NEW for 2023

ROOTFiX™

our first cereal inoculant
from elite strains of *Bacillus*

For enhanced germination, nutrient mobilisation, and relief of biotic and abiotic stress: a microbial biostimulant offering powerful crop acceleration

Crop science, inspired by nature

About Legume Technology

Dr. Bruce Knight
Founder and CEO of Legume Technology

Legume Technology is a British-based inoculant and biostimulant pioneer, creating solutions for the world's most important crop varieties. For more than 20 years, our research-led approach has refined the science of soil and root microbes and championed their use in everyday, large-scale crop production as a valuable addition to conventional inputs and – for legume crops – as a direct replacement for synthetic fertilisers.

Reflecting the growing demand for novel, sustainable crop inputs, we enjoy a powerful partnership with Green Universe – a bio-alliance that supplies farmers in more than 50 countries across four continents.

With a company philosophy built on science, we're proud to be launching our latest innovation, ROOTFiX™. Our first inoculant designed for cereal crops but with broad-spectrum capabilities, it builds on the established success of products such as LIQUIFiX™ and MYCOFiX™, and the trust placed in them by farmers around the world.

> **Today's farmers need innovation if they're to grow crops more productively, more sustainably and more profitably. We believe more widespread adoption of biostimulants such as ROOTFiX™ can help them achieve those objectives.**

What is ROOTFiX?

ROOTFiX is a microbial biostimulant used as a seed treatment, containing the bacteria *Bacillus*.

Bacillus, a naturally occurring soil bacteria, is also one of the most widely distributed, with each gram of soil containing millions of microbes. Highly competitive against other soil micro-organisms, more than 300 different species of *Bacillus* have been identified since the genus was first classified in 1872.

Today, many of them find applications in our industrial fermentation processes, synthesising antibiotics, enzymes, probiotics and feed additives, thanks to the bacteria's wide-ranging abilities and properties.

Bacillus has long been recognised as a 'plant growth promoting bacteria' (PGPB). Many species can develop close relationships with plants, including common crops, where they act on plant root systems as well as soil biological systems.

Key to these relationships are the powerful enzymes, metabolites, proteins and organic acids produced by *Bacillus*, and its inherent ability to outcompete other microbes, including pathogenic species. Crucially, *Bacillus* can also induce the plant's own defence mechanisms, a process known as systemic acquired resistance (SAR), significantly improving overall plant health.

This product is ideal for:

Corn

Sunflower

Wheat

Soybeans

Peas

How does ROOTFiX work?

ROOTFiX harnesses the natural ability of three *Bacillus* species and turns them to our advantage in crop production:

- increases root mass
- improves the plant's resistance to abiotic stresses such as drought, temperature, and other environmental extremes
- enhances the plant's ability to solubilise phosphate, the macronutrient that plays a vital role in root development, photosynthesis, and cell division (the biological process in crop growth).

Together, these properties deliver the benefits we have observed in trials – results borne out by use in real-world, field situations:

- faster germination
- improved early vigour
- higher establishment rates
- increased yield.

ROOTFiX comprises three elite, proprietary strains of *Bacillus*. They are available only in ROOTFiX, and each contributes valuably to the product's performance:

Bacteria	IAA production	Siderophore production	Nitrogen fixation	Phosphate solubilization
B. *subtillis*	-	✓	✓	✓
B. halotolerans	✓	✓	✓	✓
B. atrophaeus	-	-	✓	✓

IAA production: indole acetic acid (IAA) is one of the primary compounds produced by PGPB that stimulate and facilitate root growth.

Siderophore production: siderophores are organic compounds, produced by PGPB, that help in the supply of iron to plants. They have also been observed to limit the development of non-beneficial microorganisms, such as *Pythium* and *Fusarium*, by depriving them of iron.

Nitrogen fixation: *Rhizobium* are well-known for their nitrogen fixation; *Bacillus* spp with these 'nitrogen-fixing genes' do occur naturally and can 'fix' nitrogen, albeit in smaller amounts than the rhizobial association can supply.

Phosphate solubilisation: increased supplies of phosphate for the crop enhance crop vigour and growth.

High efficiency

ROOTFiX is a high-efficiency biological seed treatment. We guarantee this, because of the way we manufacture and package all our products.

We have adopted 'axenic' production practices at our manufacturing plant outside Nottingham, UK. This means that we exclude ALL bacteria from the production process, EXCEPT those that make up the finished product, and then package it in sterile, sealed conditions.

Very few biological seed treatments are produced to such exacting standards. For us, it's a crucial part of the attention to detail – the trialling, the quality control, the continuous product improvement – that lies behind every one of our products.

Why is it so important? Think of it in the same way as plant protection products: when you buy and mix a herbicide, say, you want to be sure that the product contains the active substance and that alone. You don't want unrefined by-products of the manufacturing process in the spray tank, nor any dilution of the stated rate of active substance.

It's the same with biologicals. Each pack of ROOTFiX contains $5x10^8$ CFU/g of our three elite strains of *Bacillus*. And nothing else: that's the guarantee of an axenic production line, and our incredibly refined, and constant, quality control parameters.

It also guarantees a long shelf life and a product that's as fresh – and as effective – as the day it left our production site.

Why use ROOTFiX?

> **By using ROOTFiX on a crop, you're investing in and protecting that crop's yield potential.**

One of the biggest benefits of biological seed treatments, such as *Bacillus*, is their ability to persist in the soil. While chemical seed treatments perform their functions admirably at drilling and during germination, for ROOTFiX that's just the beginning of what it has to offer.

The bacteria multiply in the soil, increasing their benefit to crop and soil health as the population increases. In addition to the protection they offer to crop roots and greater root mass, as their numbers increase so too do other key metrics, such as soil mineralisation and more rapid breakdown of soil organic matter.

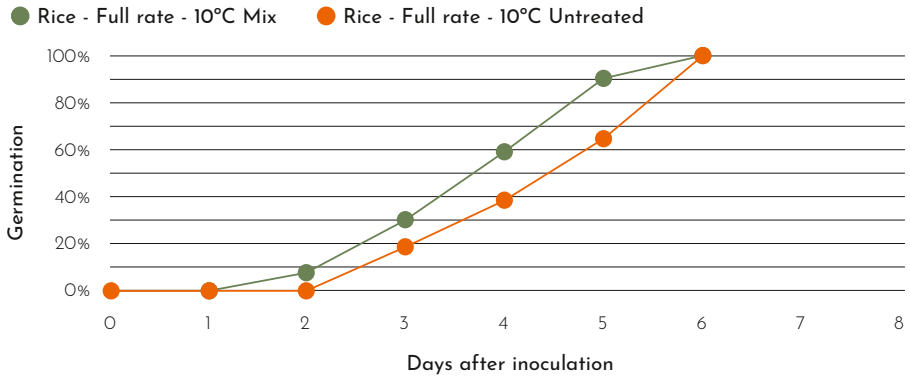
This latter point is crucial: by improving availability of components such as chelates, phosphorus, iron, zinc and other micronutrients, crop performance is less likely to be impaired by a limiting factor.

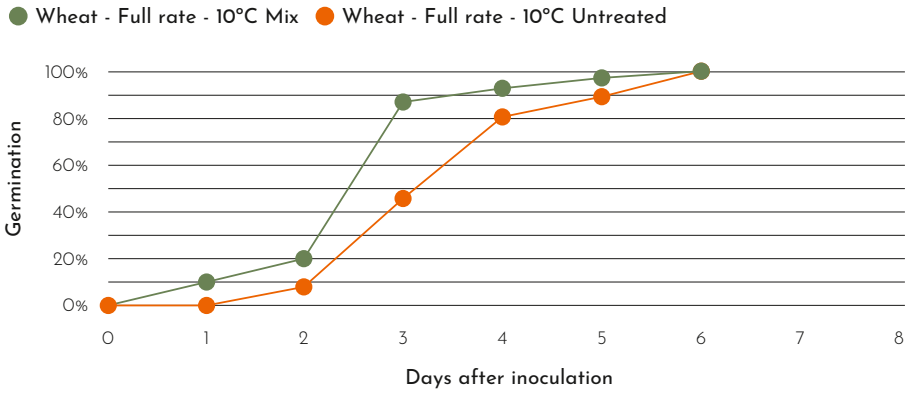
Each of those elite *Bacillus* strains works hard to perform its own function in the soil, improving nutrient availability, guarding the roots, and producing the array of metabolites that protect and nurture the crop.

At Legume Technology, we have tested ROOTFiX on a wide range of crops. We've observed and recorded a broad-spectrum bio-stimulatory effect on crop growth as a result of the application of the bacteria.

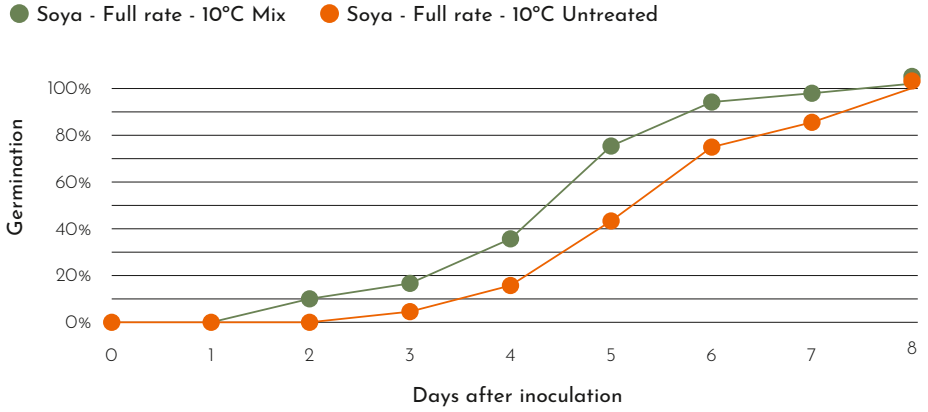
Proven in trials

The graphs below show the improved germination rates displayed by wheat and rice seeds following treatment with ROOTFiX. These trials were performed under controlled conditions by Professor Steve Rossall, an independent professor at the University of Nottingham, UK.





In legumes such as soybeans and peas, and cereal crops like rice, ROOTFiX also demonstrates strong results.



Proven in trials

The photograph shows the impact of ROOTFiX on early vigour in pea plants. Treated plants displayed a significant increase in growth rate and canopy development.

Untreated

ROOTFiX

Proven in trials

> **ROOTFiX also offers growers the opportunity to guard crops against damage incurred by abiotic stress – as demonstrated in trials with rice.**

Trial type: Controlled environment

Methodology: Rice seedlings were subjected to a temporary period of drought (watering was stopped).

Outcomes: The control – plants untreated with ROOTFiX – were seen to wilt and showed extreme signs of abiotic stress. Meanwhile, treated plants were able to withstand this artificial exposure to drought significantly better, as seen in the picture below.

During the same trial, the effect of ROOTFiX on phosphate solubilisation was also tested.

Untreated plants showed stunted growth and signs of phosphate stress, while those treated with ROOTFiX improved their early establishment and vigour – an observation confirmed in separate trials at the University of Nottingham, where seeds treated with ROOTFiX showed significantly improved establishment, growth rate and vigour.

We are now repeating these trials in the field.

Proven in trials

> ROOTFiX can also significantly increase yields – illustrated in trial results from Canada.

Crop	Untreated seed	Conventional treatment	ROOTFiX	LSD 95%
Spring Barley	4.718	4.823	5.103	0.4
Corn	Not available	12.369	12.754	1.3
Winter Wheat	4.487	4.473	5.096	0.2
Spring Wheat	3.717	3.822	4.018	0.5

Worse than untreated seeds

Better than untreated seeds

Better than conventionally treatment

Significant increase in yield

ROOTFiX and biotic stress

We have also collected positive initial results into the effects of ROOTFiX on biotic stresses in wheat. This has prompted further studies, now underway, into the role ROOTFiX might play in farming systems affected by pathogens like rust (*Puccinia graminis*).

The photo shows how seeds of one of the UK's most common wheat varieties responded to ROOTFiX treatment. In plants growing from ROOTFiX-treated seeds and dosed with the rust pathogen, development of the fungal pathogen has been slowed down or stopped.

Use ROOTFiX as a seed treatment for your cereals and:

- Get healthier plants
- Get healthier soil
- Reduce farm chemical usage
- Save money
- Increase yields

CROPS	Cereals, Legumes, Sunflower, Sugar Cane, Peas, Grass
STORAGE TEMPERATURE	+5°C to +15°C
SHELF LIFE	12 months
FORMULATION	Liquid
ACTIVE SUBSTANCE	$5x10^8$ CFU/g of Bacillus spp.
APPLICATION RATE	2 - 4l/t
APPLICATION METHOD	Standard seed treatment process

READ THE LABEL BEFORE USE. USING THIS PRODUCT IN A MANNER THAT IS INCONSISTENT WITH THE LABEL MAY BE AN OFFENCE. FOLLOW THE CODE OF PRACTICE FOR USING PLANT PROTECTION PRODUCTS

Crop science, inspired by nature

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