

A close-up photograph of a person's hand holding a small, vibrant green seedling with two leaves. The seedling is growing out of a small, cracked, light-brown eggshell pot filled with dark soil. The background is a soft, out-of-focus green and yellow, suggesting an outdoor setting with sunlight.

INNOVATION INCUBATOR

Microbes at Work

Kyle McKinney

Alltech[®]
CROP SCIENCE

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Discover.

We look at what the world needs to feed itself.

+

Innovate.

We discover through scientific curiosity natural, nutritional answers.

+

We relentlessly drive for knowledge-led innovations that nurture.

=

Deliver.

We deliver accessible and agile solutions that work better for the world.

THE ALLTECH
WAY

See what the world needs, look for innovative solutions, and deliver these solutions to the marketplace.

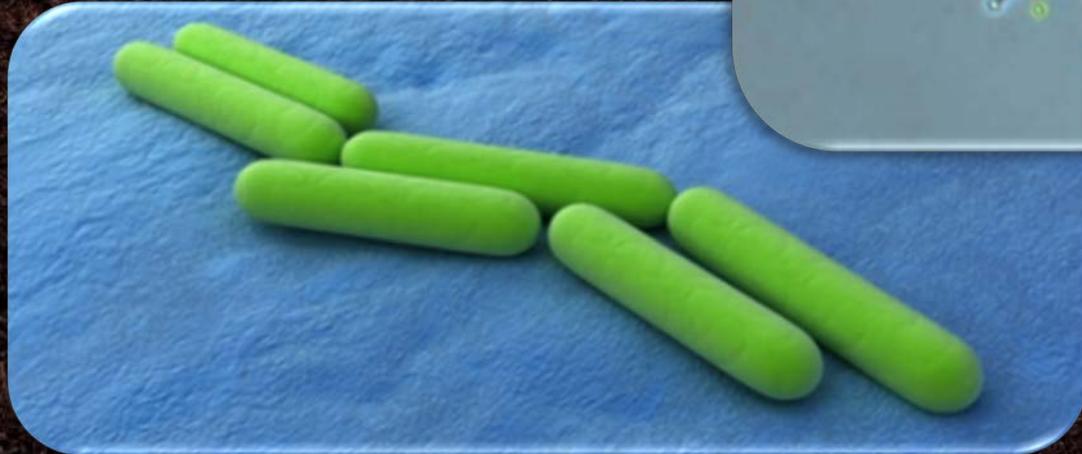
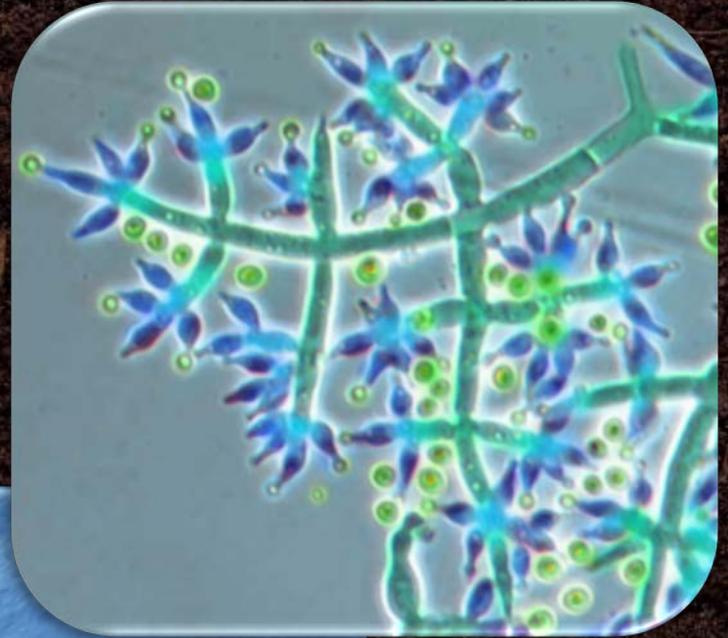
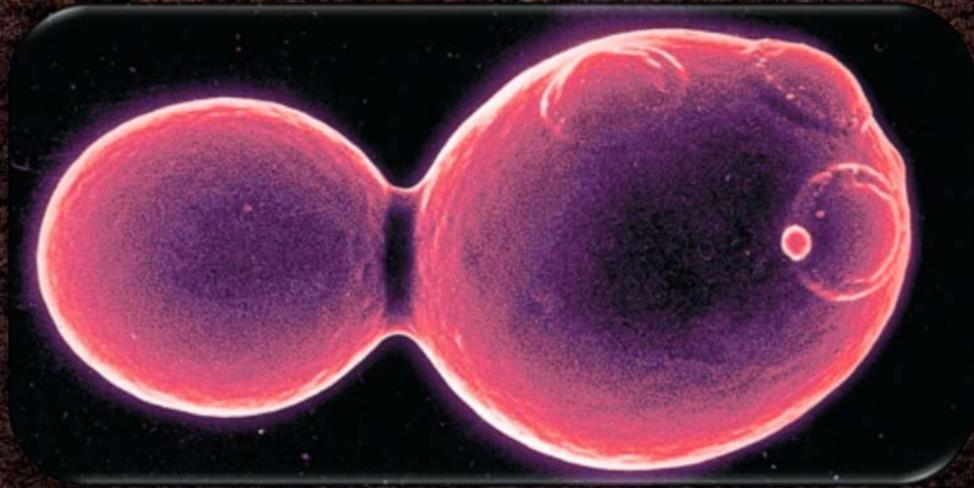




Contagious Curiosity

Alltech Research

35 years of research
into **microorganisms,**
fermentation, and
natural nutrition



Microbe/Plant Partnership

Microbes support plant health by:

- Aiding nutrient availability
- Neutralizing toxic compounds in soils
- Providing disease suppression/resistance
- Helping temper environmental extremes



In 1 teaspoon of soil there are...



Bacteria	~100m to 1billion	160 g/m ³
Fungi	> 100,000	200 g/m ³
Actinomycetes	> 100,000	160 g/m ³
Algae	> 10,000	32 g/m ³





***Are we helping or
hindering this partnership?***



PESTICIDE PLANET

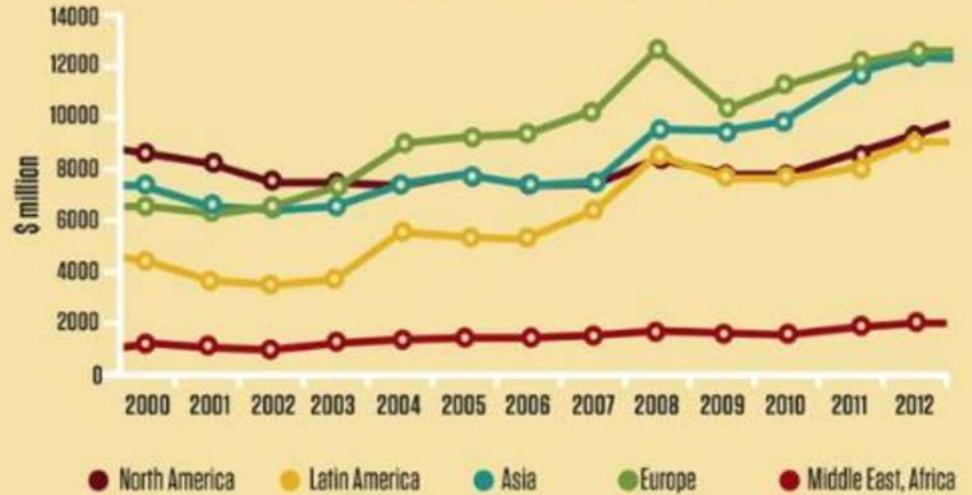
In a world of humanmade chemicals, pesticides are second only to fertilizer in the amount applied and extent of use. They are effective tools for protecting crops, fighting disease-causing insects, and dealing with nuisance animals such as rodents, fleas, and ticks. But herbicides, insecticides, and their kin can harm the environment and are dangerous to workers if improperly used.





MORE DEMAND, MANY USES

Global pesticide sales by region



Pesticide sales are increasing in Asia, Latin America, and Eastern Europe. In addition, companies often charge lower prices for older products and in poorer markets, boosting sales. Africa uses far less pesticide than any other region.

Variety best form of defence against kiwifruit disease

Last updated 07:17, February 13 2015



French winemakers demand action on 'incurable' grape disease devastating vines

EUROPE

Fear of Ruin as Disease Takes Hold of Italy's Olive Trees

By JIM YARDLEY MAY 11, 2015

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RACALE, Italy — Across the stony heel of Italy, a peninsula ringed by the blue-green waters of the Mediterranean, olive trees have existed for centuries, shaping the landscape and producing some of the nation's finest olive oils. Except now, many of the trees are dying.

Sprinkled among the healthy trees are clusters of sick ones, denuded of leaves and standing like skeletons, their desiccated branches bereft of olives. The trees are succumbing to a bacterial outbreak that is sweeping across one of Italy's most famous olive regions, as families who have manufactured olive oil for generations now face ruin, even as officials in the rest of



they need



FAR FROM THE MADDER CROWD
NOW PLAYING



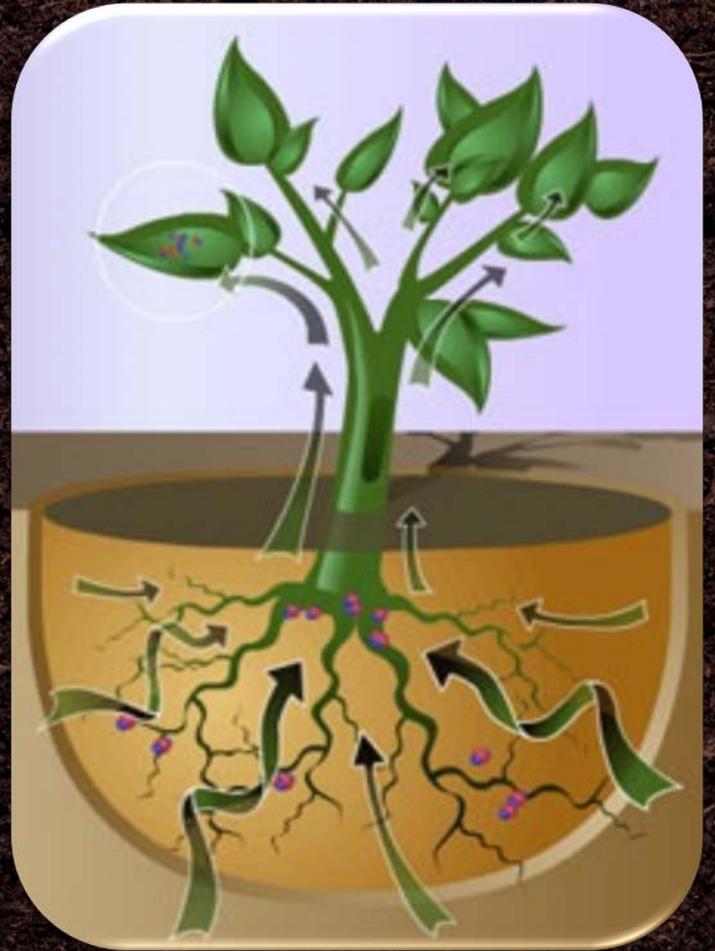
One of the kiwifruit



*Can we reduce our
dependence on pesticides
before it's too late?*

Microbes...

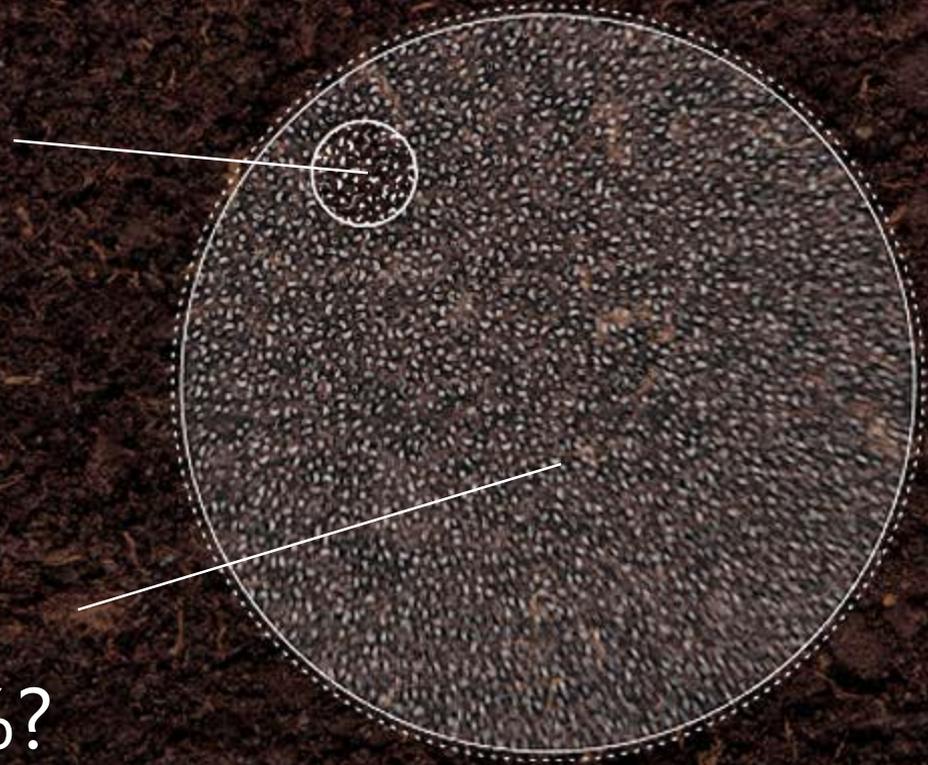
- increase nutrient availability
- enhance plant root growth
- neutralize toxic compounds
- make plants more resistant to disease, heat, flooding & drought
- deter pathogens & predators





We have only identified 2% of all microbes in the soil!

What if we were to harness the unidentified 98%?



NEWS

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Antibiotics: US discovery labelled 'game-changer' for medicine

The heyday of antibiotic discovery was in the 1950s and 1960s, but nothing found since 1987 has made it into doctors' hands.

In January, researchers using a new technique for identifying microbes discovered 25 new antibiotics from a sample of soil from the researchers back yard.

**25 New
antibiotics in 1
sample of soil!**



Paydirt?



\$2.1 Billion

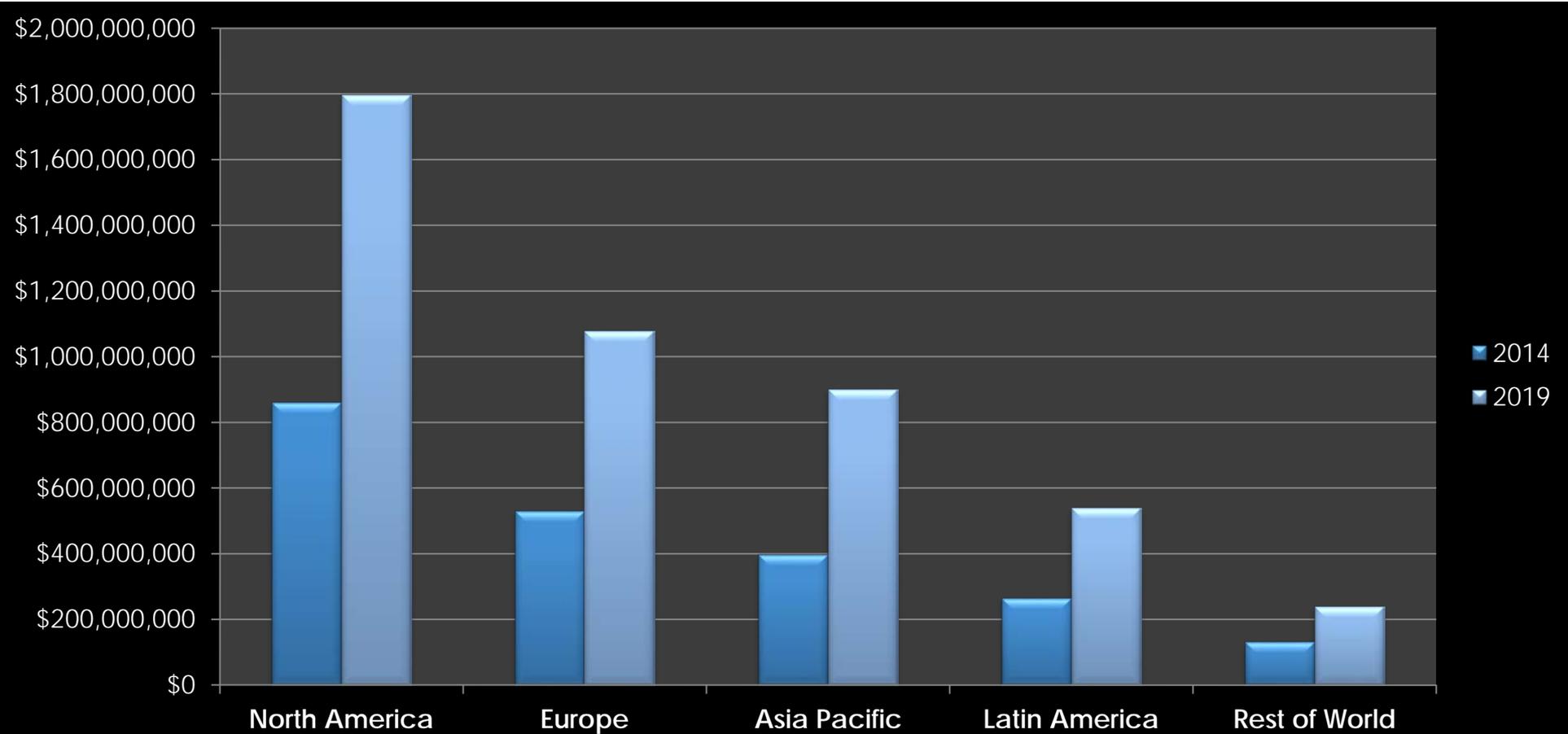


\$4.6 Billion

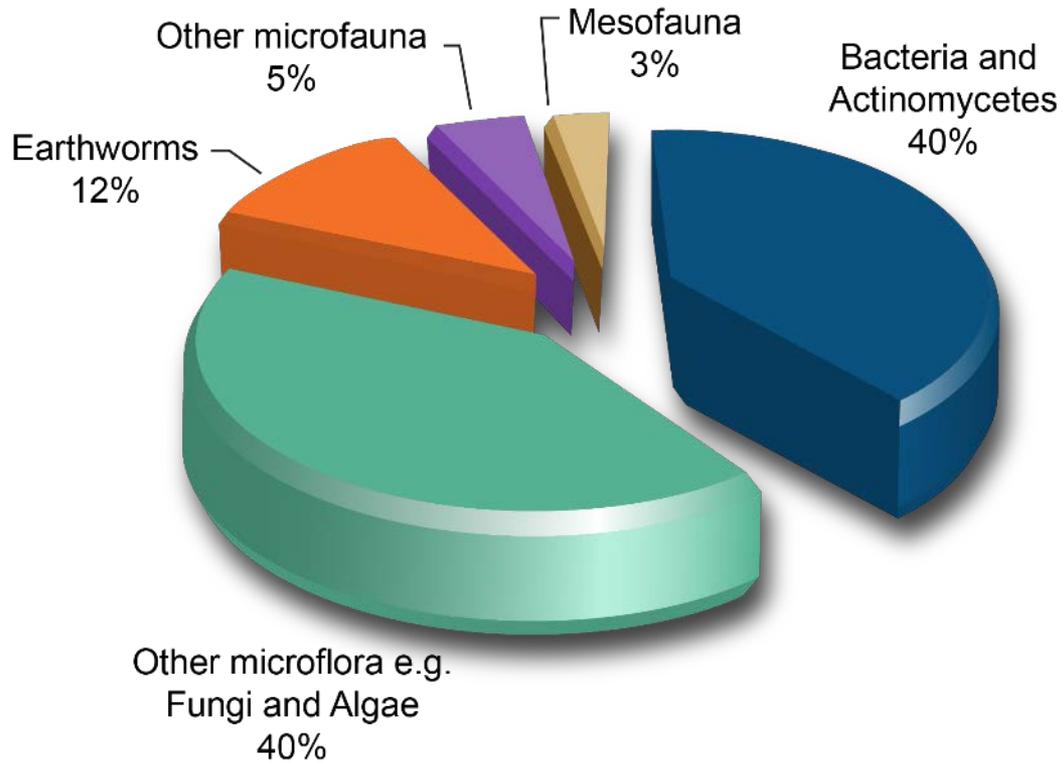
"MICROBIALS" BUSINESS OPPORTUNITY?



Global Crop Microbial Market

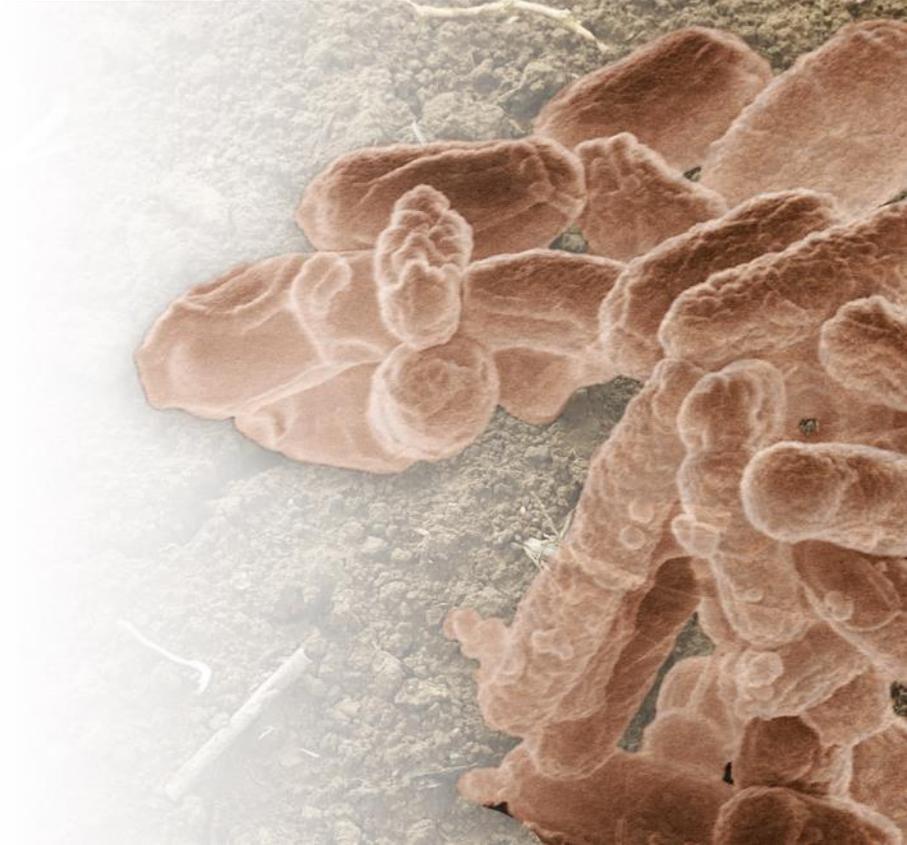


Soil Microflora



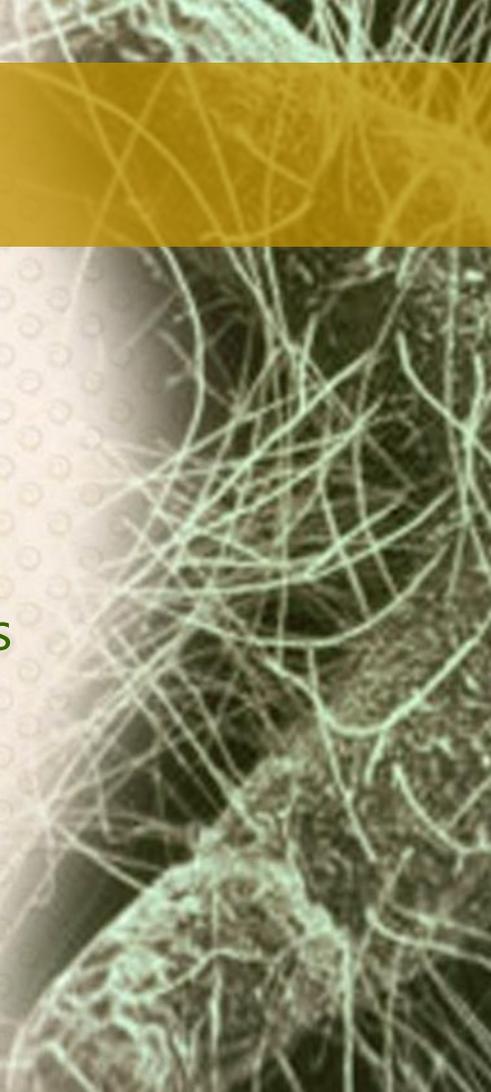
Role of bacteria and actinomycetes

- **Nitrogen fixation**
- Breakdown of pesticides and herbicides
- Bioremediation of heavy metals
- Decomposition of organic material
- Biological waste recycling
- **Suppression of soil-borne pathogens**
- **Plant nutrition**
- Production of antibiotics
- Solubilization of insoluble nutrient sources
- Improving soil aggregation



Rhizobacteria

- Free-living **rhizobacteria** thrive in the rhizosphere where some can enter roots
- Rhizobacteria play several roles
 - Synthesize vitamins, amino acids, auxins, gibberellins that stimulate plant growth
 - Produce antibiotics that protect roots from disease
 - Absorb toxic metals or make nutrients more available to roots

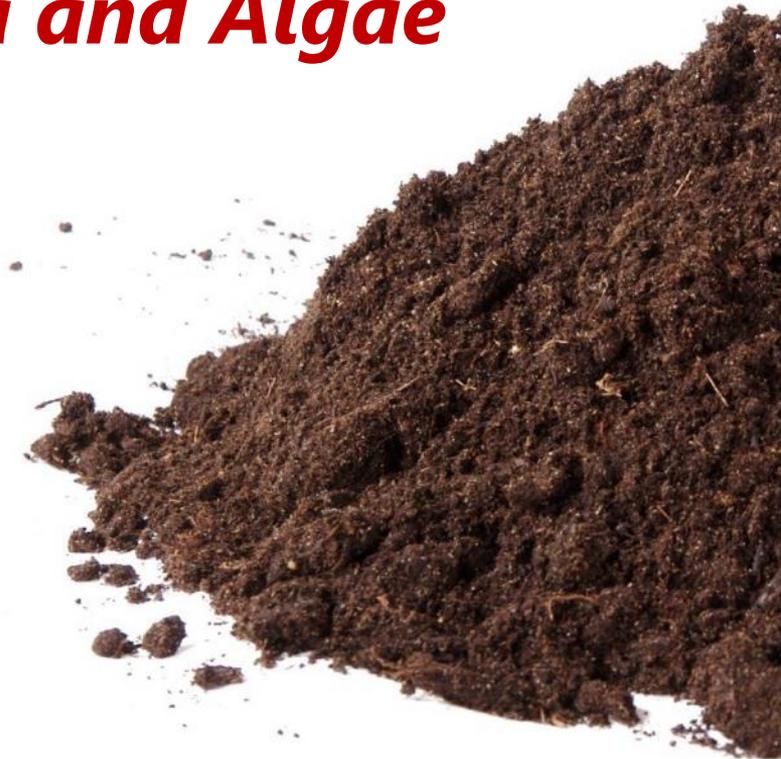


Soil Microflora

40% Fungi, Protozoa and Algae



Other microflora e.g.
Fungi and Algae
40%



Soil Fungi

- Break down most organic matter
- Critical for soil enrichment
- Retain nutrients in the soil
- Compete with plant pathogens







Solid State Fermentation

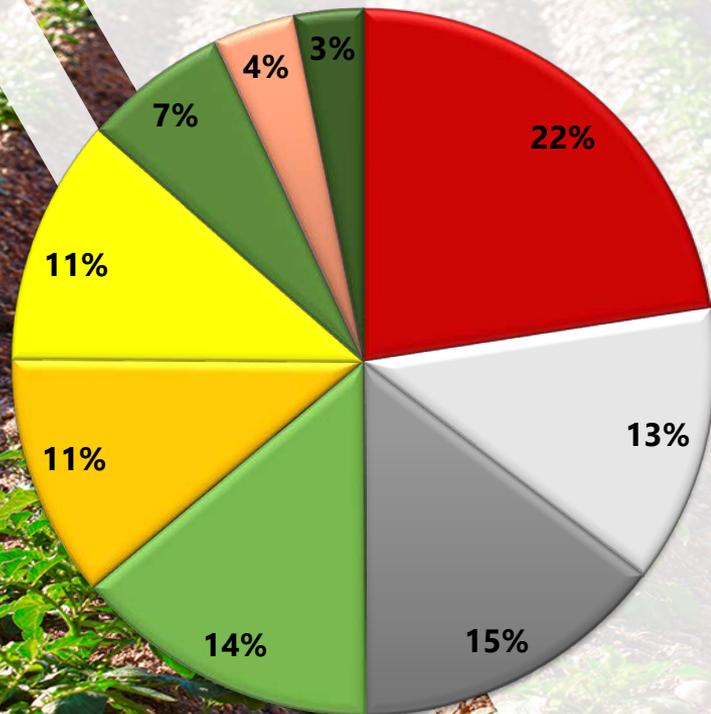


THE ALLTECH APPROACH: *Saving the Banana*

What other agricultural industries can learn from Central America's fight against diseases that threaten the extinction of this household staple

Main Agricultural Products

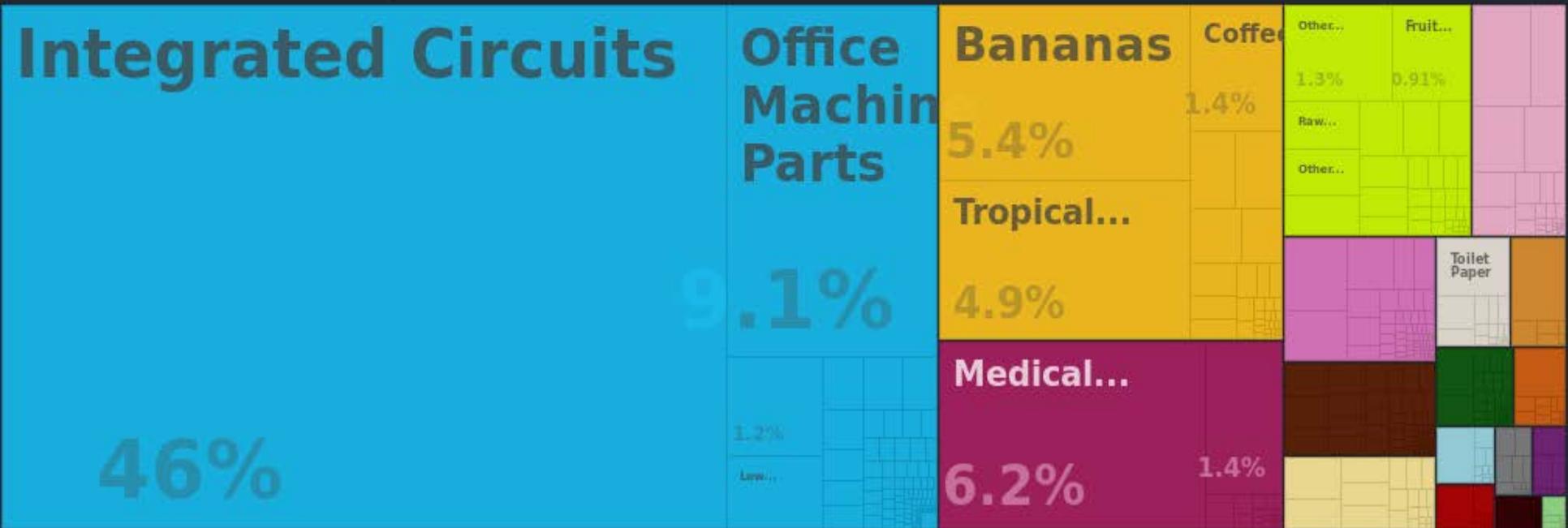
Hectares dedicated by product



- Coffee (85 000)
- Rice (48 000)
- Palm oil (55 000)
- Sugar cane (53 000)
- Pineapple (42 000)
- Banana (42 500)
- Citrus-Oranges (25 000)
- Vegetables (14 200)
- Beans (12 000)

Costa Rica Exports

Total: \$25.6B



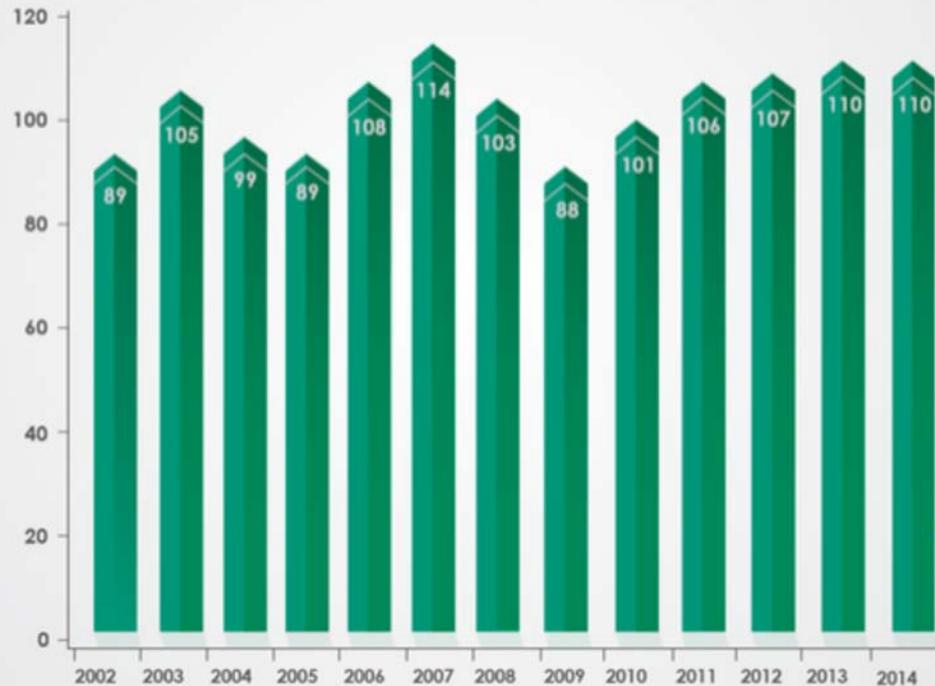
Banana Production Industry



- Bananas are a top 3 crop.
- Costa Rica currently exports an average of 110 million boxes of bananas, equivalent to 10% of world exports.
- Creates over 100,000 jobs or 10% of total workforce.

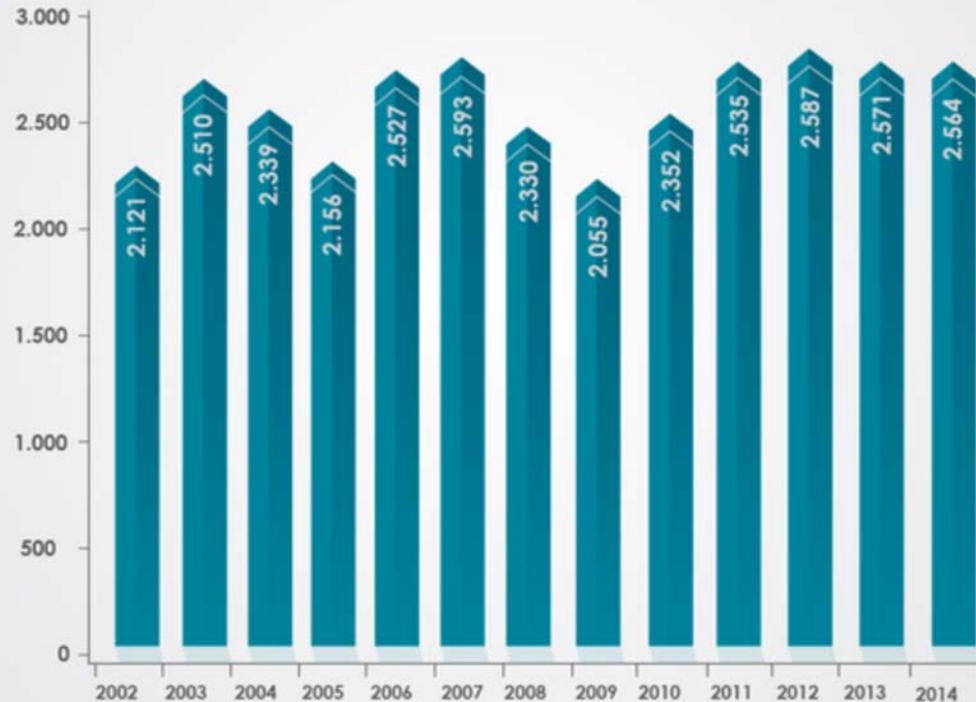
Banana Exports

(million boxes)

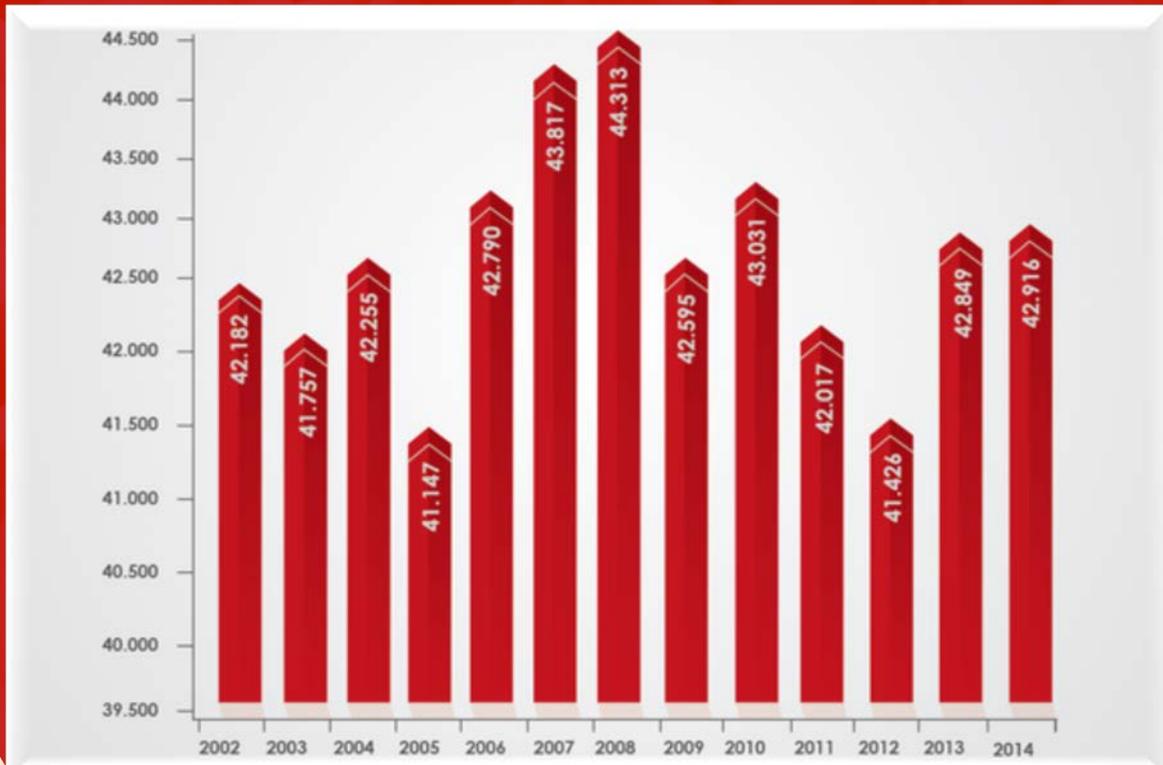


Yield per hectare

(boxes / ha / year)



Export Total Area (hectares)



The Problem?



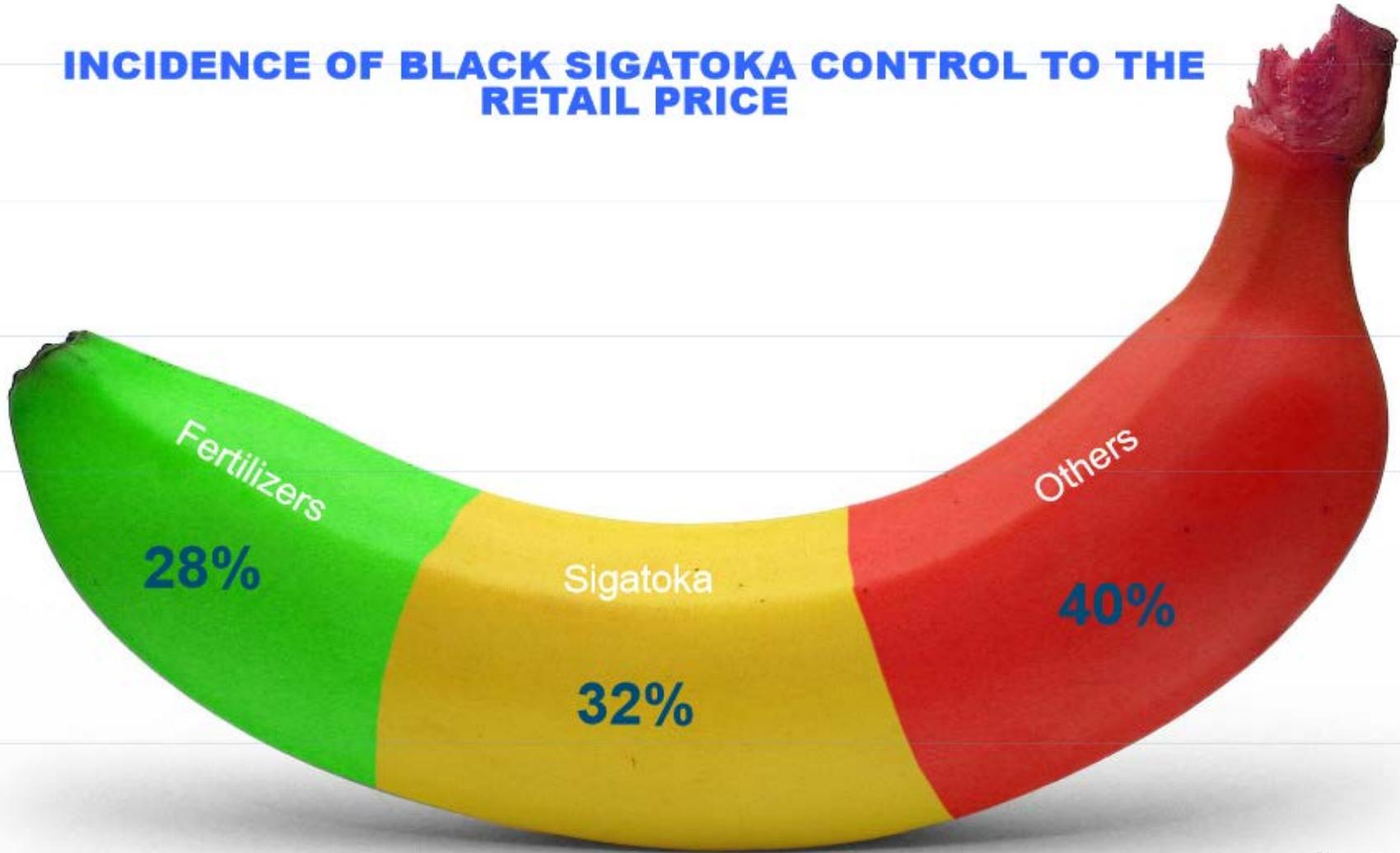
**Black
Sigatoka**



Battling Sigatoka Disease

- Economic impact- 50% Yield Loss
- Increased Production cost of 25%
- Small Farm plantations forced to shut down

INCIDENCE OF BLACK SIGATOKA CONTROL TO THE RETAIL PRICE





Integrated Black Sigatoka Management Program

1. Standardize control measures at a national/regional scale
2. Cultural practices
3. De-leafing
4. Timing and quality of treatments
5. Fungicides by aerial application
6. Monitoring *M. fijiensis* population sensitivity to fungicides (fungicide resistance)
7. Use of resistant cultivars

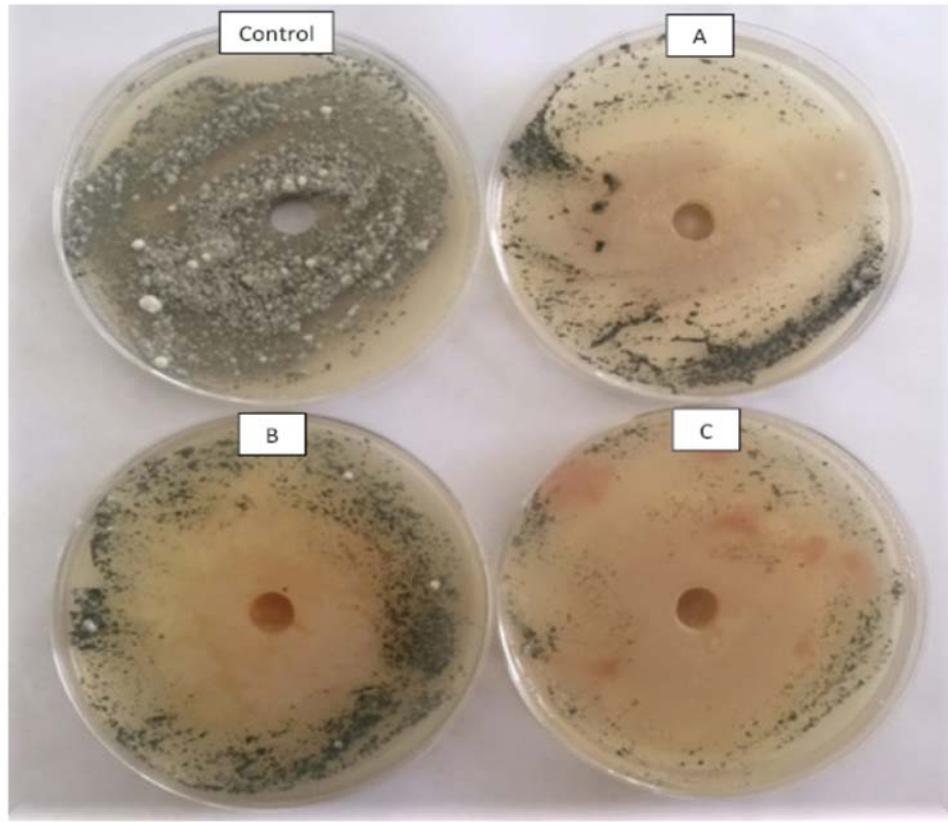


OPPORTUNITY:
We Built a Lab



Inhibition of Black Sigatoka

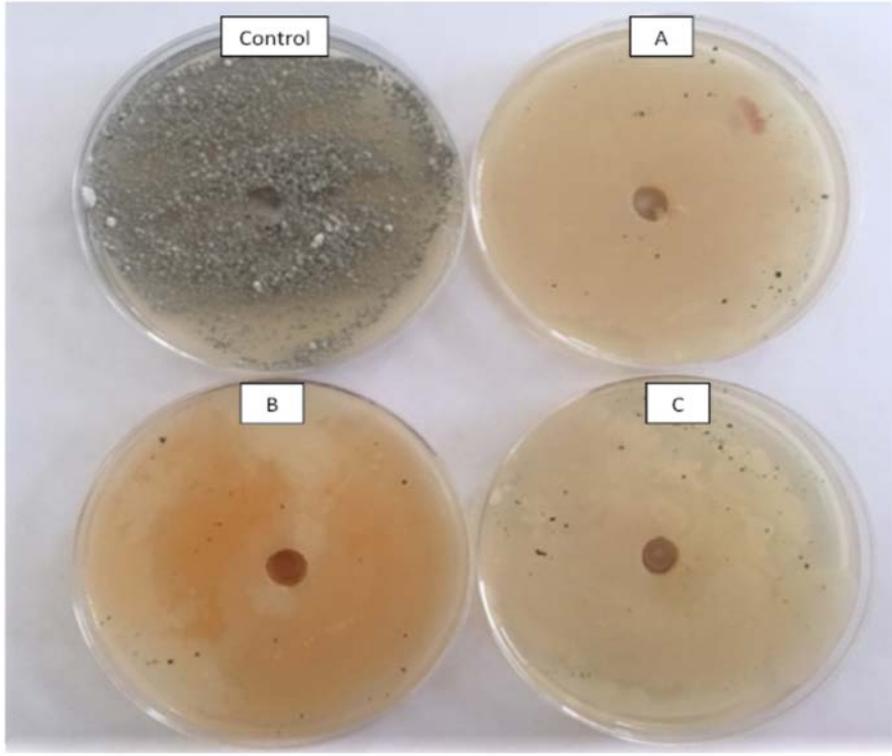
Wild isolate: Zona Testigo San Carlos



Inhibitory effect on the mycelial growth of *Mycosphaerella fijiensis* Alltech product (A-B-C)

Inhibition of Black Sigatoka

Isolate from comercial plantation: Cartagena



Inhibitory effect on the mycelial growth of *Mycosphaerella fijiensis* Alltech product (A-B-C)

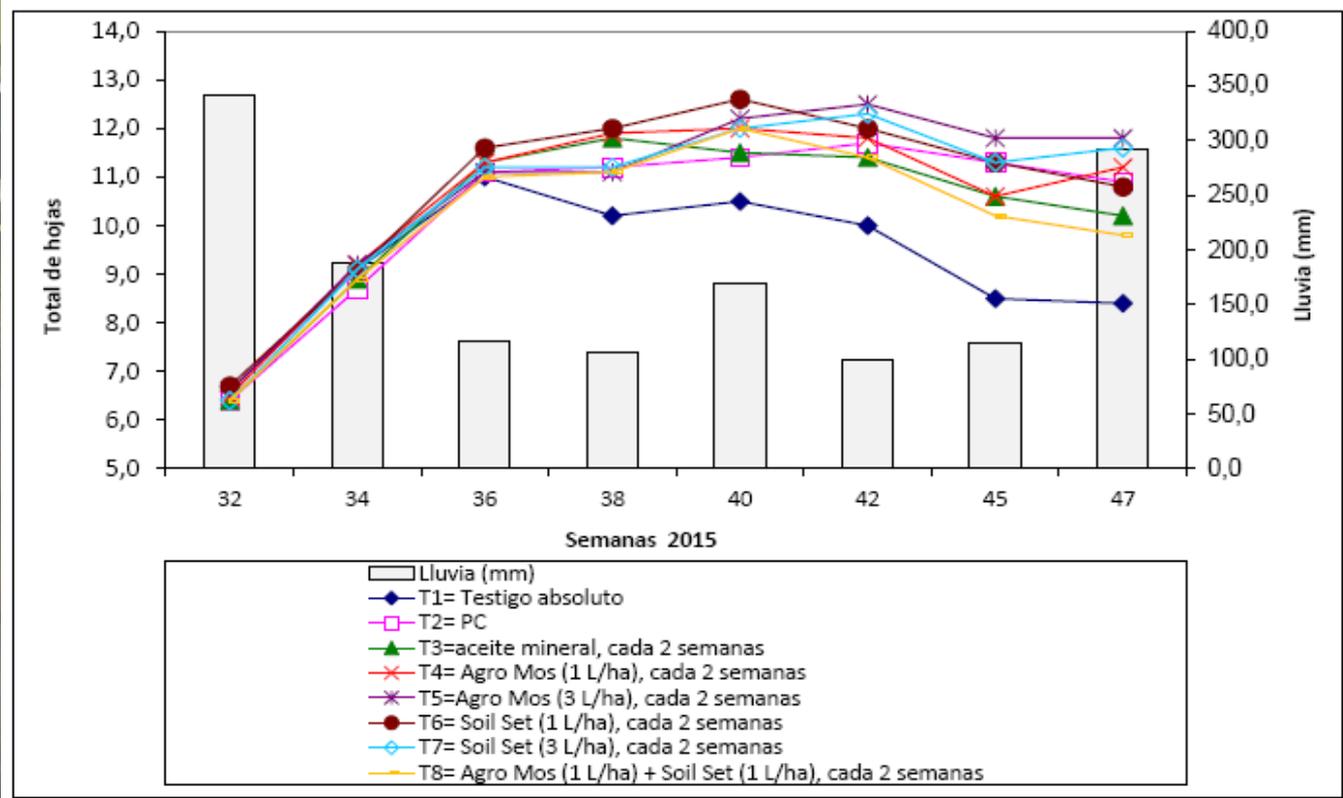


FIELD TRIALS
Bananas
COSTA RICA

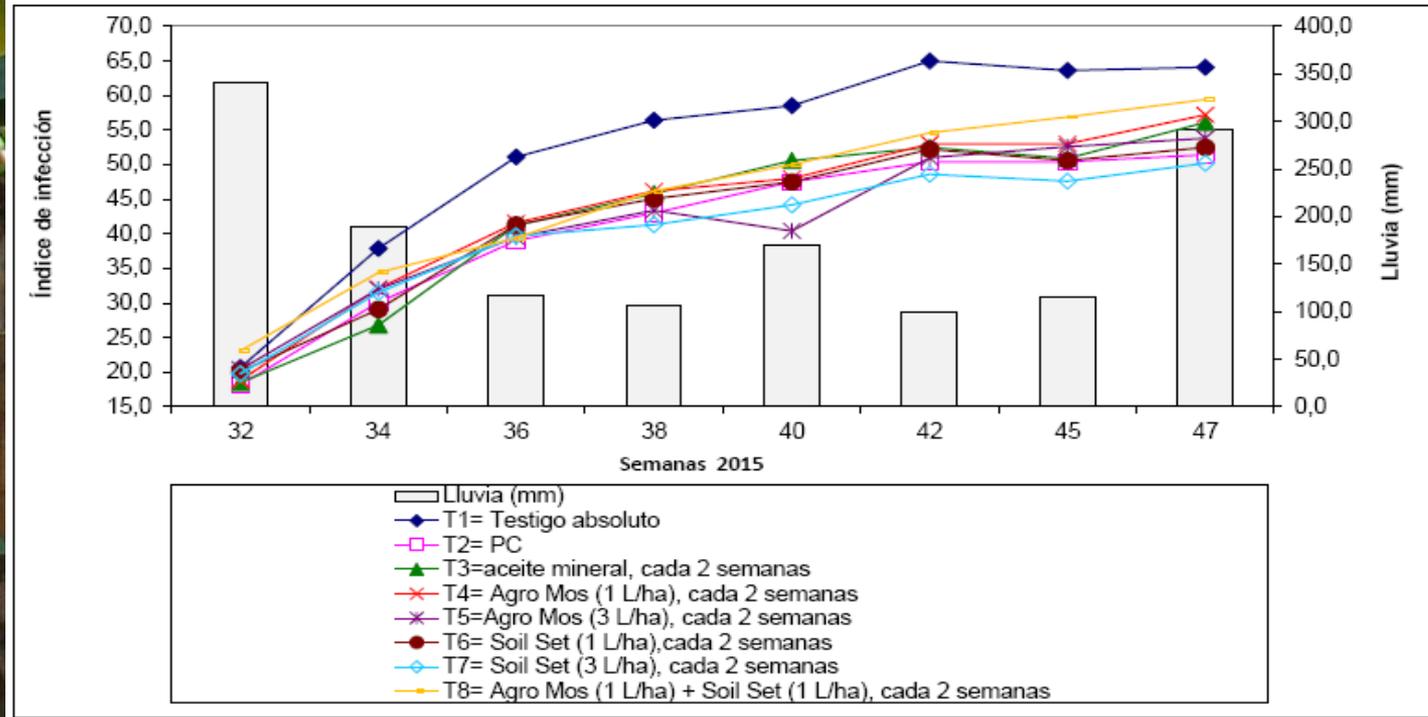
Program Applications

# cycle	Date	Treatment								Oil (L/ha)	Interval (days)
		T1	T2	T3	T4	T5	T6	T7	T8		
1	31/7/15	-	S + DH	S + DH	S + DH	S + DH	S + DH	S + DH	S + DH	7	-
2	10/8/15	-	V + DH	V + DH	V + DH	V + DH	V + DH	V + DH	V + DH	7	10
3	13/8/15	-	DH	AC	AM (1 L)	AM (3L)	SS (1 L)	SS (3 L)	AM (1) + SS (1)	3	3
4	18/8/15	-	DH	DH	DH	DH	DH	DH	DH	2	5
5	25/8/15	-	DH	AC	AM (1 L)	AM (3L)	SS (1 L)	SS (3 L)	AM (1) + SS (1)	3	7
6	31/8/15	-	SG + DH	SG + DH	SG + DH	SG + DH	SG + DH	SG + DH	SG + DH	5	6
7	08/9/15	-	DH	AC	AM (1 L)	AM (3L)	SS (1 L)	SS (3 L)	AM (1) + SS (1)	3	8
8	14/9/15	-	DH	DH	DH	DH	DH	DH	DH	3	6
9	21/9/15	-	DH	AC	AM (1 L)	AM (3L)	SS (1 L)	SS (3 L)	AM (1) + SS (1)	3	7
10	29/9/15	-	OP + DH	OP + DH	OP + DH	OP + DH	OP + DH	OP + DH	OP + DH	7	8
11	06/10/15	-	DH	AC	AM (1 L)	AM (3L)	SS (1 L)	SS (3 L)	AM (1) + SS (1)	3	7
12	14/10/15	-	DH	DH	DH	DH	DH	DH	DH	5	8
13	21/10/15	-	DH	AC	AM (1 L)	AM (3L)	SS (1 L)	SS (3 L)	AM (1) + SS (1)	3	7

Inhibition of Black Sigatoka

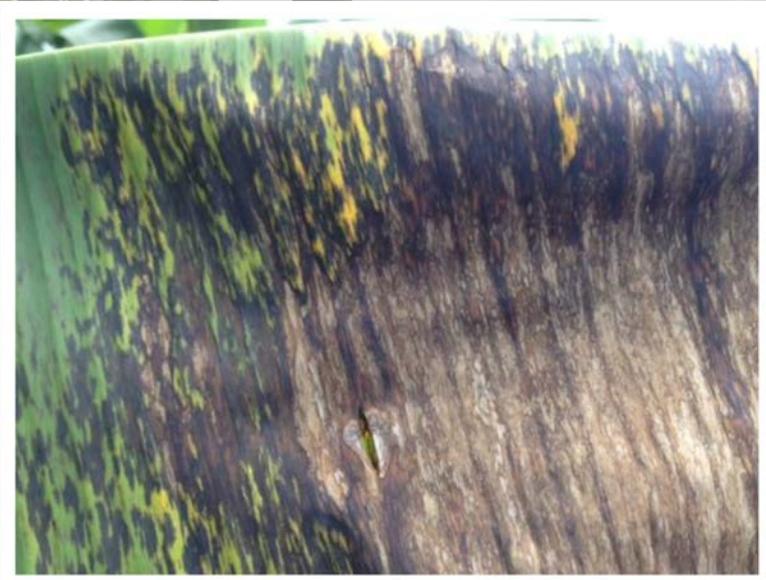


Inhibition of Black Sigatoka



Inhibition of Black Sigatoka

No Control



Treatment



A close-up photograph of a yellow pencil with a silver eraser tip. The pencil is positioned diagonally, with the eraser tip resting on a white surface. The word "CRISIS" is written in red ink on the surface, and the eraser is actively erasing it, leaving behind a cloud of red eraser shavings. The lighting is dramatic, with strong shadows and highlights, emphasizing the texture of the paper and the eraser.

CRISIS

New Crisis: "Fusarium Race 4"



Tropical race 4 (TR4) is the name given to the fungal strains of *Fusarium oxysporum* f. sp. *Cubense* (*Foc*) that cause Fusarium wilt (popularly known as Panama disease).

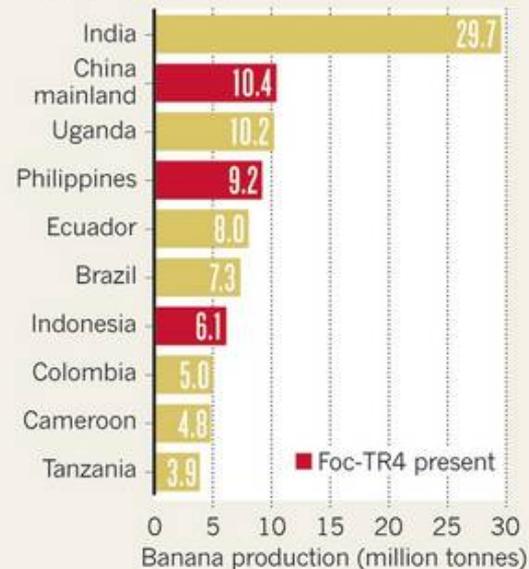
New Crisis: "Fusarium Race 4"



-  **Problem Area (Race 1)**
 This area is under attack by Race 1 of Panama disease.
-  **Problem Area (Tropical Race 4)**
 This area is under severe attack of the new Tropical Race 4 (TR4) strain of Fusarium.
-  **Banana daily diet area**
 This area is on risk. The farmers here made the banana their living.

FRUIT THREAT

A fungus strain that kills banana plants has been detected in three of the world's top producers of the fruit.



How to recognize TR4



G. Blomme

Leaf yellowing and wilting



M. Dita

Splitting of the pseudostem



M. Dita

Emerging leaf symptoms



A. Javellana

Pseudostem discolouration



**Why bananas as we know them
might go extinct (again)
Oct. 2015**

**[UPDATED] New Study
Confirms That Bananas
Are Going Extinct
A fungal disease is
wreaking havoc on the
world's favorite fruit.
Dec. 2015**



6th International banana CONGRESS

XXI International Meeting ACORBAT

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***What if the silver bullet...
is just a myth?***



Greater than \$23 million in federal research grants and extension funds to find a cure...

But what is the best approach?

Feb. 26, 2015

US EPA approves emergency use of clothianidin for Florida Citrus

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Source: U.S. EPA

Tags: [US EPA](#), [tolerance](#), [clothianidin](#), [Florida](#)

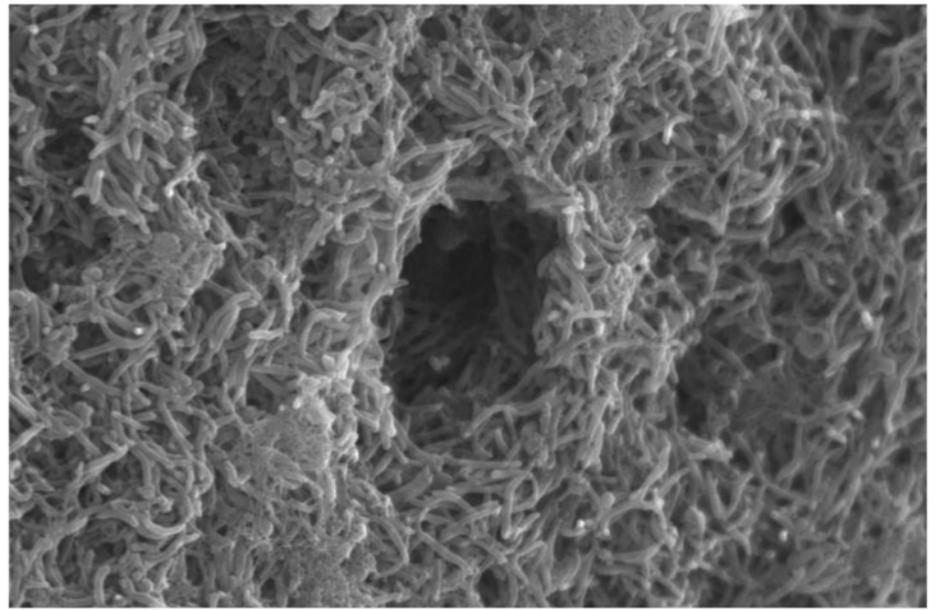
The US Environmental Protection Agency (EPA) has established a time-limited tolerance for residues of clothianidin in citrus of Florida. The time-limited tolerance is effective on February 25, 2015, and expires on December 31, 2017. Objections and requests for hearings must be received on or before April 27, 2015.



The Florida Department of Agriculture and Consumer Services requested the EPA Administrator to issue a specific exemption for the use of clothianidin as a



Focus on this bug? ...or that bug?



...or the tree?





Surprising find: UF/IFAS discovers citrus greening affects roots before leaves

🕒 Published: April 30 2014

📂 Category: Agriculture, Business, Florida, Research

GAINESVILLE, Fla. — Although citrus greening enters trees through their leaves, [University of Florida](#) researchers have discovered that the deadly disease attacks roots long before the leaves show signs of damage – a finding that may help growers better care for trees while scientists work to find a cure.

"The role of root infection by insect-carried bacterial pathogens has been greatly underestimated," said Evan Johnson, a research assistant scientist with [UF's Institute of Food and Agricultural Sciences](#).

Hundreds of researchers around the world are rushing to find a viable treatment for citrus greening, which is devastating Florida's \$9 billion citrus industry and has affected citrus production throughout North America.

WHAT'S THE SOLUTION?

- **Outside the box thinking**
- **Fermentation capabilities**
- **Plant nutrition**
- **Can we culture the pathogenic bacteria?**



Biological Product Development

Program to develop and screen microbial and natural control strategies for plant pathogens

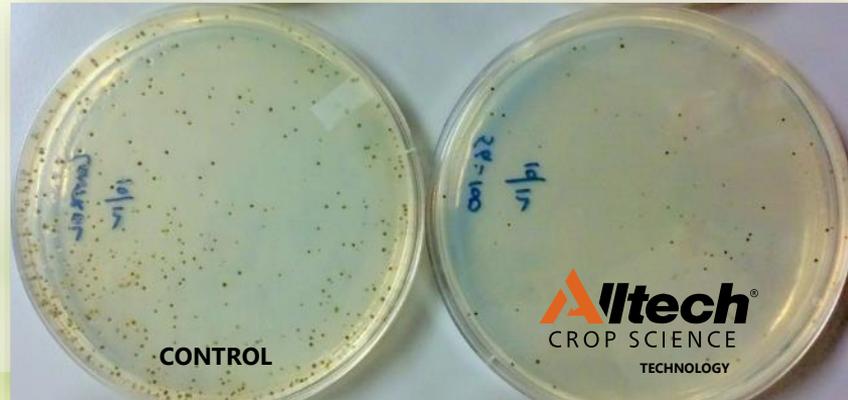
Trichoderma spp.

Inoculation of Yucca roots



Mycosphaerella fijiensis

Black sigatoka banana disease control





Solutions?

Innovation
Speed
Implementation



one

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Co-founder of Apple Computer, Inc.
and Chief Scientist of Primary Data



Alan Mulally

President and CEO,
Ford Motor Company (2006-2014)



John Calipari

Head Coach,
University of Kentucky
Men's Basketball team

