asymptomatic stress in many crops, which until now has largely gone unnoticed.

"We'll need further research to prove it, but hidden stress might well be one of the barriers of the wheat yield plateau. Modern wheat varieties should be able to deliver 20 tonnes/hectare. Is asymptomatic stress another of the limiting factors?"

Seed treatment

In trials with wheat plants, the Fyteko biomolecule was applied as a seed treatment. The objective was to increase plants' resistance to lack of water (drought stress) and to improve the recovery rate once water became available again.

The results (Figure 1) show how a simulated severe drought stress has irreversibly injured the tissue of the untreated plants. Those growing from treated seed, however, showed an improved rate of recovery. Wegria says that these results suggest the bioactive could have a role to play in improving crop resilience in the face of episodic drought or prolonged irrigation intervals.

"It's the seed treatment that perhaps presents the most interest," Wegria highlights. "It appears to be effective in accelerating germination and early seedling establishment, 'biopriming' the crop seeds. Successful early establishment is known to be essential for optimising the crop's yield potential, but the signal molecule appears to take this a step further, offering additional protection against subsequent abiotic stress."

In experiments where plant seeds were treated with the signal molecule, it triggered a faster response to stress from young plants' internal defence mechanisms. Osmo-protection increased, as did antioxidant synthesis.

Fyteko has now signed a distribution deal signed with Sumi Agro, a European subsidiary of Sumitomo Corporation; an exclusive global evaluation with Janssen PMP, a division of Janssen Pharmaceutica; and a wide-scale distribution agreement with Technisem, an African seed supplier, to roll out the product to smallholders in West Africa.

Wegria – Going back to nature to find the properties required

As to how the process actually works, Wegria says that Fyteko's approach of working with single molecules makes identification of modes of action (MoAs) very much easier.

"Biostimulants are the fastest-growing category in plant protection worldwide, but the vast majority of commercial biostimulants are a cocktail of actives and different molecules," he notes. "This can create problems in a like-for-like comparison against conventional agrochemicals because the multi-compound formulation makes it difficult to generate consistent results for analysis and refinement."

A new stimulus

Fyteko claims to be the only company working to develop biostimulants from novel natural signal molecules and one of very few to be developing them based on single, identifiable active ingredients with a specific effect on the crop.

This specific effect is down to a very simple MoA. When applied to seeds, the signal molecule is absorbed by cells. Here, it effects a change in gene transcription – prompting a 'remapping' of metabolic processes, pathways and cell functions.

"You can think of it as swapping the ECU chip in a car or tractor," explains Wegria. "We're reprogramming the plant, supercharging its ability to fight stress."

Another problem with multi-compound biostimulants is knowing how well they will integrate with other products, biobased or conventional. "Something that looks good in the lab may perform very badly in the field, because you must understand all the other interactions.

"But our biomolecule is a single compound, applied at low rates. We know how it's going to behave, and we've already assessed its performance when used in existing seed treatment processes – it displays excellent compatibility."

This precise understanding has allowed Fyteko to make rapid progress on commercialising the biomolecule, with two specific formulations: the foliar formulation Nurspray and the seed treatment product Nurseed. Both products have received registrations in most of the EU27 and across the US, allowing further development work to progress.

"These will be just the first," says Wegria. "Our development pipeline is interesting, to say the least – and entirely biological. The agri-biomolecule is a brave new world, and it's the world we need to see in tomorrow's agriculture." ●

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