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A robust biological level

“Our focus has been to create effective soil biology that the farmer can't break.”

Innovation Insight

Consistent performance from consortia of bacteria has been the aim for a range of soil-acting products from Biolevel. CPM tracks its progress.

By Tom Allen-Stevens

It's all very well to put the soil first and encourage good biology. But it can be difficult to know whether what you're doing is helping it thrive or condemning it to die.

This is all the more important when it comes to biology you can apply — the microbes may have amazing capabilities, but how can you be sure they haven't withered soon after, or sometimes even before, they land in your field?

This is the innovation Biolevel claims to have brought to the market. “Our focus has been to create effective soil biology that the farmer can't break,” says co-founder Laurence Berman. “We want static inputs that become active in the soil — so a formulation that preserves the microbes, gives the product shelf life and is flexible in terms of how you apply them. But they must be robust and thrive in a typical farming system.”

The story starts with Glenside Group, a supply business born out of organic farming. It was founded in 1982 and started importing seaweed products. Ian Robertson, the son of the founder, joined the business in 2000 and could see that mindful farmers — those looking for a more balanced approach that reduced dependence on synthetic inputs — weren't just the organic ones.

“This was most prevalent in the fresh

produce sector, where they were facing severe restrictions on chemical use,” says Ian. “But the mindset for productive agriculture revolved around chemistry and physics, ignoring biology. What's more, there was interest in non-synthetic sources of nitrate, but there was also potential for phosphate, potash and other nutrients.”

Ian's approach revolves around releasing these from the soil. “We tend to view the soil as a small fridge with readily available nutrients that must be topped up regularly. It's actually more like a massive deep freezer, with loads of nutrients that aren't readily accessed.”

Consortium working together

So he set about formulating a biological product you could apply to the soil that would open up this reserve, working with a leading UK microbiologist and his team. “We knew the microbes we wanted — bacteria that must be N-fixing, P-mobilising and K-releasing. It's not just a single strain, but a consortium that works together,” continues Ian.

“And the crucial requirement, probably the hardest to overcome, was a product that didn't come with a whole string of caveats for what you shouldn't do with it. It had to be stable, robust, easy to apply with a good shelf life.”

This was brought together with PhosN, a concentrated culture of microorganisms designed to solubilise phosphate reserves in the soil and increase nitrogen fixation in the rhizosphere. Enzymes produced by the consortium of bacteria disassociate P from ions to which they're tightly bound, such as aluminium, calcium and iron.

During this process, a hydrogen ion is attached to the P, resulting in a form of P the plant roots can take up. The consortium includes nitrogen-fixing bacteria that convert

atmospheric nitrogen to plant-available ammonia. Although ubiquitous in soils, it's thought their activity is suppressed by applications of synthetic N. Applying the right bacteria close to the roots of crop plants can enhance this.

Although PhosN was a success, Ian was focused more on the advice side of Glenside, setting up Sustainable Soil Management in 2010. “What the product needed was layer two of the innovation — getting it into a variety of formulations, suitable for a range of crops for use in different climates, and with trials and scientific data that backed up the benefits of what we were seeing in the field,” he says.

This is where Biolevel comes in, a company co-founded by Laurence Berman and Lutz Glandorf. Lutz was keen to delve into the science. “It's what I call peeling the onion — not only looking at whether there's a yield increase, but also looking at the detail and measuring whether it squares up with assumptions and expectations about how the microbes work,” he says.

Working with Wageningen University in the Netherlands, and a number of other research partners in the UK and US, Biolevel



Ian Robertson could see that mindful farmers weren't just the organic ones.



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set about "peeling back the layers" on the biological activity. Lutz explains that Biolevel is focused on bionutrition, increasing nutrient availability to the plant, specifically through the soil, rather than any form of biocontrol or biostimulation within the plant itself.

"In the rhizosphere, fungi play an important beneficial role in soil biology but are very sensitive and expensive. Growers often experience that the concept of fungal products does not work under field conditions. Bacteria, however, are more robust than fungal products and fungi as secondary colonisers benefit from beneficial bacteria as primary colonisers being introduced first."

The bacteria Biolevel is most interested in are those that fix N from the atmosphere, mobilise P from soil reserves and release K, making these key nutrients available to the plant. "The microbes that do these activities are well known. The focus for us is the consortia of bacteria and how they interact. They are not only performing the primary roles, but opening up the metabolic pathways."

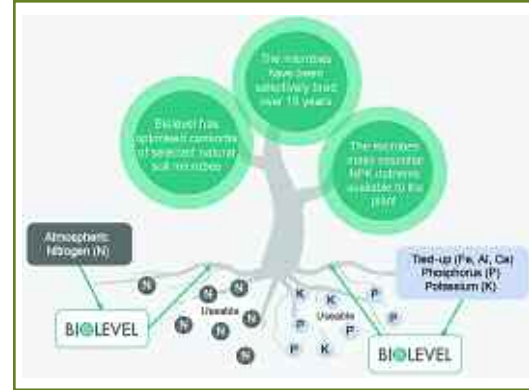
Stress factors

Lab experiments included seeing how the microbes behaved in different levels of tricalcium phosphate, and work was undertaken to measure root mass to confirm available P released by the microbes was being taken up by the plant. "We also progressively introduced stress factors to ensure we had a robust breeding stock."

Out in the field, researchers looked at how the microbes behaved in their natural environment. "We needed to understand each individual stress factor and avoid any antagonistic effects. That's a place where you can make many mistakes," continues Lutz.

A key part of Biolevel's work has been to refine concentrations of the product for different application methods. "We're treating the soil, aiming for a specific CFU count (colony-forming units). But an in-furrow treatment will deliver a very different rate to a seed dressing, and then a seed drilled at

How the consortia of microbes work



Source: Biolevel

180kg/ha will require a different loading to one drilled at 25kg/ha.

"We also looked at the shelf life of the product to ensure the microbes were stable in normal storage conditions, both in its powder form as well as the liquid formulation applied to seeds."

The result is a robust formulation that can be used across a range of different crops and climates, claims Lutz. "The liquid formulation is the perfect solution for small grains as a seed coating. The soluble powder can be dissolved in water and applied in-furrow at seeding or with an early spray application. It's fine to be mixed with most pesticides, apart from bactericides, and can even be applied with slurry."

Just one application during the growing ►

Tramline trials yield healthy benefits

Edwards Agricultural Supplies offers a range of services to farmers across Herefordshire, Shropshire, Worcestershire and the Welsh Borders. It's focused on soil services, and for around five years has been using Biolevel products to boost the biological activity of soil for clients.

"The key for us is to apply the microbes early and then feed them. So we apply the product with a seaweed and humic mix which helps the bacteria multiply as the crop grows," says David Edwards.

David and his son Mike carried out tramline trials with GramaxNP last year on Costello winter wheat and Bazooka hybrid winter barley. Both crops were sown into deep, clay loam soils towards the end of September with a Kongskilde direct drill. GramaxNP was applied across two tramlines in each test field on 15 October at a concentration of 275g/ha.

"We applied it with the seaweed/humic mix at 2.0 l/ha, and the seaweed was applied again with the fungicide sprays," recalls Mike. "Both crops also received three dressings of 27N + 7SO₃

liquid fertiliser to bring the total applied up to around 160kgN/ha."

David noticed that the treated crop appeared to grow much better. "There were more tillers and it looked a thicker crop. When you're relying just on bagged fertiliser, you get spikes of available N to the crop that may not coincide with when the crop is at its optimum growth. That's where the added biology can help."

The wheat area yielded an extra 0.5t/ha where the GramaxNP had been applied, while the barley crop pushed out an extra 1.2t/ha.

"We're repeating the trials this year, and this time looking to cut applied N by around a third," says David. "As we move towards



David Edwards applies the microbes early with a seaweed and humic mix which helps the bacteria multiply as the crop grows.

healthier soils, this will hopefully reduce our reliance on synthetic fertiliser."

Treatment	Yield (t/ha)		Bales/ha
	Barley	Wheat	Wheat straw
Control	8.4	8.3	20.3
GramaxNP	9.6	8.8	26.1
Additional output	£218.40	£85.23	£14.50

Source: Edwards Agricultural Supplies, 2021. Wheat – £180/t; Barley – £182/t; straw £2.50/bale.



Laurence Berman says the aim is to produce static inputs that become active in the soil.

► season is needed, but Lutz stresses that the microbes are soil-acting and work best when placed as close as possible to the roots of the growing crop in its early stages, to encourage the consortia to multiply within the root zone as the crop develops.

The seed treatment is an obvious solution, he says, and one for cereals will be available commercially this autumn through Certis. Field trials are currently underway, reports the company's Tim Eaton, with about 30-40t of winter wheat and spring barley seed treated.

"What impressed us is that there's not just innovation with what the product does. Biolevel has worked hard to understand the requirement for a seed treatment to be compatible with other products, to have a long shelf life and to coat the seed evenly. They're inquisitive and have done the science that shows it works."

There are three products available from Biolevel as either a soluble powder or liquid for seed application. PhosN contains a consortium of microorganisms designed to solubilise P reserves in the soil and increase N fixation in the rhizosphere. "PhosN is best suited to broadleaf crops, including potatoes, vegetables and oilseed rape," explains Laurence. "It's particularly good at mobilising P in situations where it's locked up, such as calcareous soils.



The seed treatment is an obvious solution to put the soil-acting microbes as close as possible to the roots of the growing crop in its early stages.

"GramaxNP is better suited to cereals and grazing grass and contains an extra strain of bacteria for fixing N. Then we have MaizeNP which is tweaked for maize and sweetcorn."

Initial trials carried out on potatoes by Wageningen University were a huge success and showed the value of the product, he says. "I was impatient to get the results out, but it was just the first year of a three-year trial — agriculture, it seems, has its own pace. Over the three years, out of 25 products tested, Biolevel came out on top."

Marketable yield

PhosN has now been in trials in potatoes over seven years on three continents with various universities and private research authorities, reports Biolevel chief operating officer Simon Hill. "It's shown an increase in marketable yield across 83% of trials, averaging 5%, and an increase in tuber count across 79% of trials averaging 6.9% (see charts opposite). That's a return on investment of 6.4 times," he says.

Notable results from 2021 trials in the US include where N or P have been reduced by 25%, but marketable yield has been maintained at the historical average for a grower standard application of NPK.

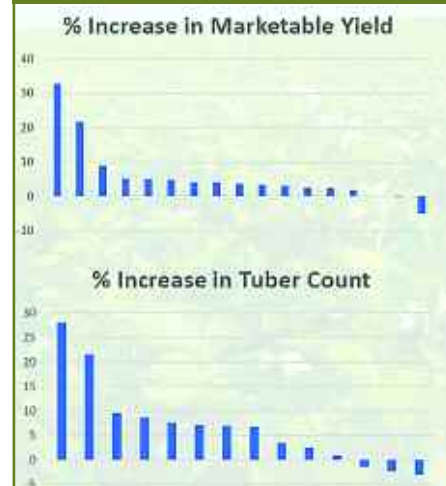
Trials in the UK by Deben Agronomy have focused on pushing up tuber numbers for salad potatoes, with PhosN used to ensure enough available P at tuber initiation. Across three varieties — Jazzy, Paris and Venezia — tuber numbers in test digs were found to have increased by 26/m², 9.5/m² and 19/m² respectively, equating to an extra £1248-3802/ha in marketable yield (see CPM April 2022 issue).

In cereals, where Biolevel was used in 2017 UK field trials of Chapeau and Westminster spring barley, yield was increased by 9.5% and 5.2% respectively, with improvements in specific weight, protein and grain size distribution. In Evolution winter wheat, its use increased yield by 11% and biomass by 14%. Tissue analysis showed it also increased availability of a range of other nutrients.

UK trials in forage maize in 2021, using MaizeNP sprayed in furrow, increased dry matter yield by 11%. Where applied N was reduced by 20%, there was still an increase in DM yield over the farm standard of 7%.

Simon believes the strength of the product is the consistency with which it yields results. "It's because we use consortia of microbes, rather than a single strain. Individually they're known to have activity across multiple pathways, that builds into a very robust consortium. We know this works across all environments and all crops, but it's

Performance of PhosN on potatoes across trials



Source: Biolevel, 2014-2021, trials carried out by universities and private researchers across three continents, using Biolevel PhosN in addition to full NPK grower standard practice.

particularly notable where excessive working of soils and years of synthetic inputs has depleted their natural biology.

"It's also a very stable product, so performs reliably across a range of application methods and conditions.

And that's what we set out to achieve — the performance of soil biology is inherently inconsistent, so we've levelled that out," concludes Simon. ■



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