Fighting microbes with microbes

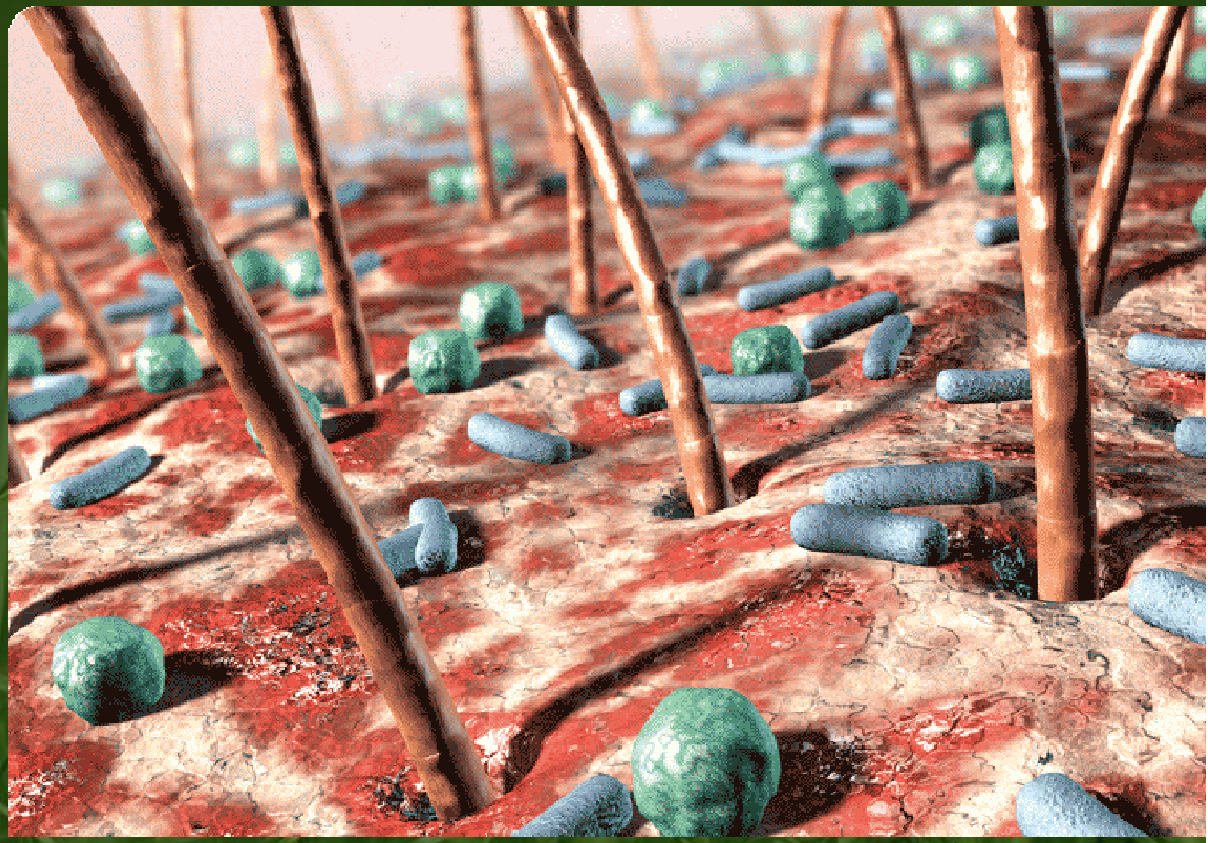
The benefits of using specific soil microbes

BactiGro AUSTRALIA PTY LTD

BIOACTIVE SOIL SOLUTIONS

Introduction

- *Like humans, plants rely on a vast array of bacteria and fungi for health and defense*
- *Plant biologists are only beginning to discover the surprising way that soil microbiota impacts plants*
- *Recent studies have led to discoveries such as fungus-wired alarm systems to soil bacteria that can trigger defensive plant behavior*
- *These bacteria have even been proven to act as some sort of vaccine for the plant when under attack from pathogen activity*
- *Your body is made up of 100 trillion cells, with only 1 in 10 being human!! The rest are bacteria and other microorganisms*

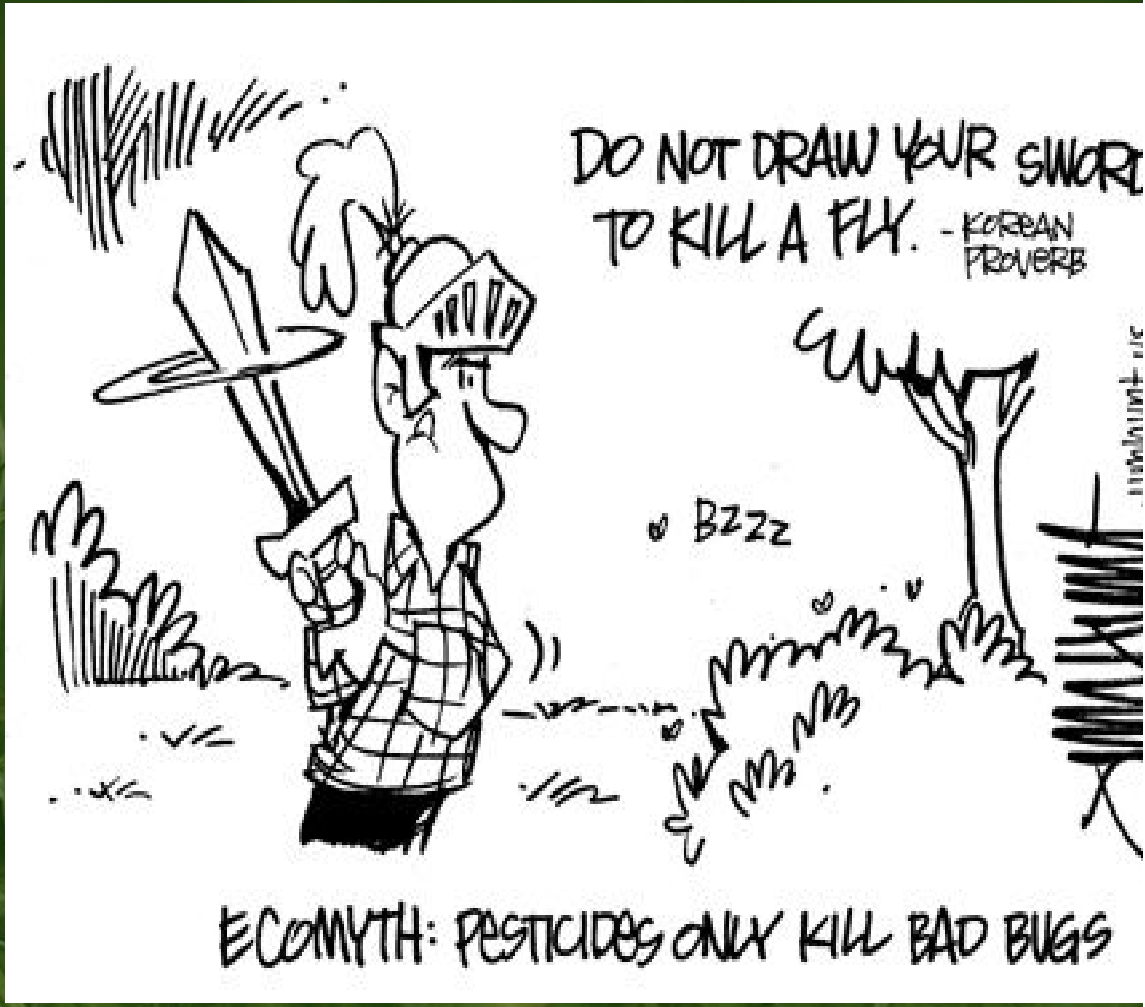


The “Bazooka Mentality”

- Since the discovery of antibiotics, medical research has been dominated by the “Bazooka Mentality” and so has agricultural science
- Alexandre Joussett, a plant scientist at the Georg-August University in Germany, recently commented “Traditionally, microbes have been viewed negatively, and focus has been placed on eradication.”
- The Human Microbiome Project discovered around 10,000 species of microorganisms. Soil contains over 30,000 species of microbes!!
- Pesticides, herbicides and fungicides and other chemicals kill off both good and pathogenic microbial communities, creating “super bugs” in the soil, much like with the overuse of antibiotics in humans

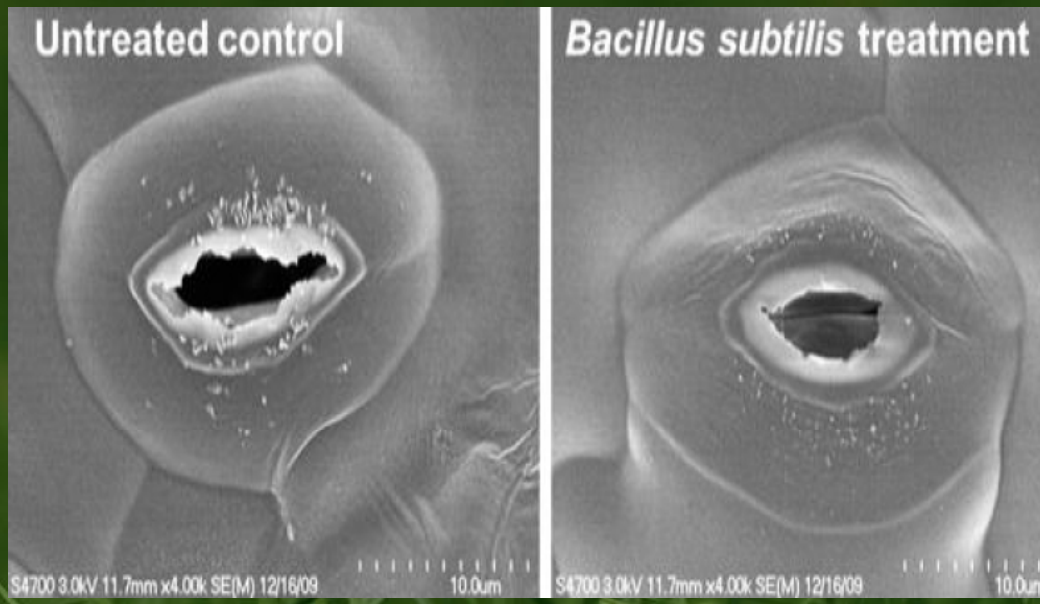
Creating the “Biological Vacuum”

- *Chemicals can “nuke” the soil but they will never kill everything*
- *This can create a “Biological Vacuum” that can become filled with opportunistic survivors and other organisms from the surrounding soil*
- *This can create strong selective pressure*
- *The few pathogens that survive face little competition and proliferate*
- *This can give rise to pathogenic communities that can evade standard treatments, such as “super bugs”*



Why use beneficial micro-organisms

- *Beneficial soil organisms can protect plants more selectively than chemicals do*
- *Scientists have found that Bacillus subtilis secretes an antimicrobial peptide that temporarily suppresses pathogens*
- *This in turn helps ward off soil-borne pathogens while a plants defenses are compromised*
- *Soil is alive and the microbes it contains create a synergy with the plant*
- *Microbes need carbon for food, and we're depleting our soil of this element by using chemical fertilizers, chemicals and over-plowing amongst other detrimental farm practices*

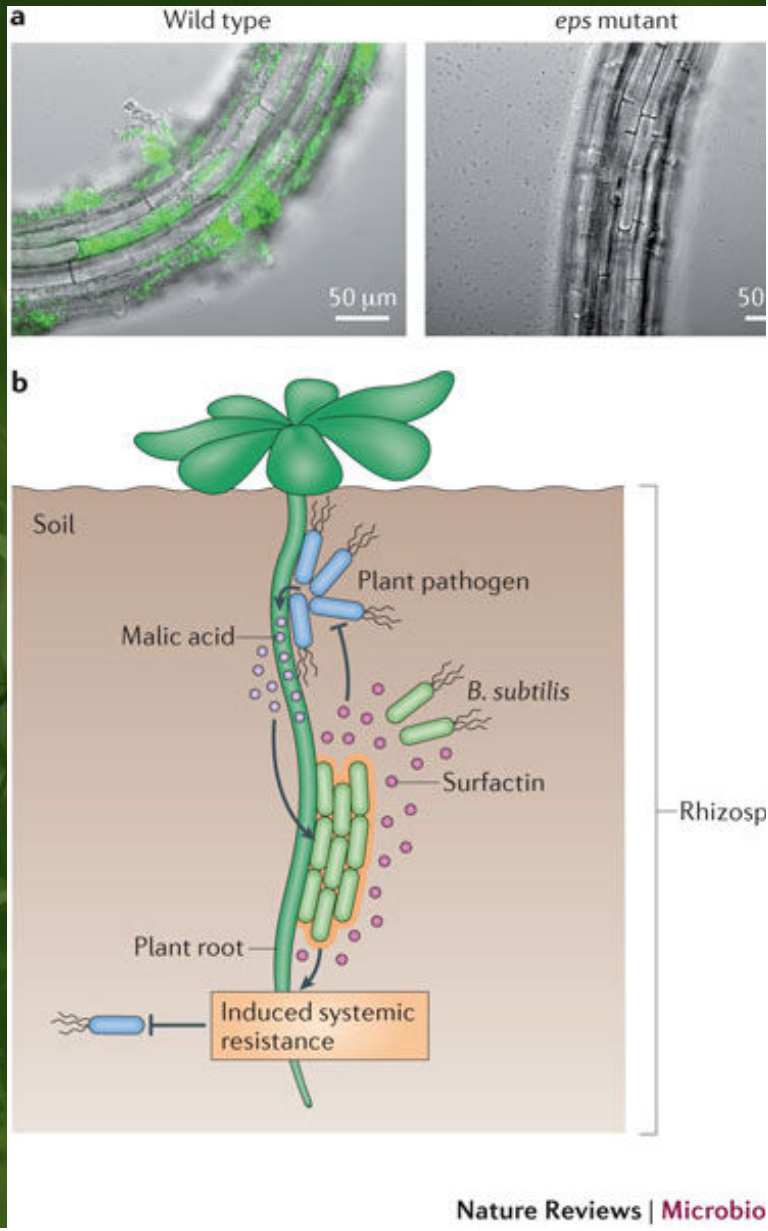


At left, a magnified stomata (pore and surrounding guard cell) on a plant leaf is shown being attacked by pathogens. However, when the beneficial bacterium Bacillus subtilis is added to the plant's soil, the bacteria signal the stomata to close, cutting off the pathogens' access to the plant interior.

Credit: Image courtesy of University of Delaware

Bacillus spp.

- *Bacillus spp. can promote growth and protect plants from infections by pathogenic bacteria, fungi and even nematodes*
- *This protection is due to the secretion of antimicrobial Compounds*
- *This is coupled by induced systemic resistance from the plant*
- *This enhances the capability of the plant to resist pathogens*
- *For example, to recruit B subtilis, the plant will excrete Small molecules such as malic acid (see picture right)*
- *These secretions encourage B subtilis to form on the root*
- *The B subtilis then excretes surfactin, which is a lipopeptide Antimicrobial*
- *This in turn induces systemic resistance in the plant and the Pathogen moves away from the rhizoshere*
- *Several Bacillus spp., including B. megaterium, B. mucilaginosus have been shown in studies to encourage the plant to suppress soil-Bourne pathogens*



The effects of Glyphosate

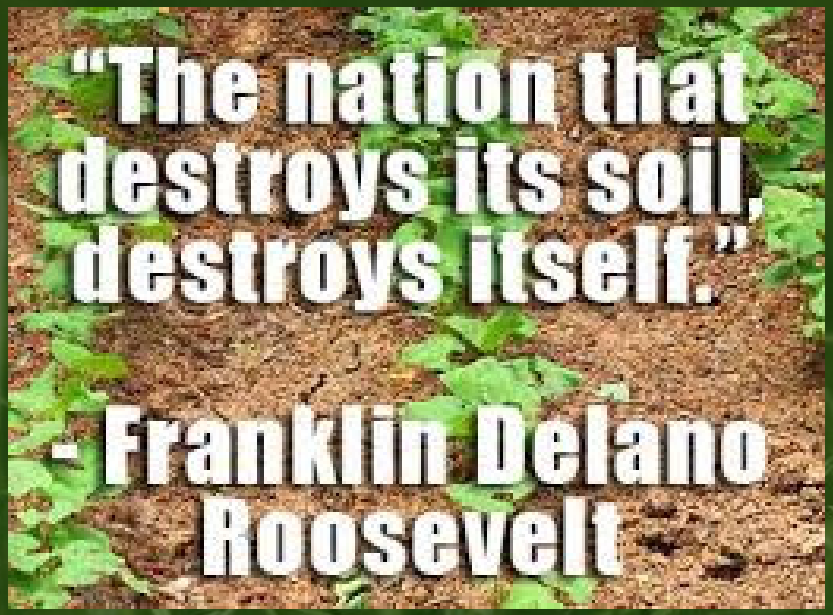
According to Dr. Don Huber, an expert in the area of science that relates to the toxicity of GM foods (that's an argument for another day!!!), glyphosate, the most widely used herbicide in the world, is one of the biggest threats to soil microbiology

About 20 percent of the glyphosate migrates out of the plant's roots and into the surrounding soil

Once in the soil, the glyphosate kills beneficial soil microorganisms in the same way it kills weeds, because they have the same critical metabolic pathway

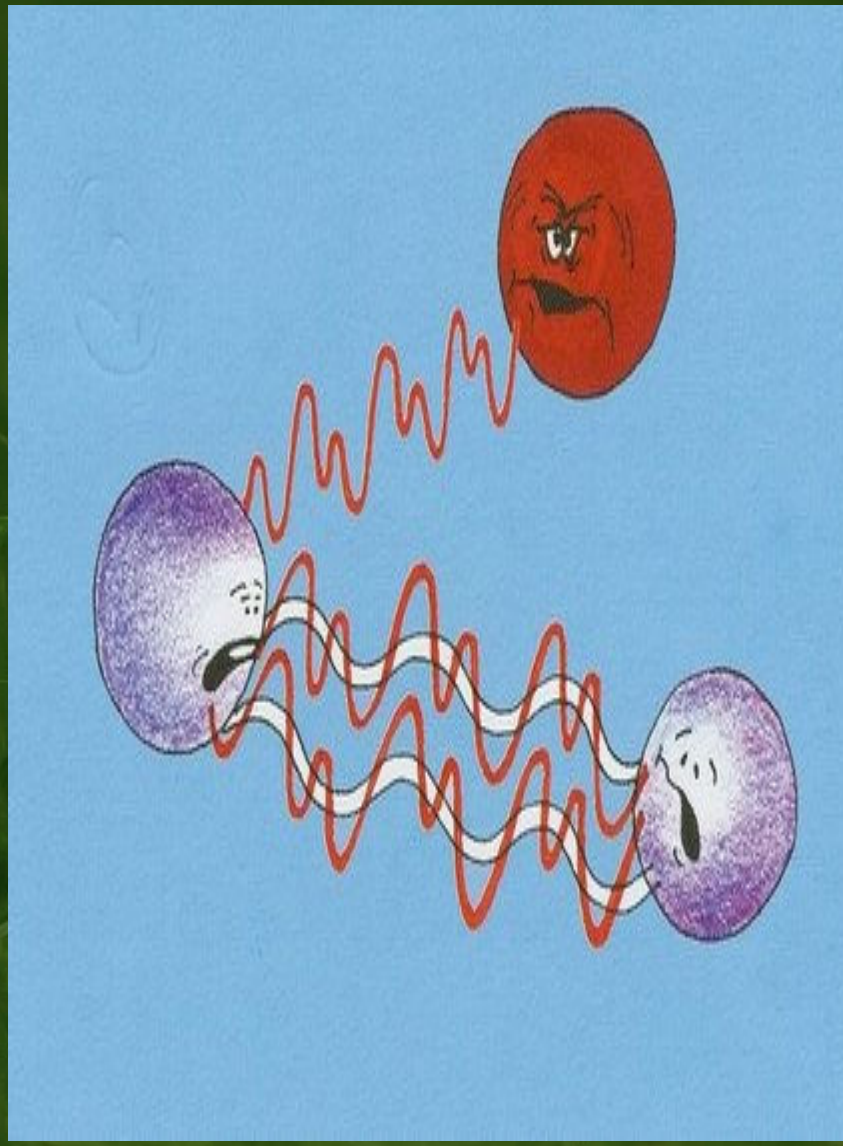
The important point we must all understand is that once you destroy the beneficial microbes in the soil, you've destroyed the food grown in it, because the quality of the food is almost always related to the quality of the soil, which depends on a healthy balance of microorganisms.

The solution, of course, is to stop assaulting our soil with chemicals that are killing off its microorganisms, and one of the best ways to do this is by utilizing the microbes themselves



Communication pathways

- one study found that plants can communicate with each other underground, via underground common mycorrhizal networks (CMNs) that interconnect roots of multiple plants
- Through this pathway, neighboring plants can ‘eavesdrop’ on defense signals coming from nearby plants that have been infected with a pathogen, allowing them increase their defenses and improve their resistance to the disease
- Microbes demonstrate complex communication and decision making, among colony members and other species
- They produce protein electrical wires, (made of conducting aromatic amino acids phenylalanine, tryptophan, histidine, tyrosine.) supplying distant colonies with electrons
- Microbes send signals triggering changes of other microbes’ behavior
- One of the most complex back and forth communications of microbes is with plants for the all important nitrogen fixation, which the plant cannot have without this process.



THE MICROBIAL COMMUNITY

In nature, different microorganisms usually present as mixed communities. They interact, and rarely act alone

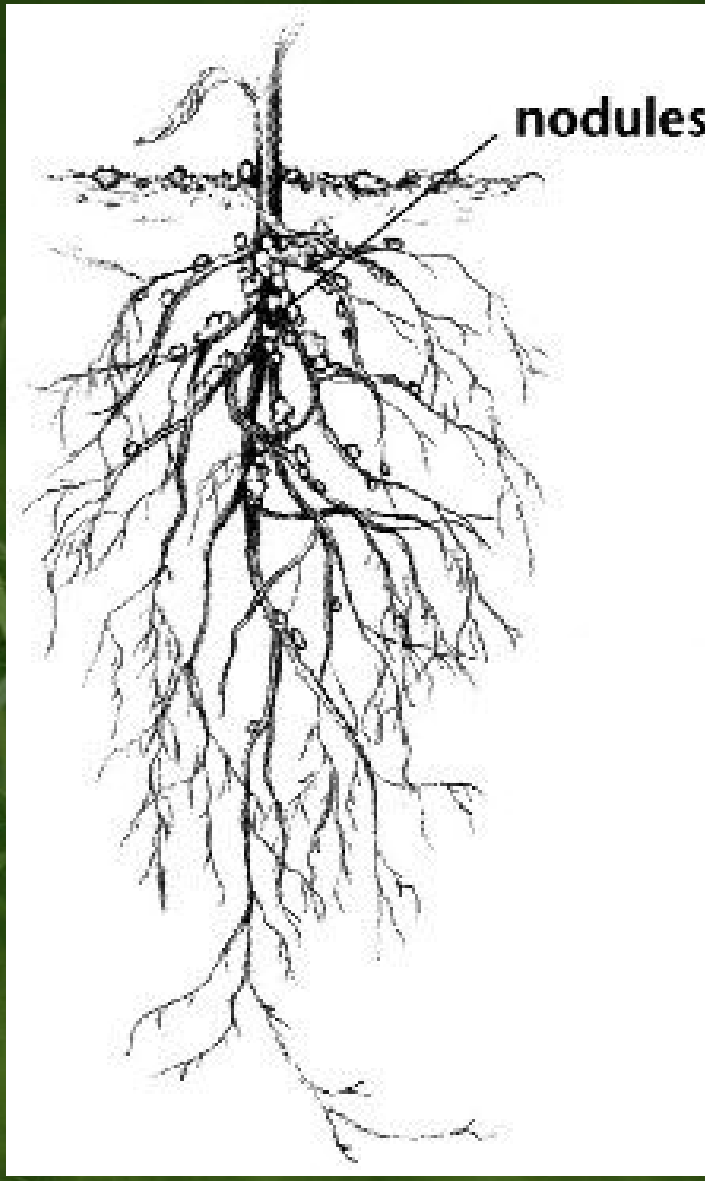
SYMBIOSES

- NEUTRALISM
- AMENSALISM (One has a negative effect on the other)
- MUTUALISM
- COMMENSALISM (one benefits while the other isn't harmed)

- ANTAGONISM
- COMPETITION

Bacterial Nodulation Fixes Nitrogen for Plant

- *Bacteria have a business relationship with plants. They capture nutrients that plant needs, then negotiate to give these nutrients in exchange for photosynthesis-derived carbon*
- *The processes involved in the formation of nodules on legumes and non-legumes are generally highly specific and are finely coordinated by molecular signaling between the bacteria and the plant*
- *The bacteria that form symbioses with plants are diverse and can modify in their important symbiotic characteristics as a result of exchange of genetic information among soil bacteria or loss of this information.*
- *Scientific studies conducted in China have shown B. megaterium and B. subtilis to fix nitrogen.*
- *The nitrogen fixing gene has been identified in both genera Bacillus and Paenibacillus*

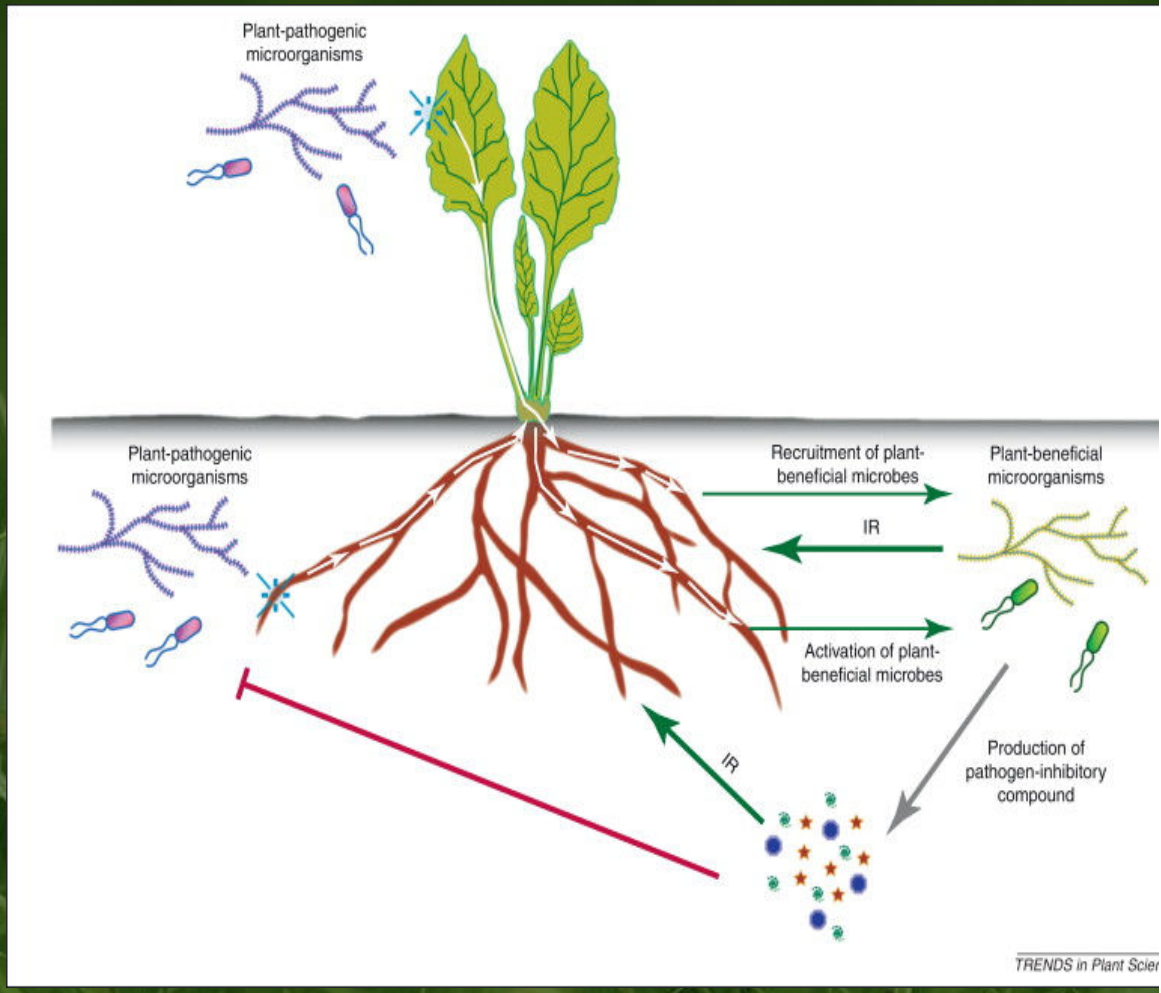


How plants attract microbes

- *Studies have shown that plants can pick and choose the beneficial bacteria species recruited during pathogen attacks*
- *When tomato plants were infected in lab with Pseudomonas syringae pv. Tomato, which causes bacterial speck, a major disease in tomatoes, the plant roots secreted L-malic acid, a food source for B. subtilis.*
- *As a result, the B. subtilis colonised the root zone and triggered production of the plants chemical salicylic acid, which helped it fight the bacterial infection*
- *Plants may even be able to recruit different bacterial species as their need for food and water changes.*
- *Evidence shows that the effects of beneficial bacteria can endure across generations*
- *Studies suggest, that just like in humans, certain bacteria function as a sort of vaccine, which can heighten disease response and then be passed on to the next generation of plants*

Overall plant response to microbes

Although most microorganisms that are beneficial to plants live in the soil, their effects are not always localised to the roots
In a study published in The Plant Journal, it was shown that beneficial soil microbes encourage the closure of stomatal pores in the leaves of Aradidopsis plants (small flowering plants related to cabbage and mustard)
Hot and dry conditions are known to trigger stomatal closure to preserve water, but this study was the first to show that soil bacteria can trigger the response when the plant is under pathogen attack.
This is an important finding, as some pathogenic bacteria enter through the plants stomata
The study showed that after B. subtilis was called into the root zone by the L-malic acid on infected plants, only 43% of stomata were left open compared to 56% in the control groups



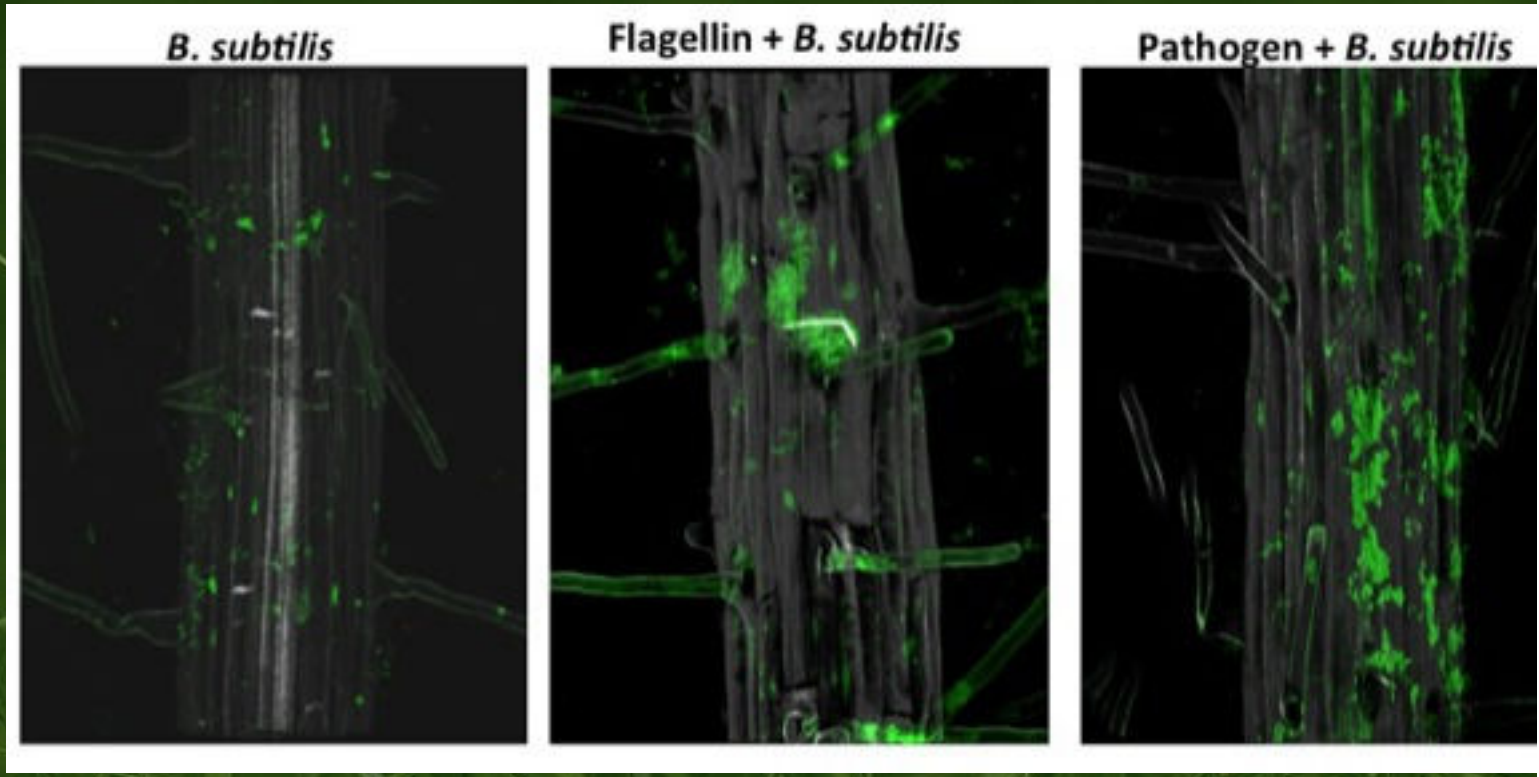
Understanding how it all works

It's much harder for pathogens to take over the human gut when beneficial microbes coat its surface

The same applies to the soil

When it comes to preventing disease, some microbes will kill pathogens directly, others consume their resources and others take up the areas that the invading bacteria would have inhabited

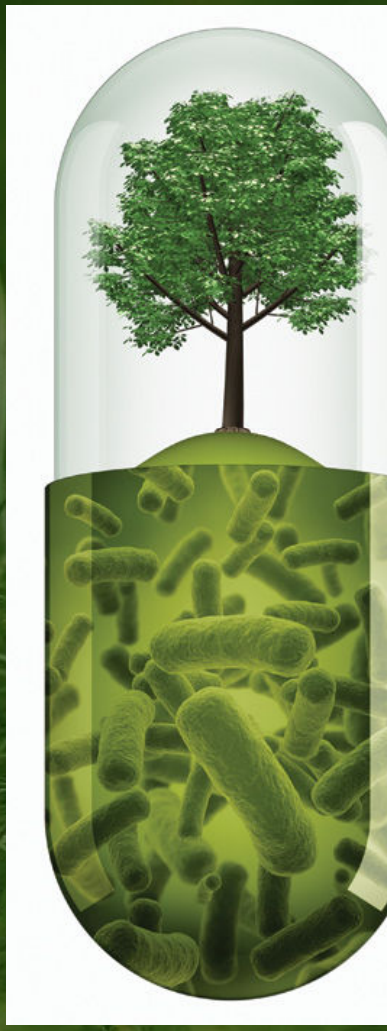
New research has shown that specific beneficial strains at these zones are more important than simply cultivating a large variety of bacteria



- *Studies conducted at the Georg-August University in Germany, showed tha the number of beneficial species in the soil and the genetic dissimilarity between them was extremely important in disease suppression.*
- *Communities with 4 to 6 species were better able to ward of infection*
- *Communities with more or less bacteria were more susceptible invasion*

Creating healthy soil

Just like antibiotics indiscriminately kill both good and bad bacteria in the gut, fungicides and chemicals impede the soils natural defense
Addition of specific soil microbes, such as Bacillus and key fungi, can influence ecological processes in the soil
These colonies can establish microbial communities that are capable of suppressing disease
This has been proven over and over again, with more scientific research uncovering that a biological approach to soil management can reduce the need for harsh chemicals and some fertilisers
Professor Joussett from the Georg-August University recently commented regarding soil microbes "it might not work exactly the same in the gut, but the mechanisms in the soil are very similar. If we can protect and cultivate the soil microbiome rather than kill important species, we might need fewer chemicals in the field"
Building soil biology and feeding beneficial microbial communities, coupled with practices aimed at building the soil profile and looking after the microbial system under our feet will pay you back in the long run.



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