The physiology of symbiotic plant nutrition

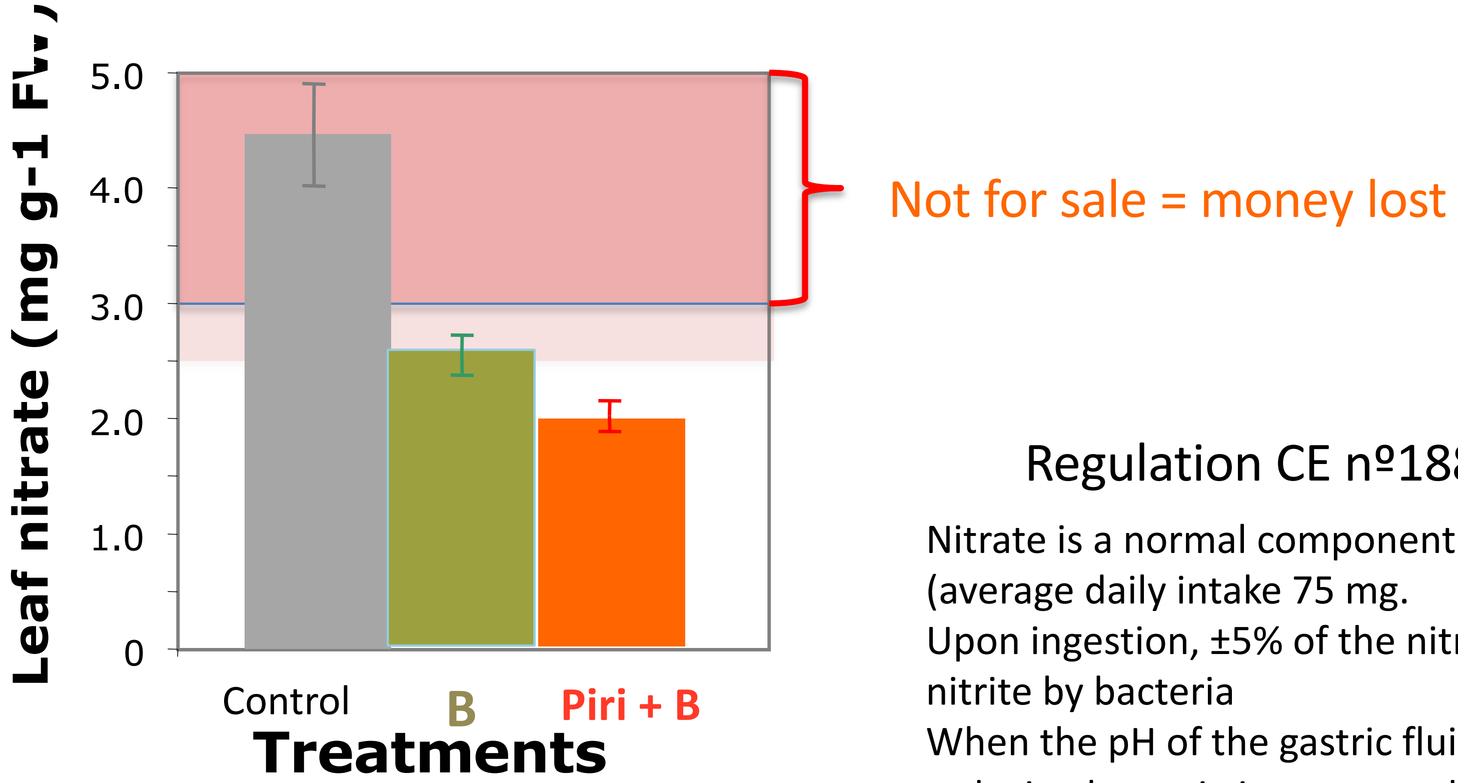
– Cristina Cruz –

ccruz@fc.ul.pt

Why do we need biofertilizers?

response of spinach to soil inoculant

Leaf nitrate



Regulation CE nº1881/2006

Nitrate is a normal component of the human diet (average daily intake 75 mg.

Upon ingestion, ±5% of the nitrate is reduced to nitrite by bacteria

When the pH of the gastric fluid is high (>5) nitrate-reducing bacteria increase and more N-nitroso compounds can be formed.

What do biofertilizers do?

Deciphering interactions

roots

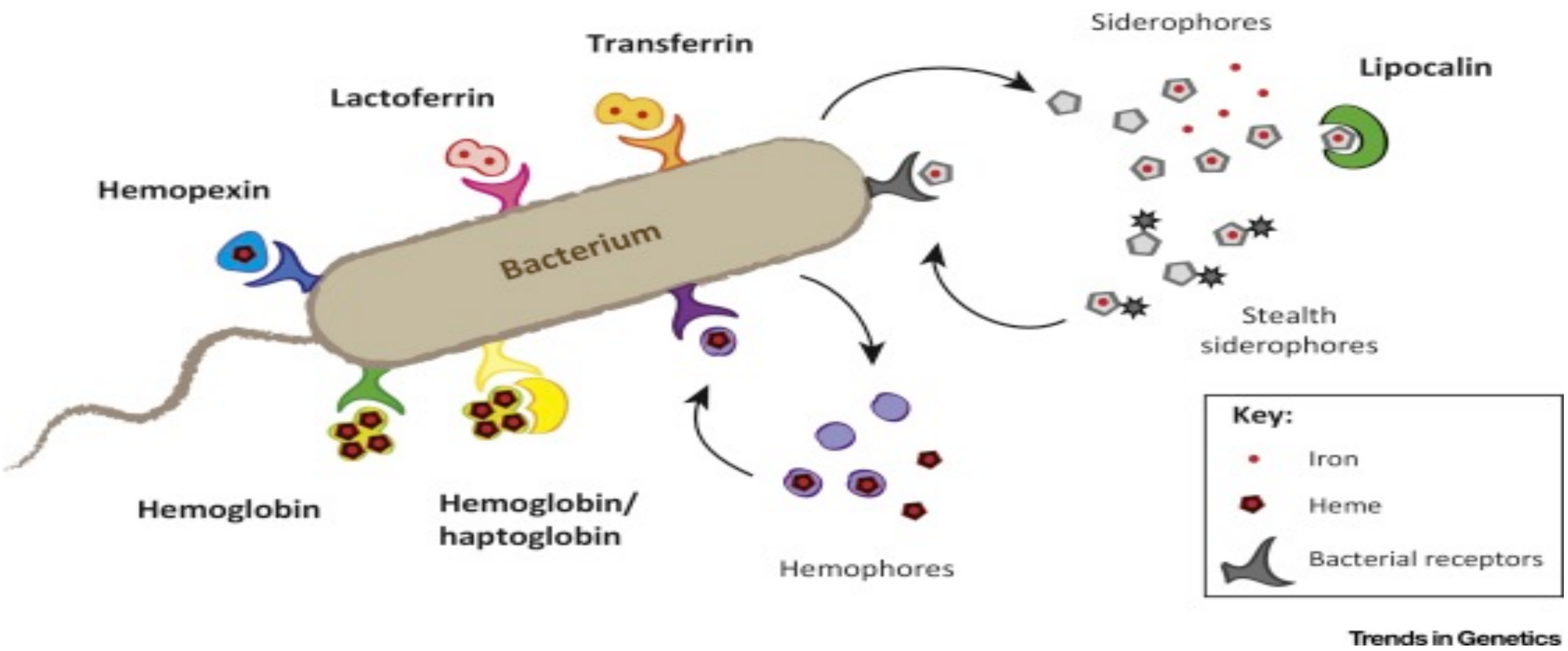
Endophytic fungi

Rhizo bacteria

Soil

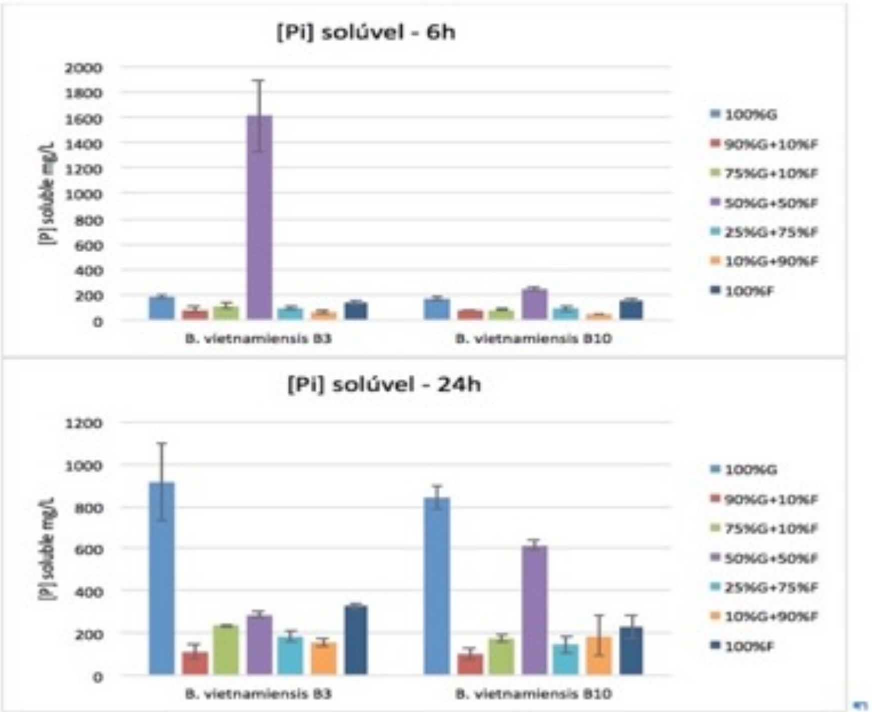
What do biofertilizers do?

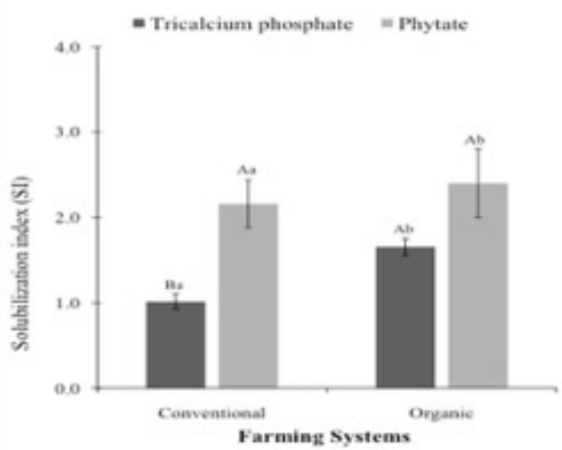
Iron dynamics in soils



Why do we need **biofertilizers**?

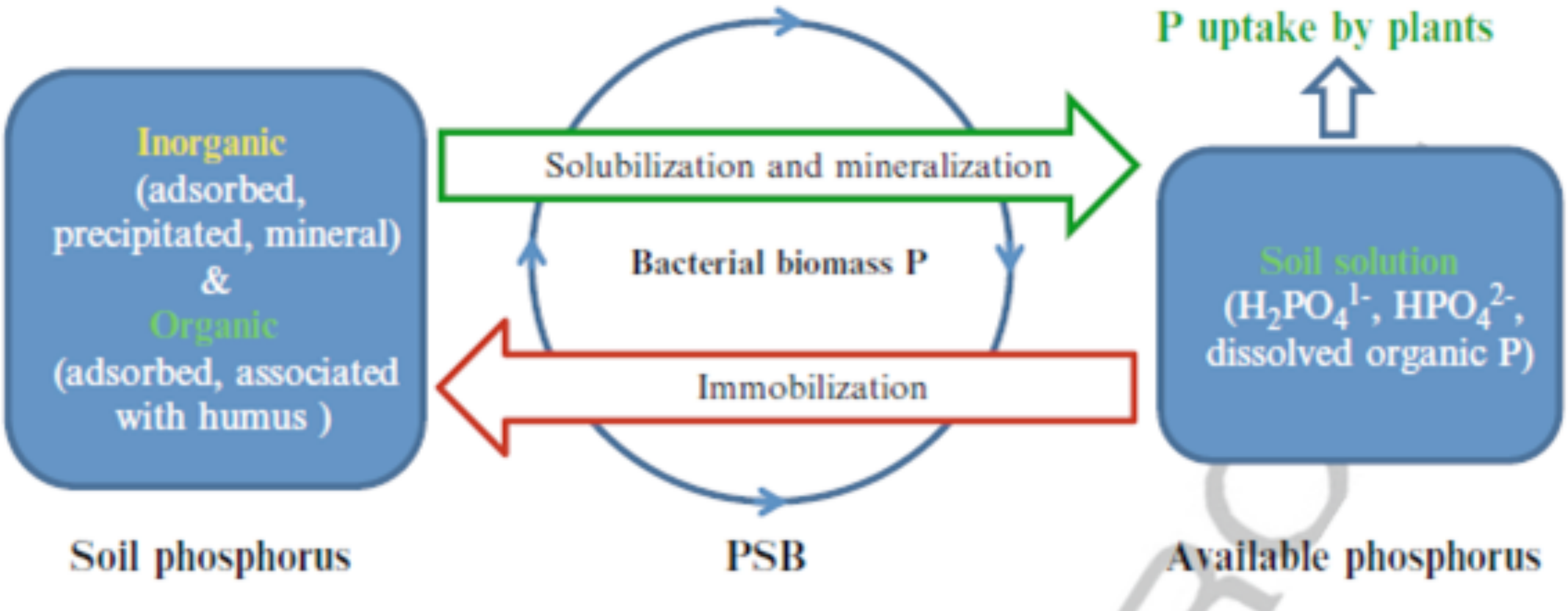
Phosphorus dynamics in soils





What do biofertilizers do?

Phosphorus dynamics in soils



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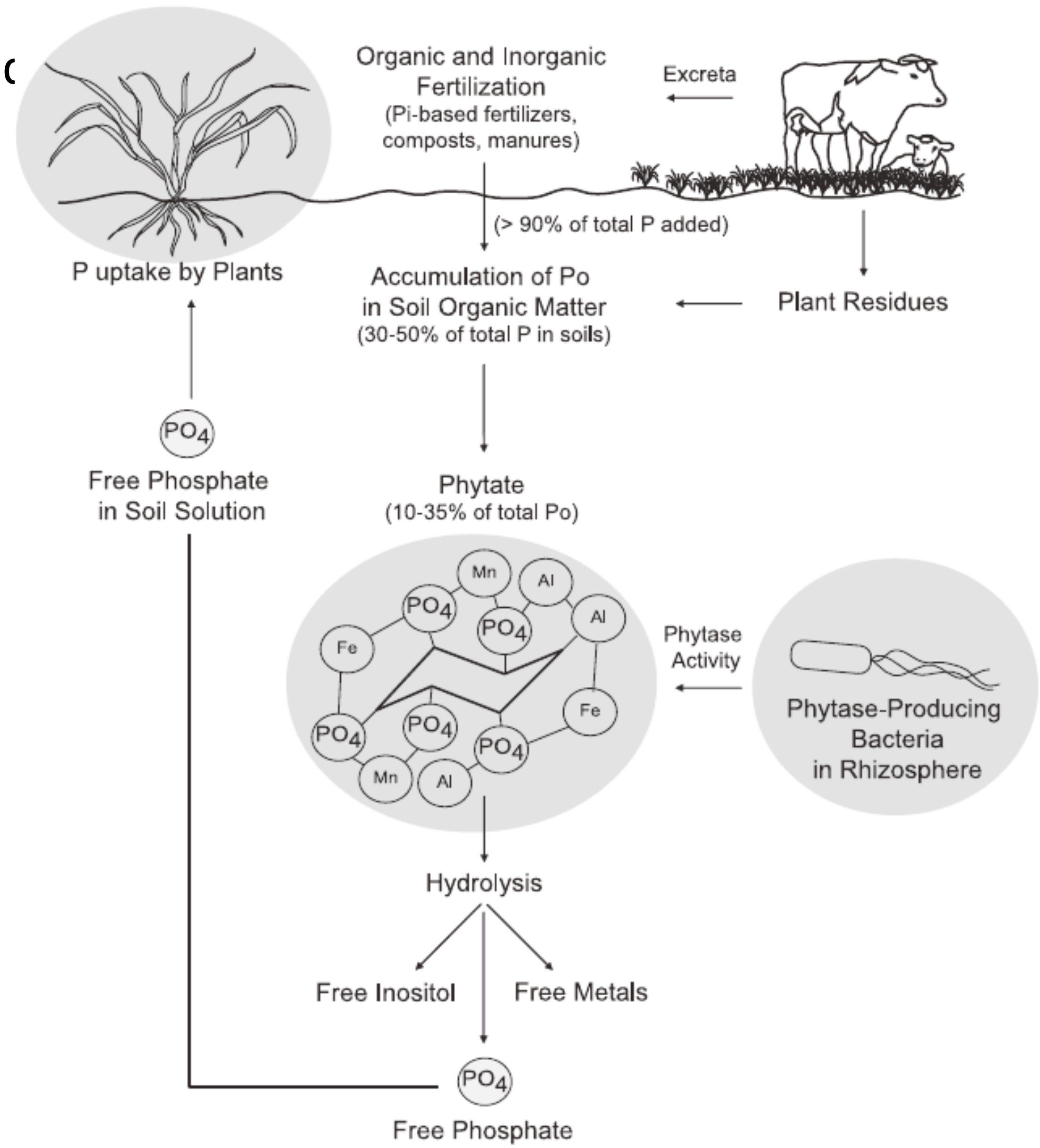
Phosphorus dynamics in soils



What do **biofertilizers do**?

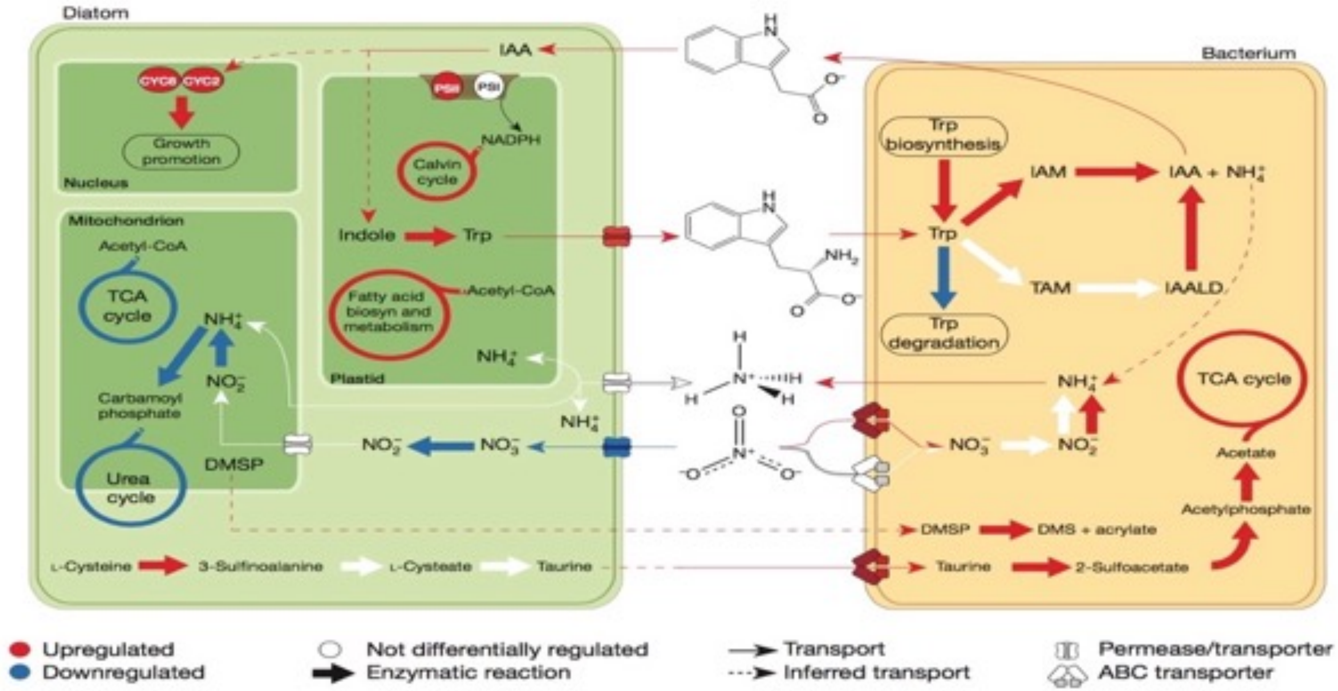
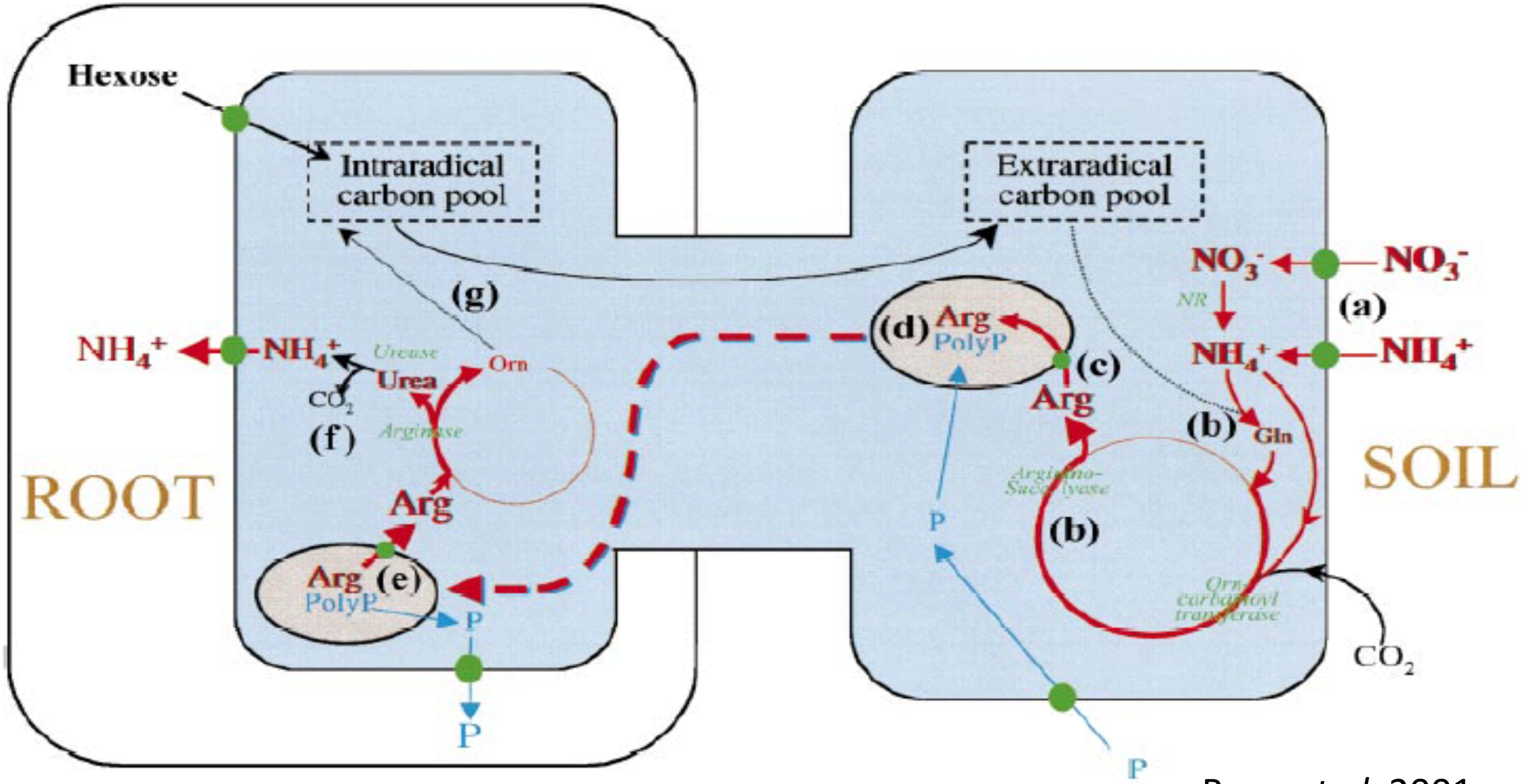


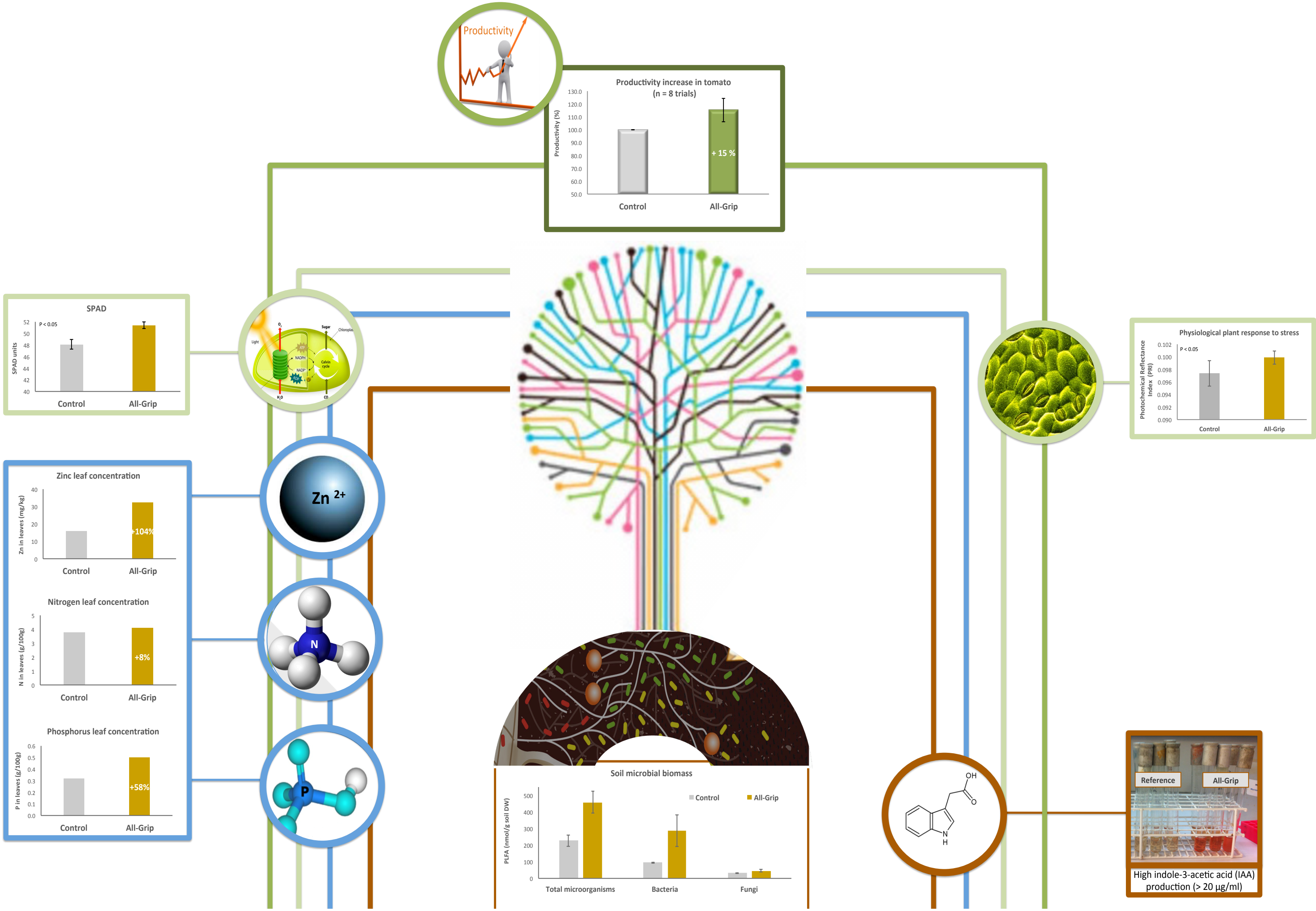
Figure 2 | Model of *P. multiseries–Sulfitobacter* interactions based on transcriptomic and targeted metabolite analyses. Molecules with a structure indicate detection in the co-culture supernatant. Genes/transporters/metabolic cycles are shown as upregulated (red), downregulated (blue), or not differentially regulated (white) in co-culture relative to monocultures. Metabolic cycles were assigned an expression pattern if at least one gene specific for the cycle was differentially expressed and no others were regulated in the opposite direction. Supplementary Information Tables 1 and 2 list fold-expression and statistical significance based on triplicate biological experiments. IAA potentially regulates expression of two cyclins that typically regulate the cell cycle[30]. Trp, tryptophan; DMS, dimethyl sulfide; PSI, PSII, photosystem I, II; CYC2, CYC8, cyclins 2 and 8; IAALD, indole-3-acetaldehyde.

What do **biofertilizers do**?



Bago *et al*. 2001
Cruz et al. Plant Physiol, 2007

BiOfertilizante



What do **biofertilizers do**?

Metabolomic analysis

FTICR-MS – Fourier Transform Ion Cyclotron Resonance Mass Spectrometry

What do **biofertilizers** **d**o?

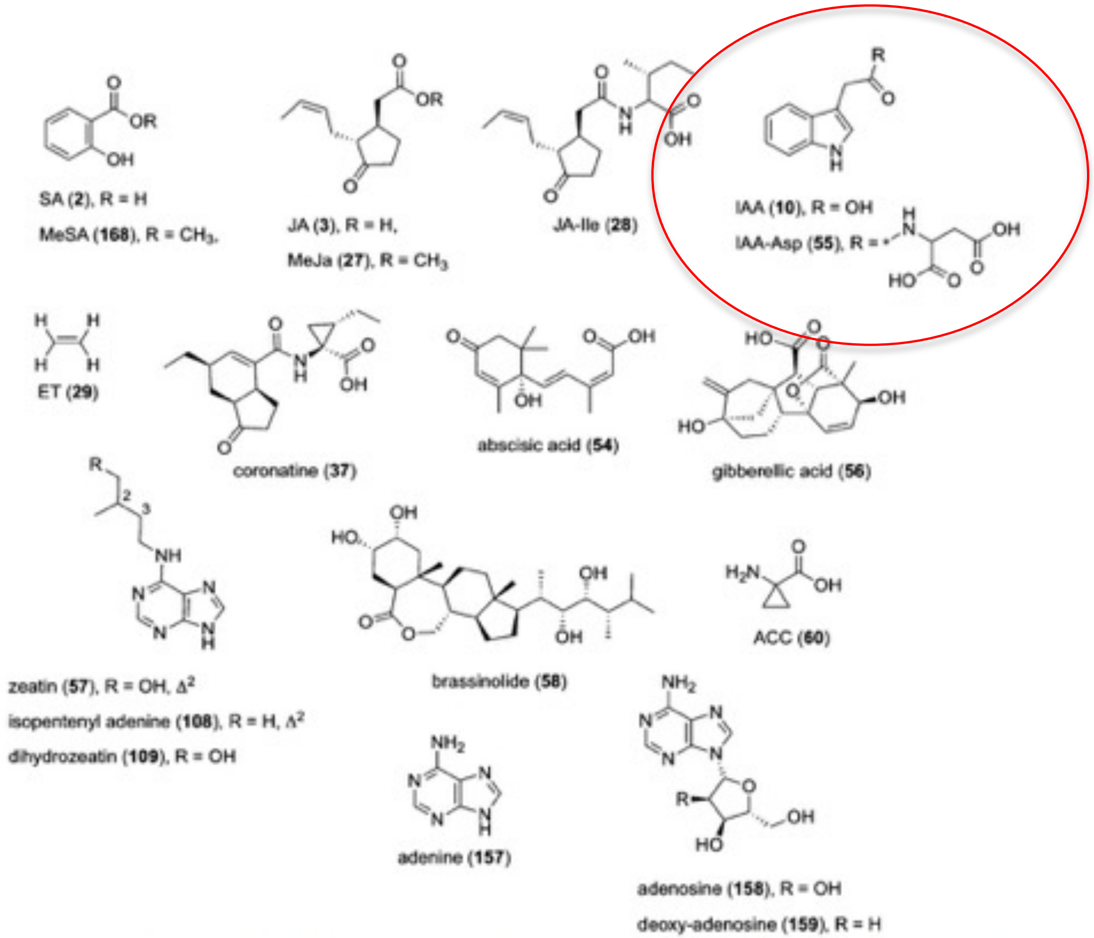
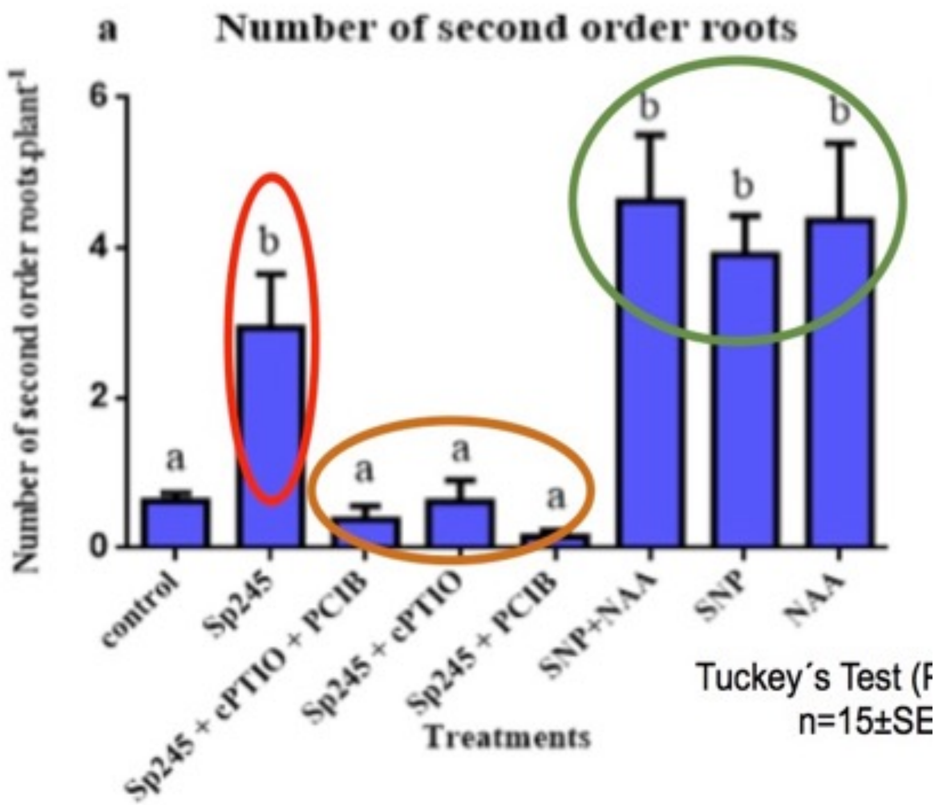


Chart 4 Plant hormones (except strigolactones), their derivatives, analogs, precursors and the JA-Ile mimic compound coronatine

What do biofertilizers do?



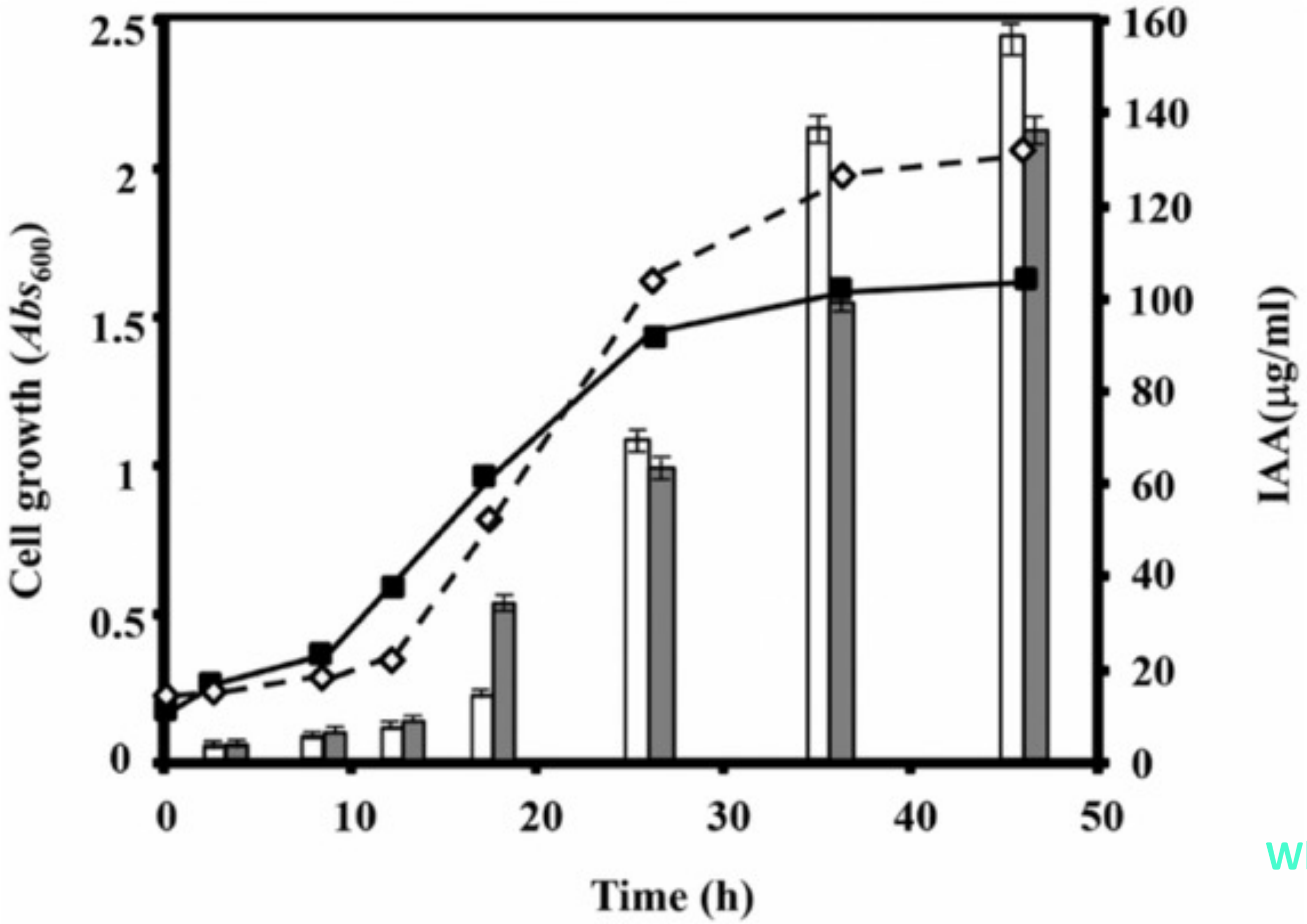
Inoculation with *A. brasilense* Sp245 or ARG2, increased the number of second order roots.

Application of a NO scavenger (cPTIO) and an auxin scavenger (PCIB), either together or apart, block the effects of inoculation

Application of a NO donor (SNP) and a synthetic auxin (NAA), either together or apart, mimic the effects of inoculation.

NO and auxins mediate the *A.* brasilense-induced increase in the number of second order roots in wheat

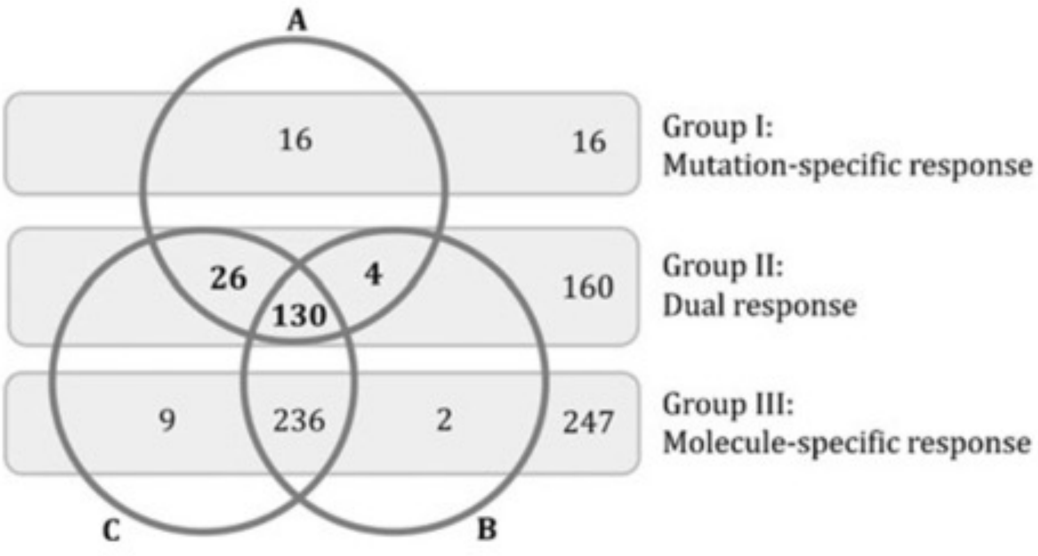
What do **biofertilizers do**?



What are the functions of IAA in *Azospirillum*?

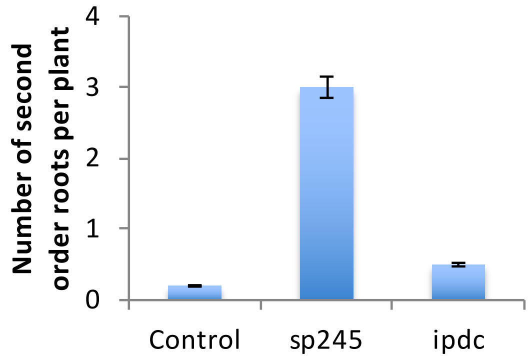
What do biofertilizers do?

Transcriptome Analysis of the Rhizosphere Bacterium *Azospirillum brasilense* Reveals an Extensive Auxin Response



Venn diagram showing the distribution of genes with significant differences in absolute fold Change. A significantly expressed genes, comparing wild type with ipdC mutante gene profile without the addition of IAA. B and C genes with a significant altered expression by addition of IAA to the wild type and ipdC mutant strain, respectively

Ferreira et al 2019, Frontiers in Microbiology



How do **biofertilizers** **work**?

But the question is how does the biofertilizer promote Plant growth?

Increased nutrient availability does not imply improved growth

What do **biofertilizers do**?

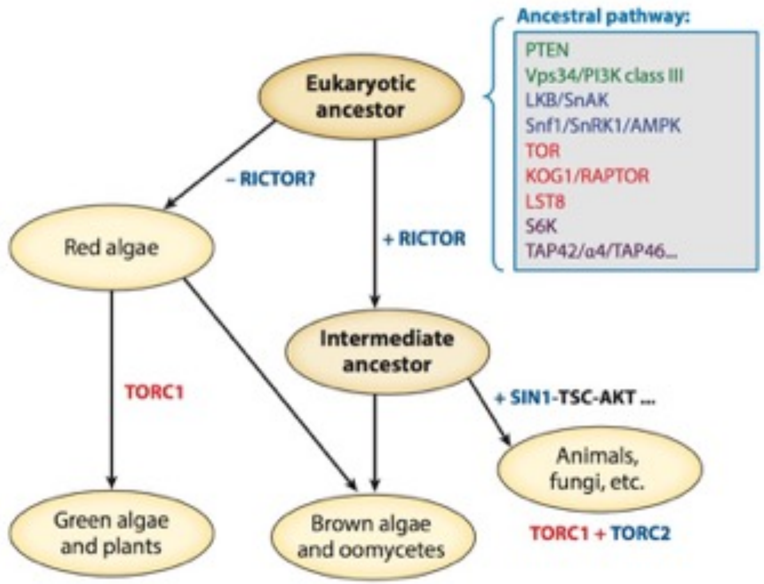
Auxin is essential in mediating *the Azospirillum* PGPR effect

(For other organisms it may be sugars, or other compounds)

So what is the mechanism that triggers the effect?

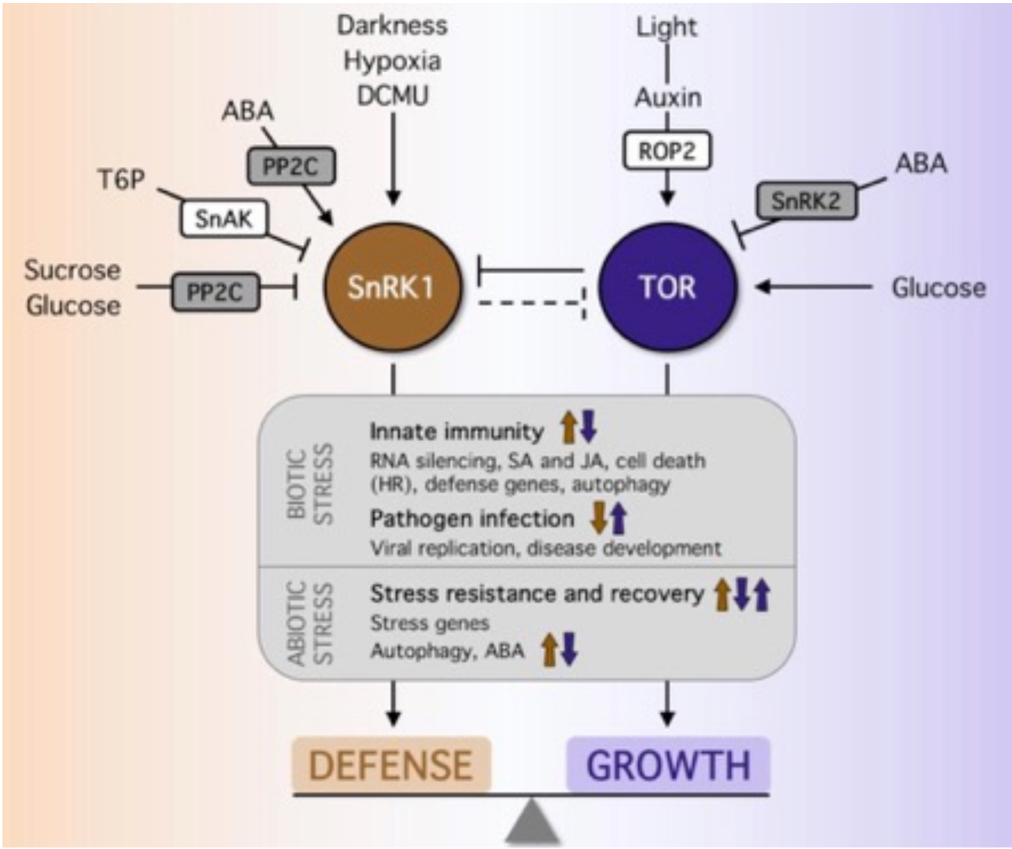
What do biofertilizers do?

Target of rapamycin (TOR) is a good suspect!



An evolutionary model of the eukaryotic TOR signaling pathway, showing the possible loss or acquisition of TOR signaling modules from the putative common eukaryote ancestor. The gray box lists the possible primitive eukaryotic core signaling components, with colors indicating different regulatory modules.

What do **biofertilizers do**?



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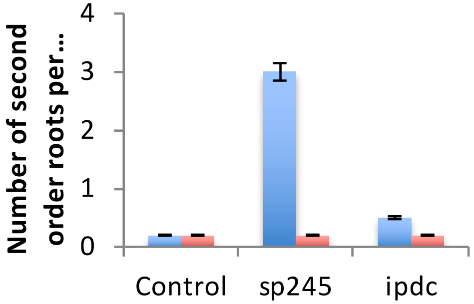
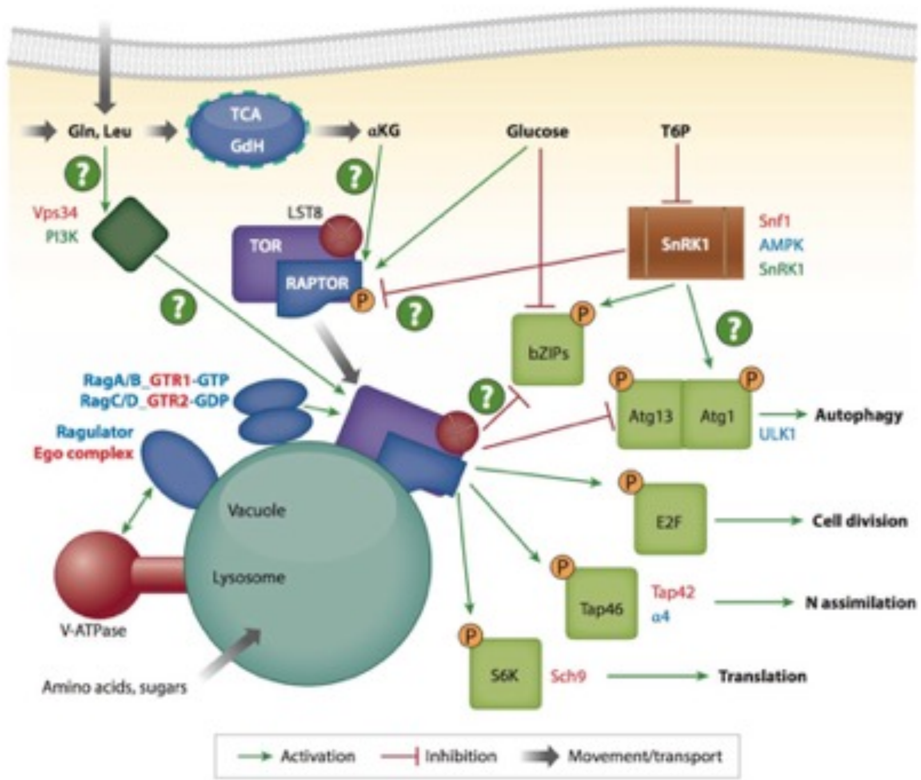


With the inhibitor AZD8055



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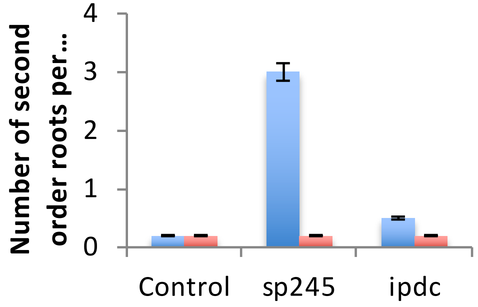
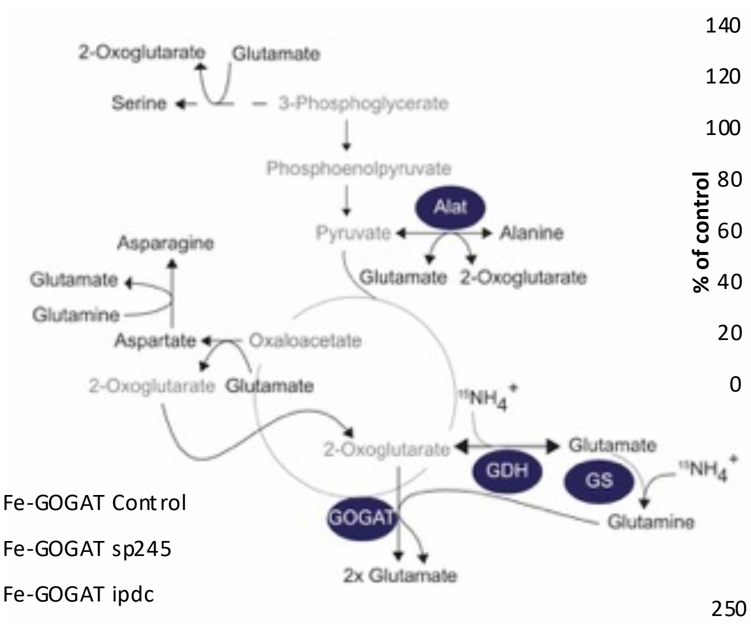
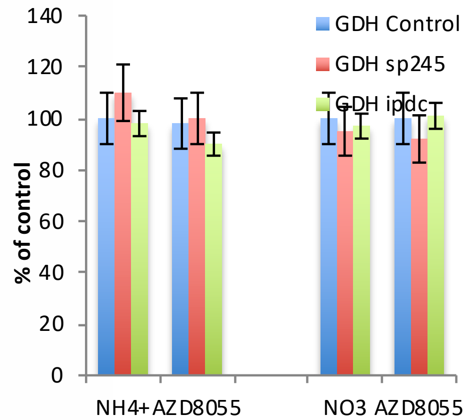
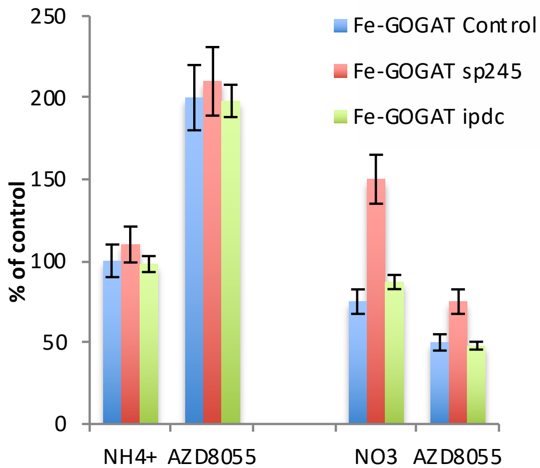
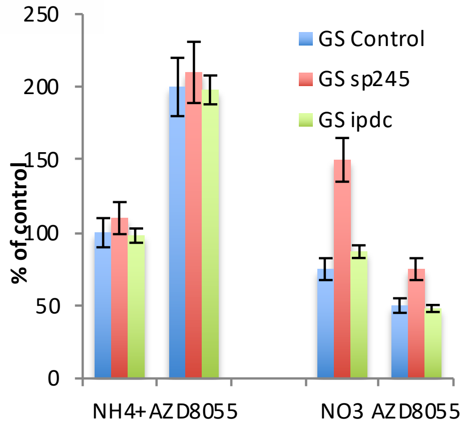






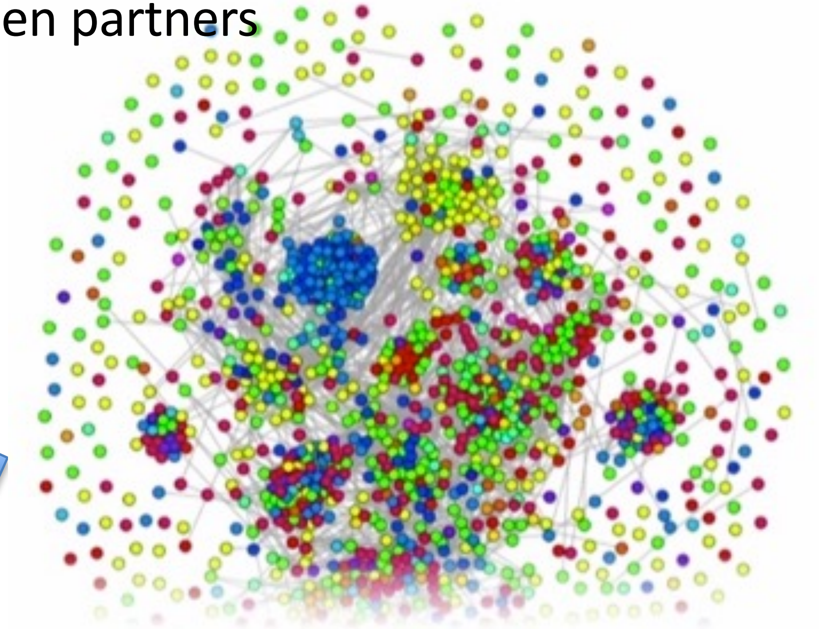




Mubeen et al 2019

Plant nutrition is optimize by a constant communication between partners

We live in a world of fast responses -



“Phytohormones are part of a common language