



# **Rhizobacteria for reduced fertiliser inputs in wheat**

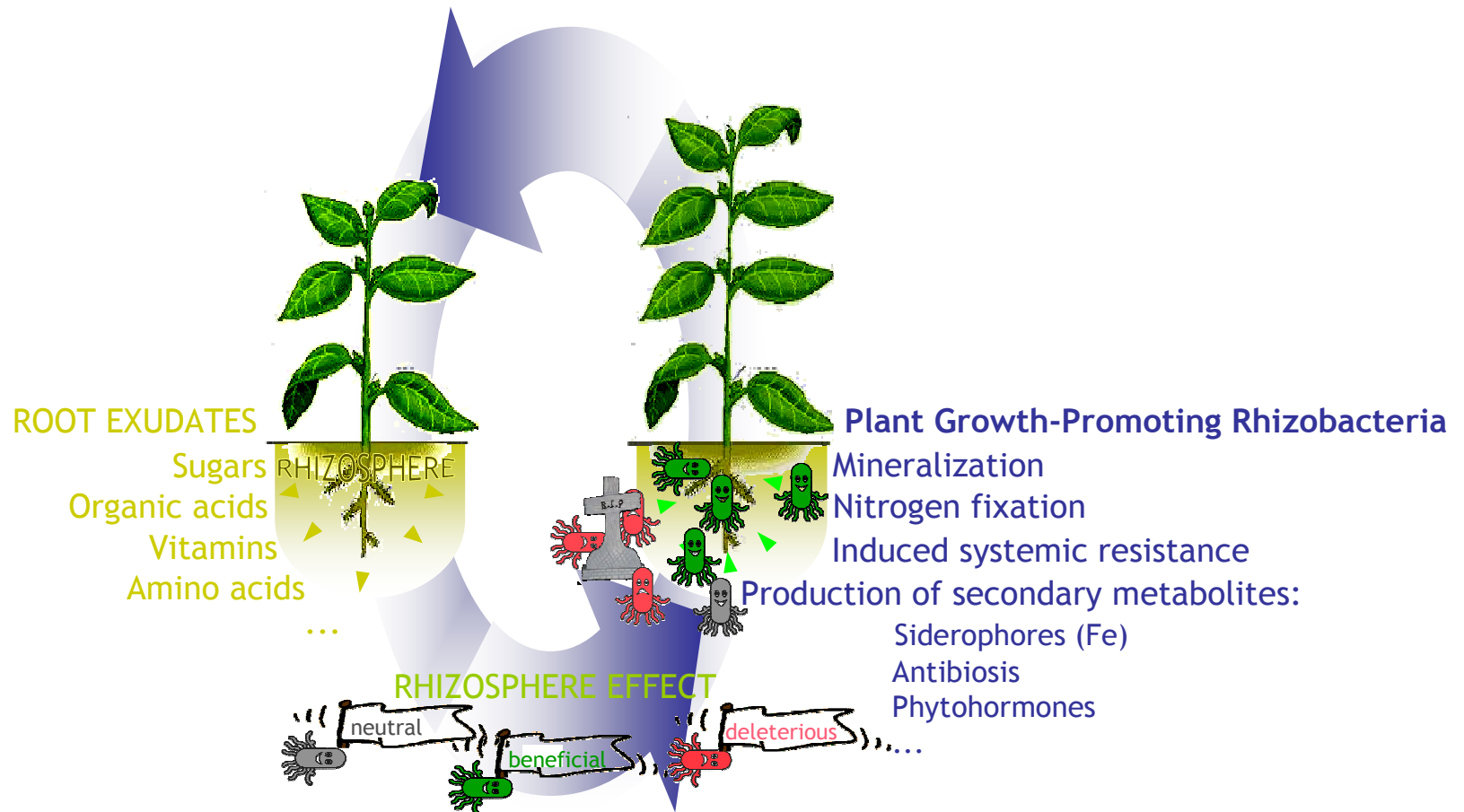
Press Meeting May 2010, Essex, UK

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May, 13th 2010



DISEASE CONTROL  
STIMULATION OF PLANT GROWTH & YIELD





Traits for rhizosphere competence	Bacterial determinants
Directed movement towards plant roots	Flagellae, proton motive force, pili, chemotaxis
(Rapid) response and adaptation in response to environmental (plant) signals	Two-component signal transduction systems, phase variation, plant-inducible genes
Growth and survival in the rhizosphere	Versatile metabolic activities, high-affinity substrate transporters, production of enzymes involved in metabolism of plant cell wall compounds
Ability to compete for limited nutrients, oxygen and colonization sites	Siderophores, high-affinity substrate transporters, high growth rates, use of alternative e- acceptors
Ability to attach rapidly and firmly to plant roots and to disperse on plant roots	Flagellae, outer membrane proteins, extracellular polysaccharides



## Biological nitrogen fixation (BNF)



Well known from symbiosis of rhizobia – legumes

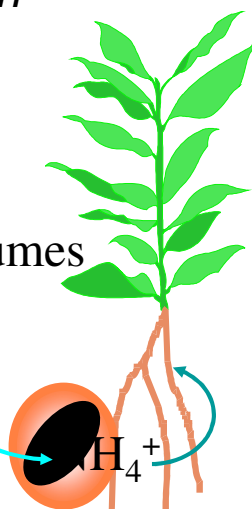
In non-symbiotic conditions fixed N does not contribute for the plant



*Rhizobium*

$N_2$

legumes

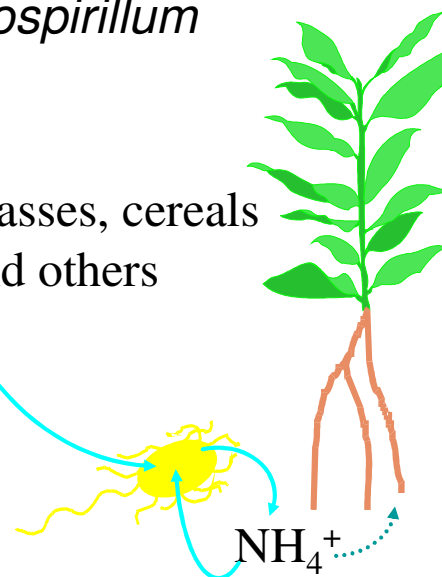


> 200 kg N ha<sup>-1</sup> year<sup>-1</sup>

*Azospirillum*

$N_2$

grasses, cereals  
and others

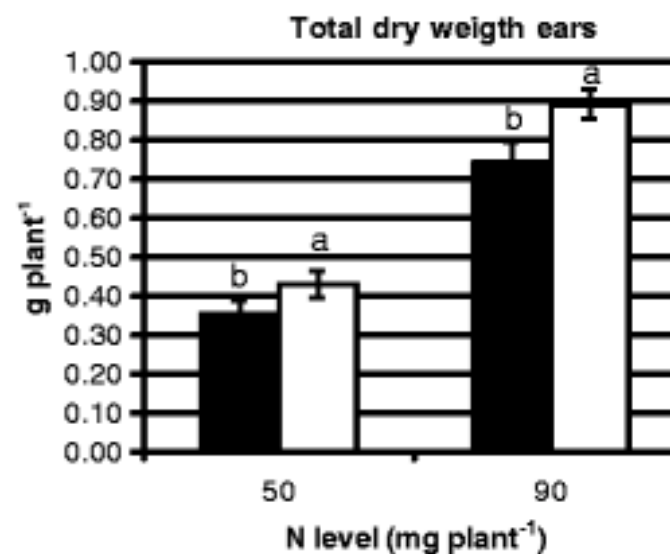
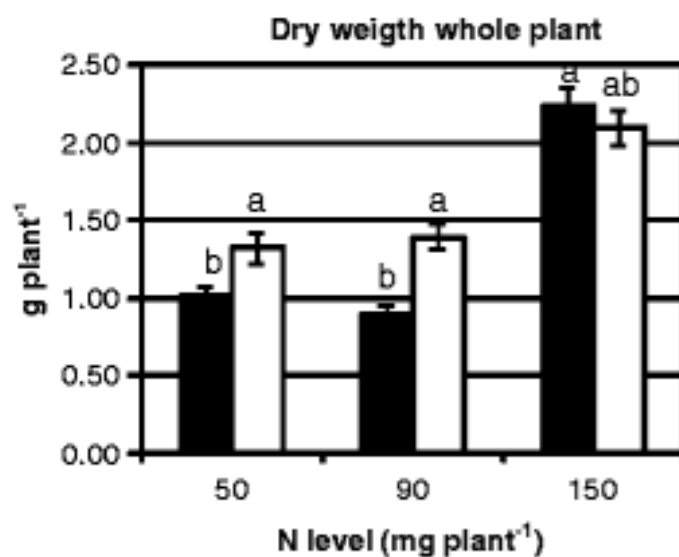


< 50 kg N ha<sup>-1</sup> year<sup>-1</sup>



Tweaking nitrogen metabolism can lead to excretion of ammonium which can benefit the plant

Example: point mutation in glutamine synthetase of *A. brasilense*



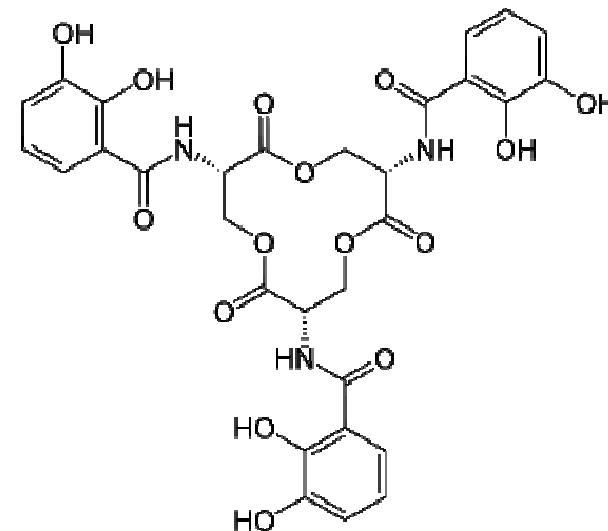


## Bio-availability of nutrients

Some plant nutrients are abundantly present in the soil, but not in a bio-available form (e.g. < 5% total P pool)

1) Phosphate solubilisation by production of phosphatases or organic acid to release organic and inorganic P

2) Secretion of siderophores (low-molecular-weight iron-chelating molecules)





## Biological control

Biocontrol involves suppressing pest organisms with other organisms

Several mechanisms:

Competition for nutrients and suitable root niches

Induced systemic resistance (ISR)

Antibiosis: production of secondary metabolites which can inhibit fungal and bacterial growth

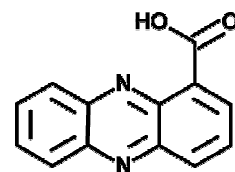
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Compound

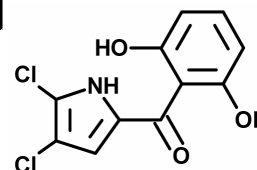
Structure

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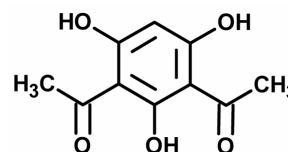
Phenazine-1-carboxylic acid



Pyoluteorin

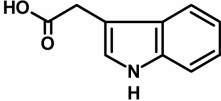
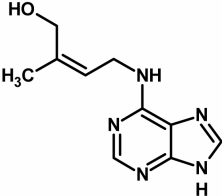
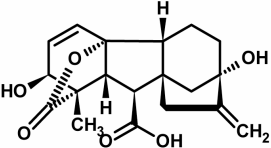
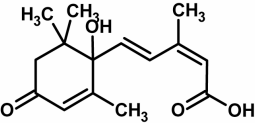


2,4-diacetylphloroglucinol



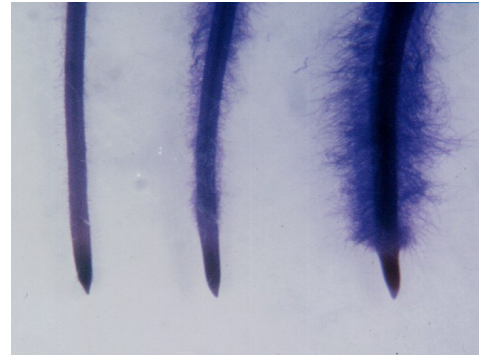


## Production of plant growth-regulating substances

Class	Example	Structure
Auxins	IAA	
Cytokinins	Zeatin	
Gibberellins	GA <sub>3</sub>	
Ethylene		$H_2C=CH_2$
Abscisic acid		

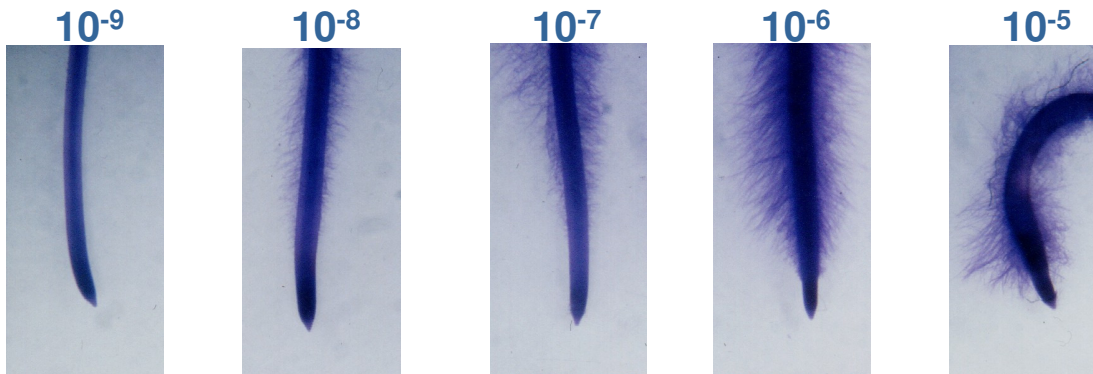


co     $10^6$   $10^7$   $10^8$   $10^9$   
cfu ml<sup>-1</sup>



co     $5 \times 10^7$      $5 \times 10^8$   
cfu ml<sup>-1</sup>

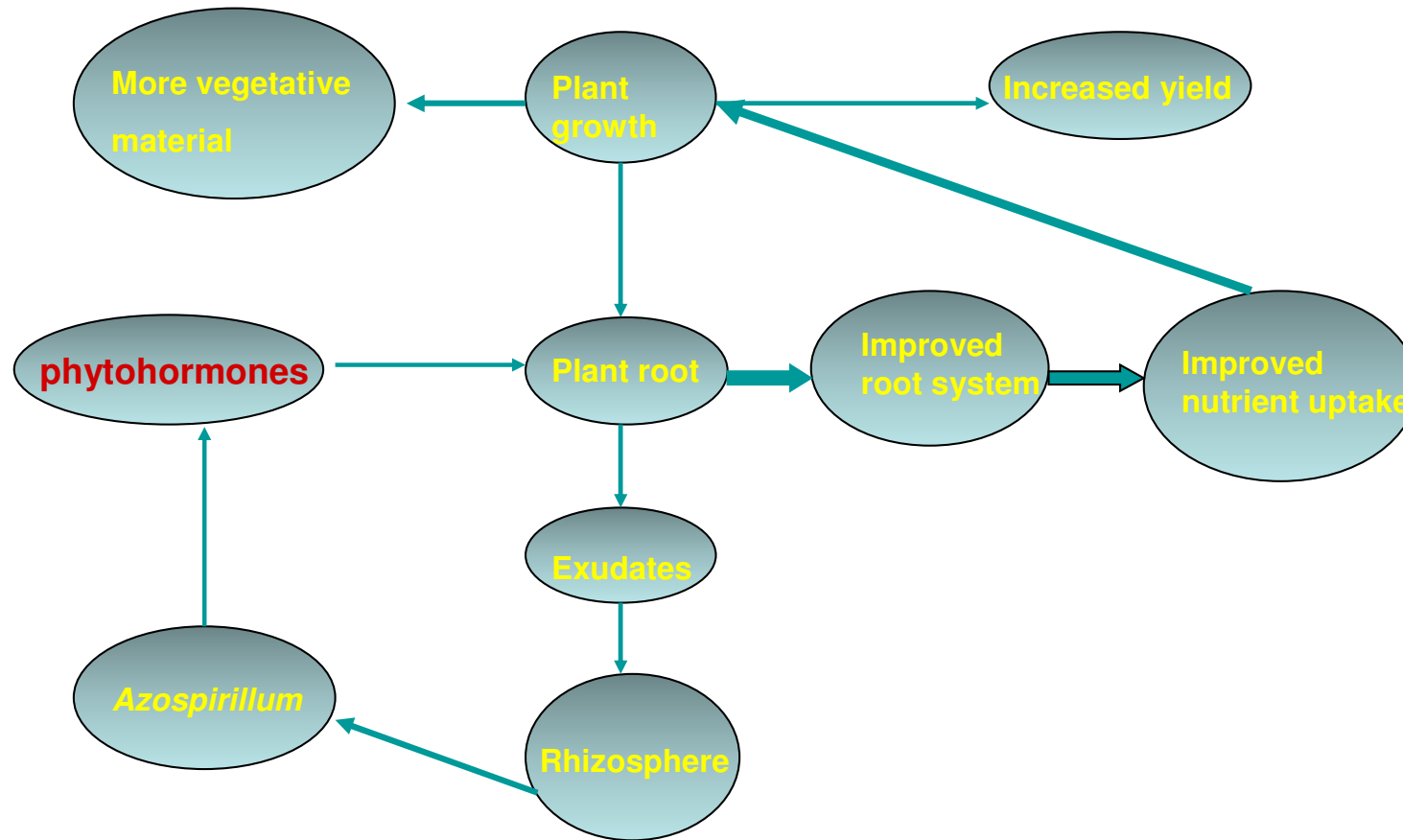
Effect *A. brasilense* Sp245  
on root hair development

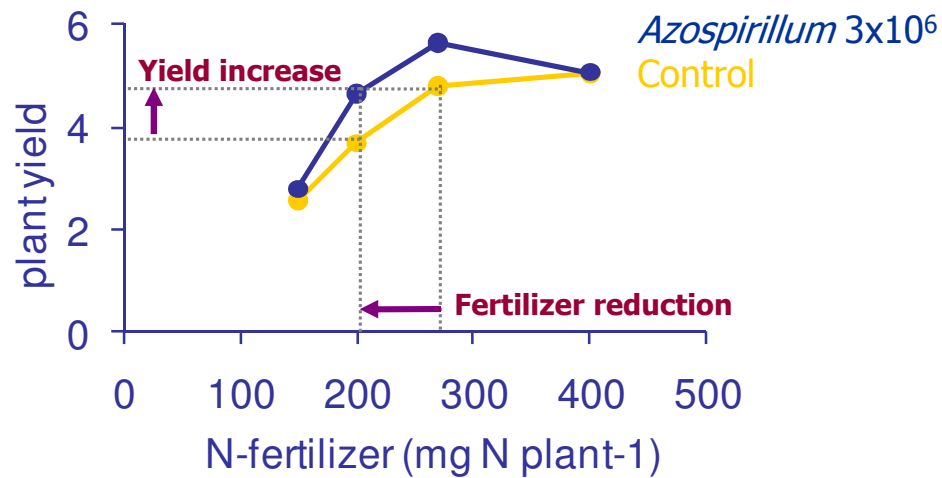


Exogenously supplied IAA  
mimics inoculation effect



## Mechanism of plant growth promotion by bacterial auxin production





Dobbelaere *et al.*, 2002

Effect *Azospirillum* inoculation:

- A. Yield increase at fixed N level
  - B. Fertilizer reduction for same yield
- Higher efficiency of fertilizer use



## Recent advances

- Know beneficial traits better understood
- More beneficial traits uncovered
- Bacterial survival traits better understood

## Remaining bottlenecks for large-scale use of microbial inoculants for plant growth promotion

- Rhizosphere competence
- Co-evolution of plant and rhizosphere microorganisms
- Plant breeding under high (chemical) input might have selected against beneficial bacteria
- Biological inputs more à la carte than chemical inputs



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