The Right Set of Circumstances

Selecting microbial bio-effectors for applications in alternative fertilisation systems

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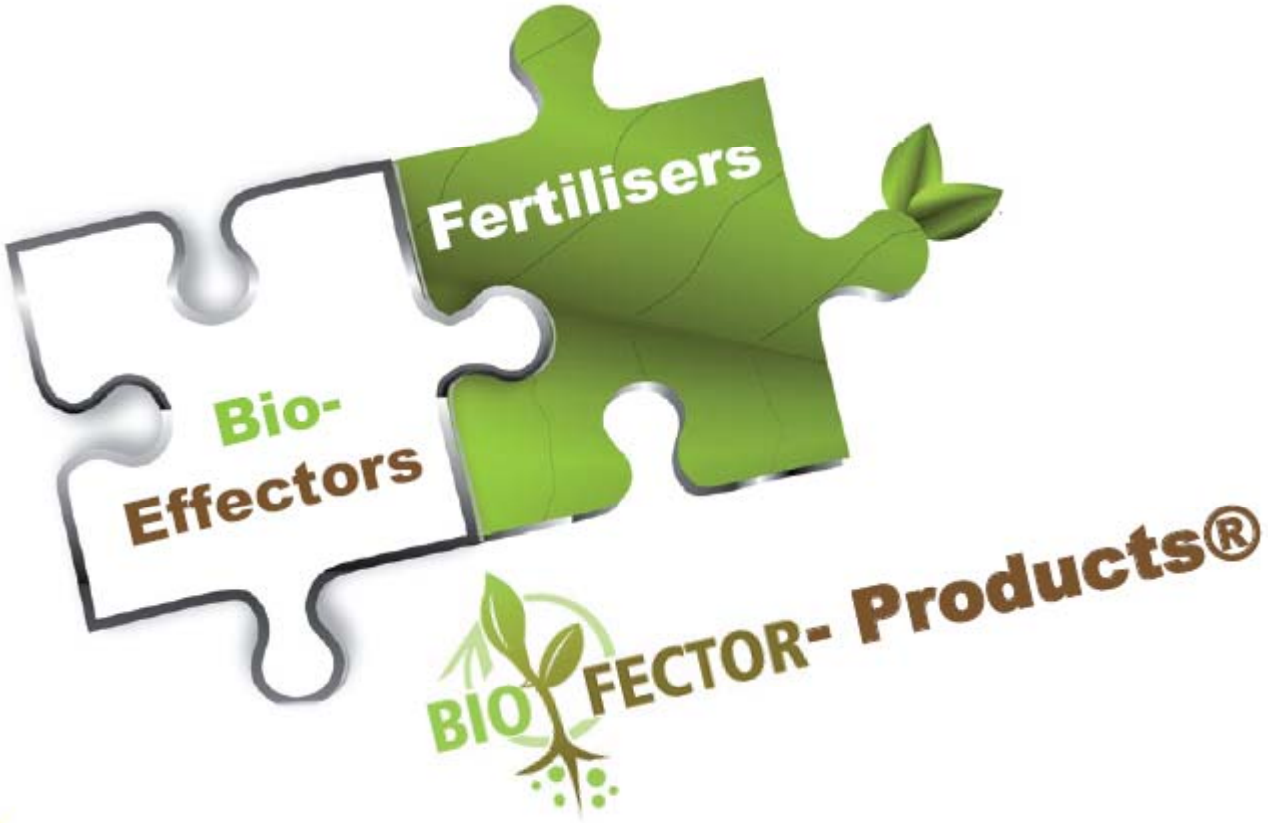


The BIO FECTOR Project

BIOFECTOR

Resource Preservation by Application of BIOefFECTORs in European Crop Production

Funded by the European Union's Seventh Framework Programme (FP7/2007-2013) under Grant Agreement n°312117

Project duration: **01.09.2012 - 31.08.2017**
Coordinatior: **Universität Hohenheim, Deutschland** (Prof. Dr. Günter Neumann)
EC Funding: **€ 5,999,821**

Participants Universität Hohenheim
plus 20 Partners from 11 Countries
7 Universities
5 Research Institutions
9 Companies and Associations

www.biofector.org

Institut für Kulturpflanzenwissenschaften
Pflanzenernährung

www.plantnutrition.uni-hohenheim.de

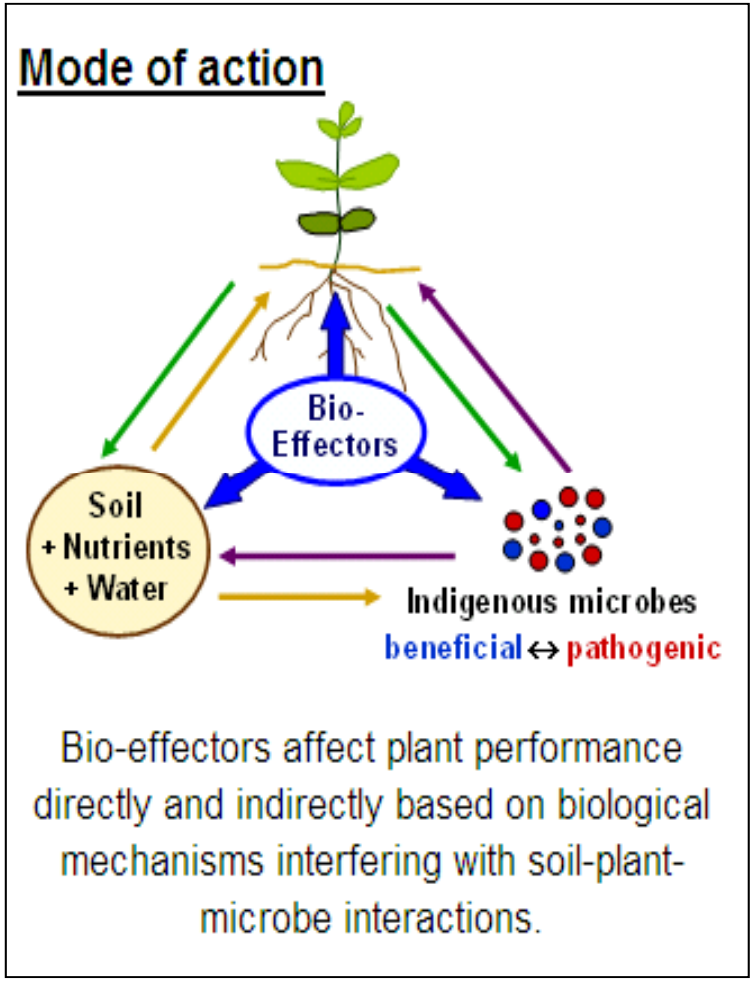
Definition and activity of Bioeffectors

Plant growth-promoting:

- **Microorganisms**
- **Bioactive extracts & Signal compounds**

Nutrient Content

NEGLIGIBLE

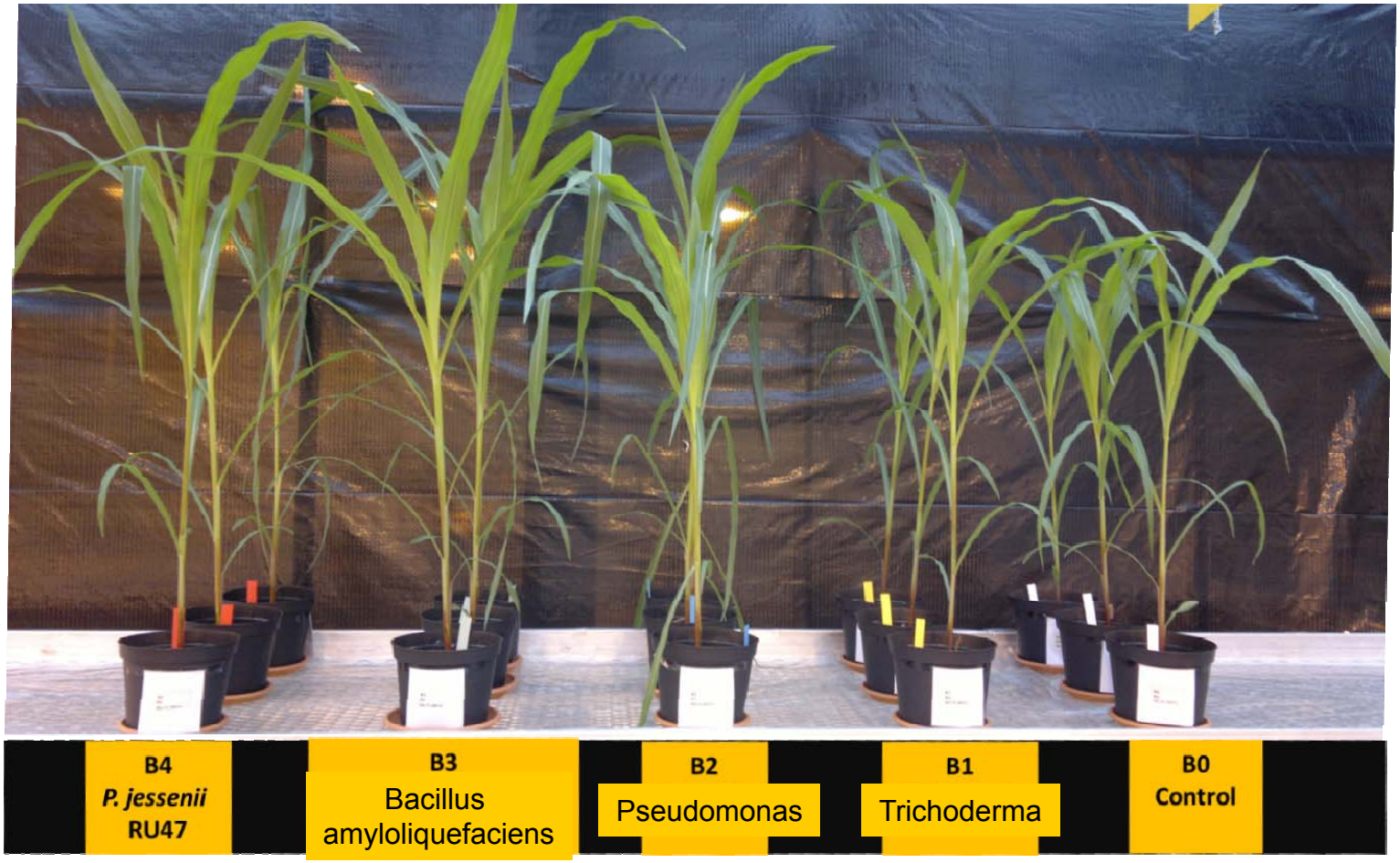


Bio-effectors affect plant performance directly and indirectly based on biological mechanisms interfering with soil-plant-microbe interactions.

Complex interactions

Responses easily affected by external factors

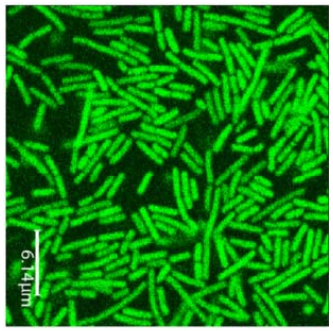
First Results

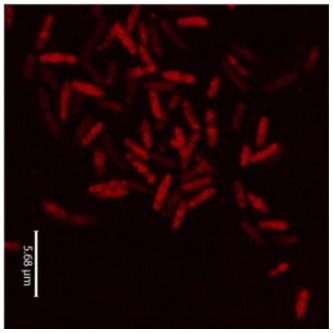


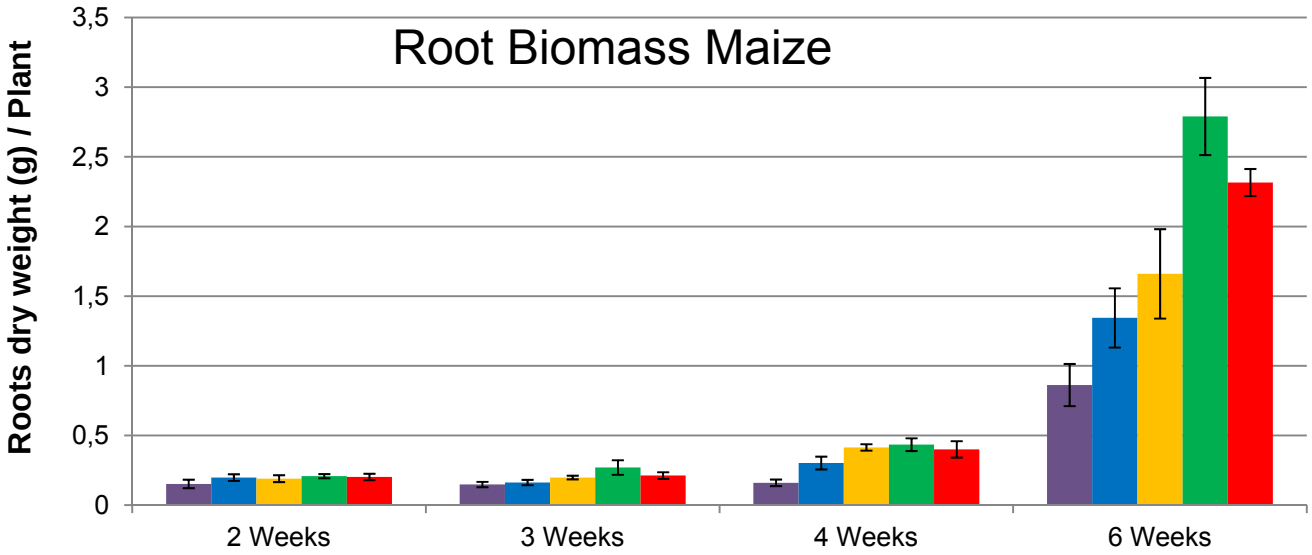
Promising results in greenhouse experiments with maize on a loamy grassland soil with limited availability and moderate P fertilisation (50 mg/kg soil)

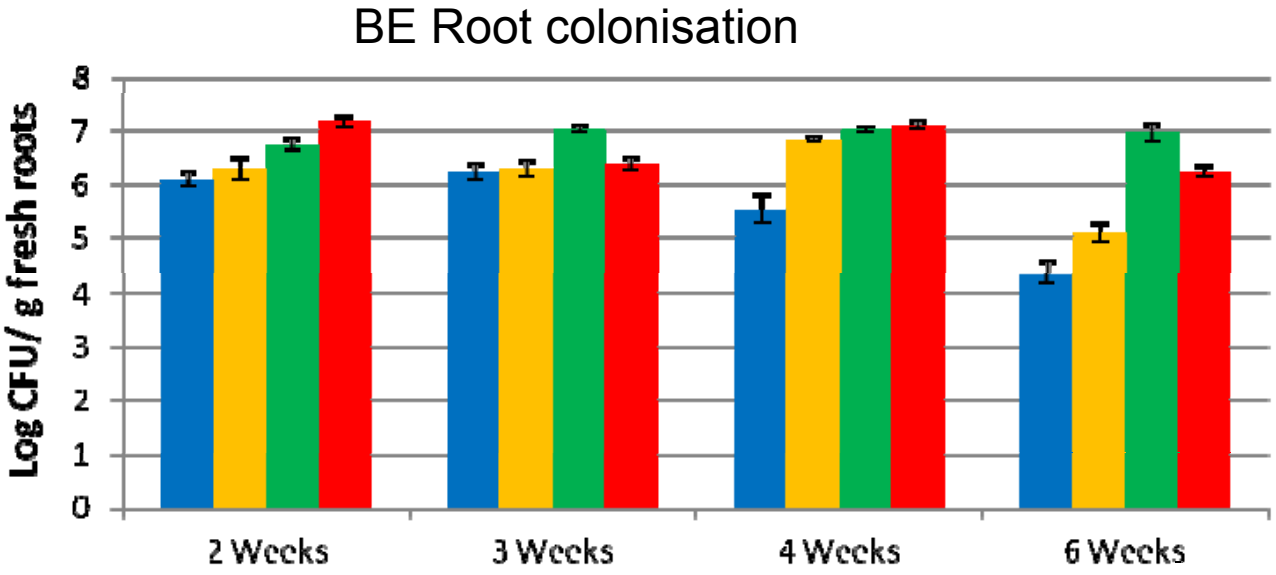
Eltnbany 2013

Control
B1 : Trichoderma
B2 : Pseudomonas
B3 : B. amyloliquefaciens
B4 : P. jessenii







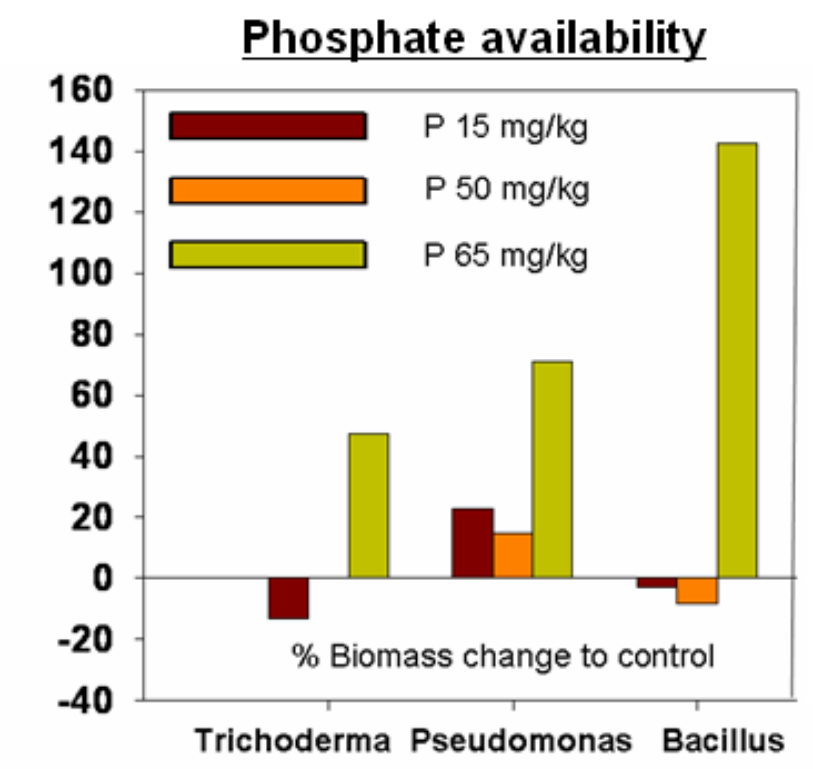


PGP effects associated with root growth promotion

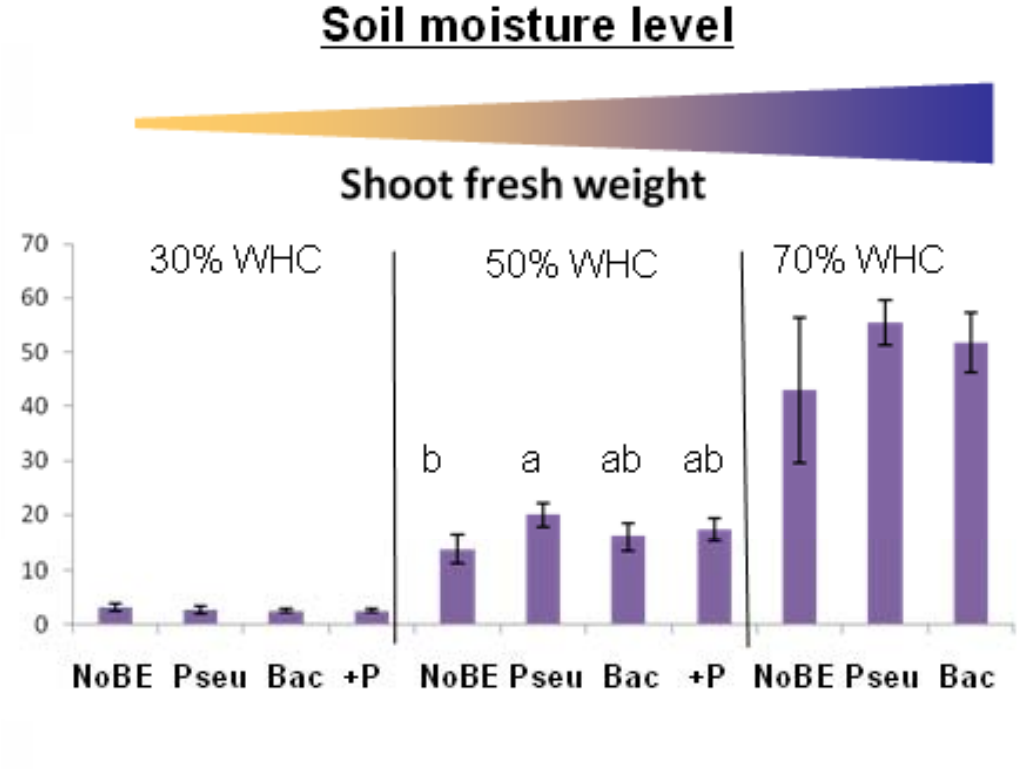
Root growth promotion reflects BE colonisation efficiency

Eltnbany 2014

Impact of Environmental Factors on PGP



• Effects mainly expressed at moderate soil P availability



• No effects at low soil moisture levels (Drought stress)

Other constraints:

- No PGP- effects at low root-zone temperature (12-14° C) during early growth
- No PGP- effects at high temperatures (≥ 30° C) during early growth

Only a narrow window for optimum expression of PGP effects

Strong dependency on environmental factors

IP: Plant growth-promoting bio-effectors for alternative plant nutrition strategies in non-leguminous plants

- **Final goal:**

…development of viable alternatives for mineral fertilisation

No stand-alone approaches for BE products available (no nutrient input)

:

- Strategy

Optimizing existing alternatives for mineral fertilisation with bioeffectors adapted to the respective fertilisation systems

® - Products

More defined conditions for BE-plant interactions

Less variability of responses

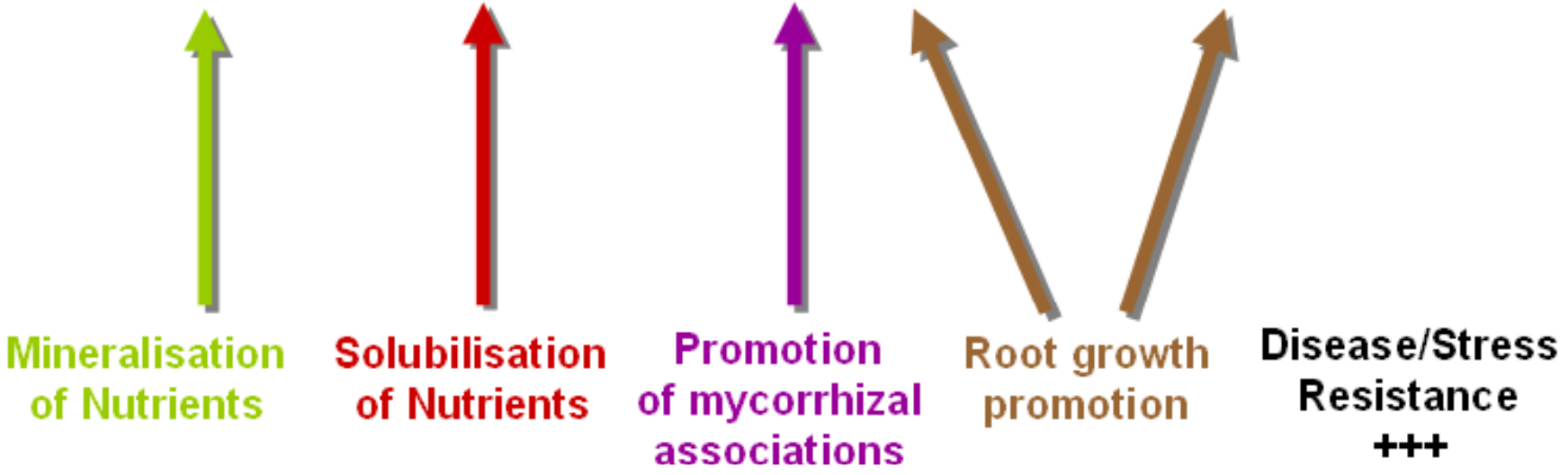
OGANIC FARMING

RECYLING FERTILIZERS
(organic, inoganic)

FERTILIZER PLACEMENT & FERTIGATION

Limited chemical availability (solubility) of nutrients

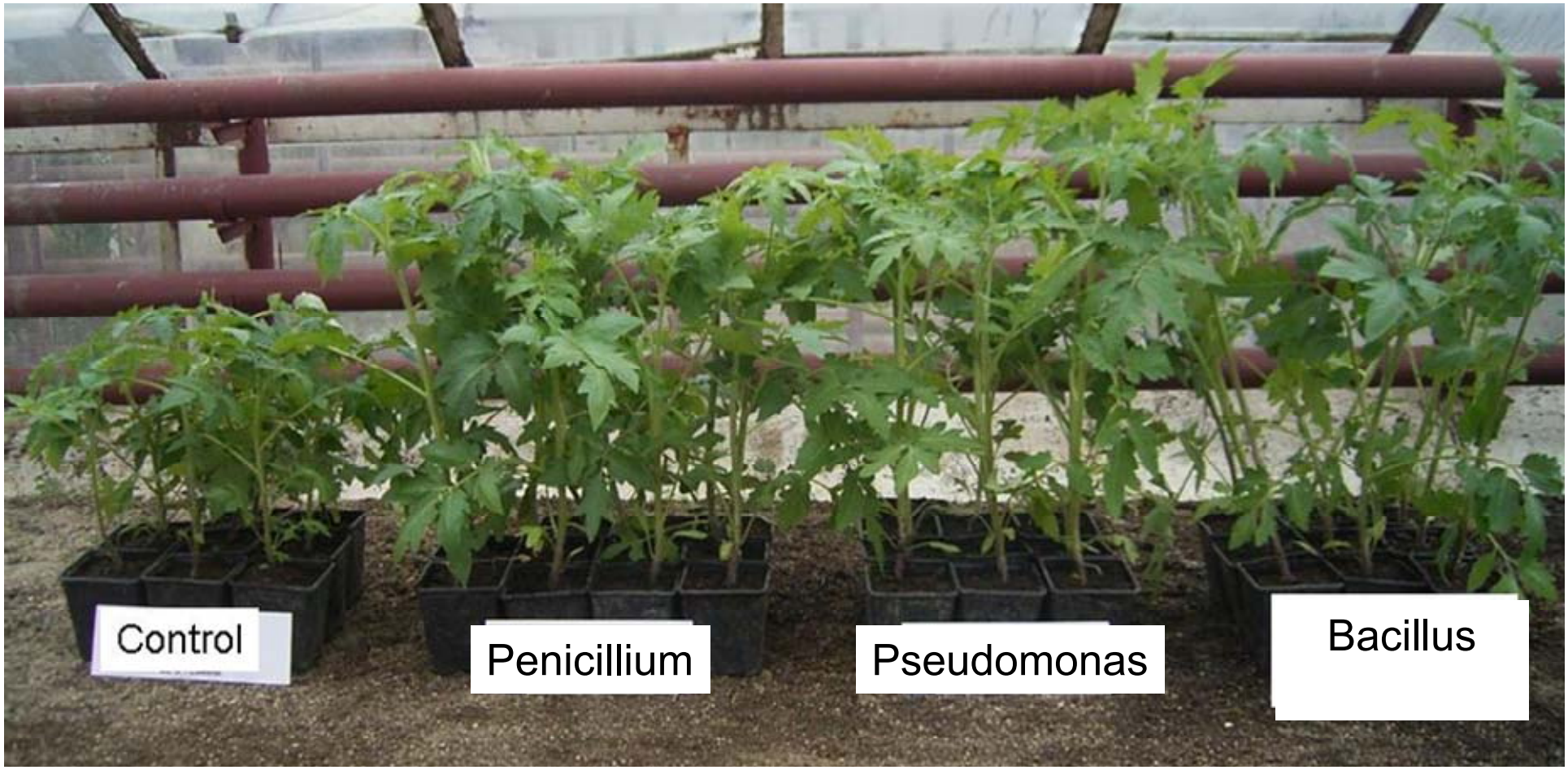
Limited spatial availability of nutrients



BIOEFFECTORS – Modes of Action


Case study:
Commercial
Greenhouse Production Trials
Tomato
2013/2014
Timisoara, Romania
5 APR 2013

First Results – Organic Recycling fertilisers

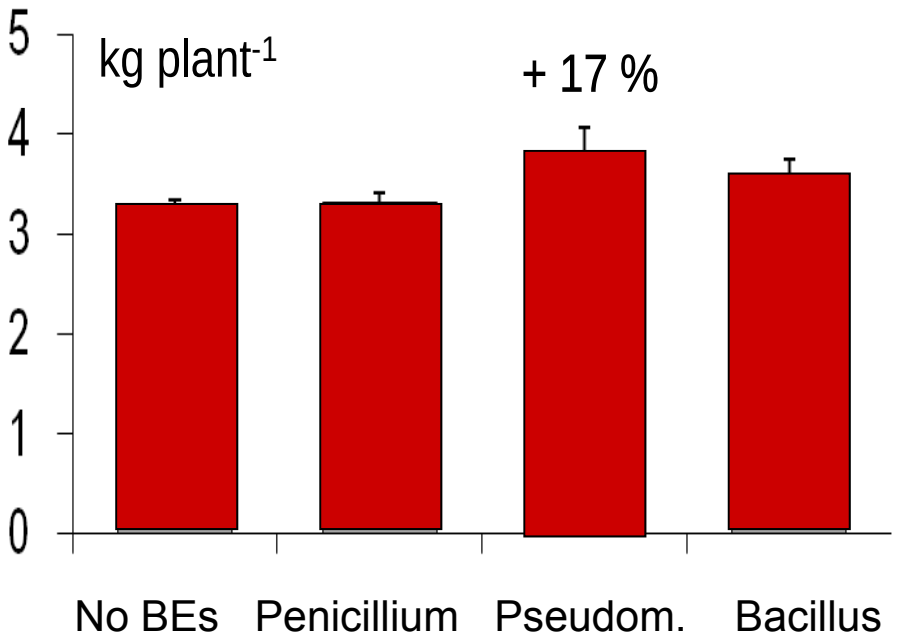


Surprisingly strong growth promotion in nursery greenhouse production of tomato under optiunm growth conditions and high organic nutrient input (45% composted cow manure 30 % soil 15 % peat 10 % sand)

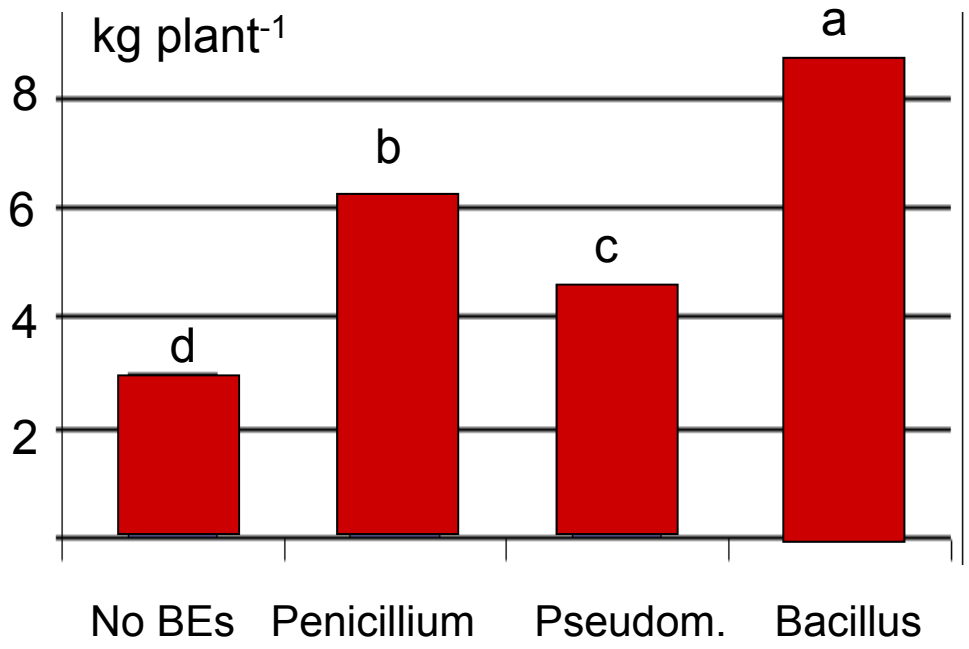
Posta et al. 2013

TOMATO YIELD

2013 High nutrient input

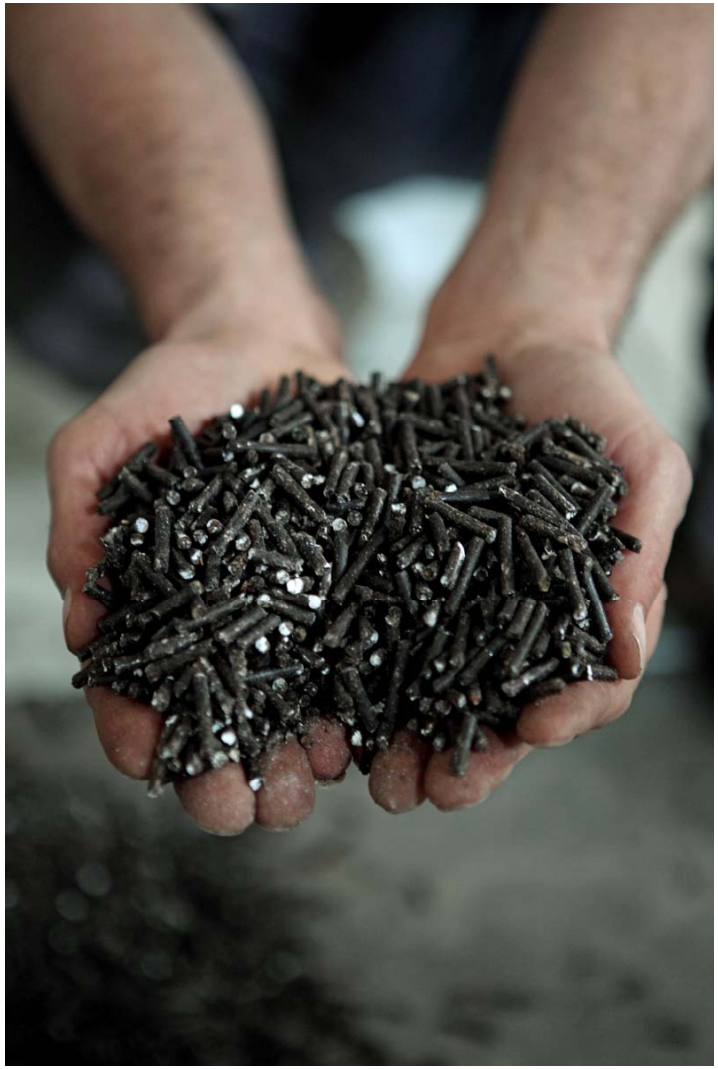


2014 Low nutrient input



- **PGP effects also in maize with similar cow/horse manure-BE combinations**

- **No effects with organic recycling fertilisers based on compost, sewage sludge and digestates**



Standardised manure-based pellet fertilisers

Bacillus-based BEs (endospores)

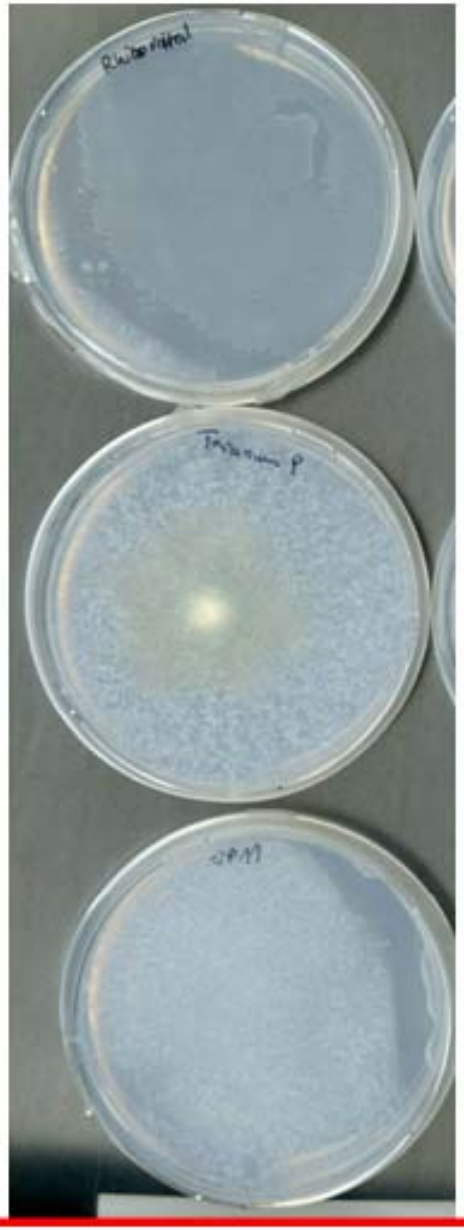
Improved organic recycling fertiliser

Proradix ✓

Paenibacillus m. ✓

Biol. Fertilizer OC ✓

Kuhlmann & Nkebiwe, 2014



Rhizovital ✓

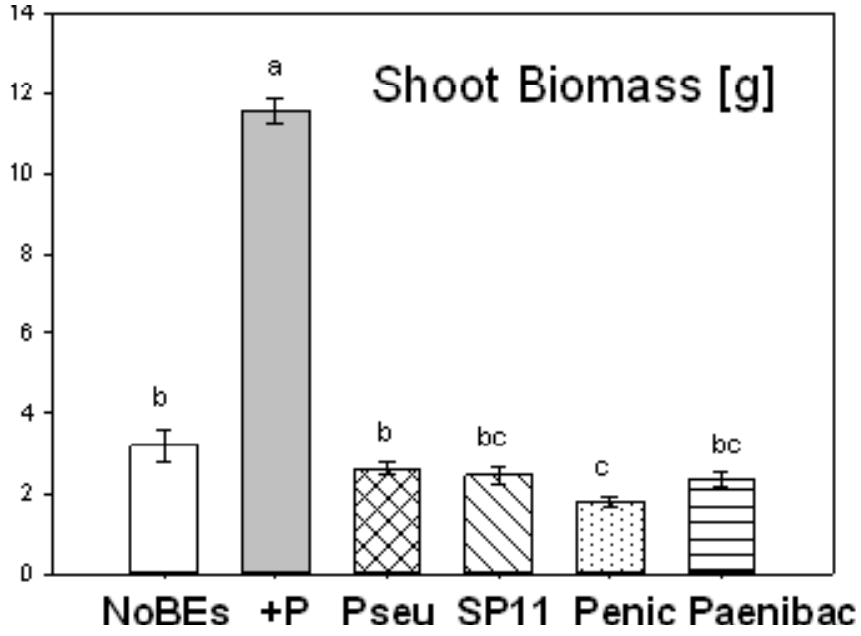
Trianum P ✗

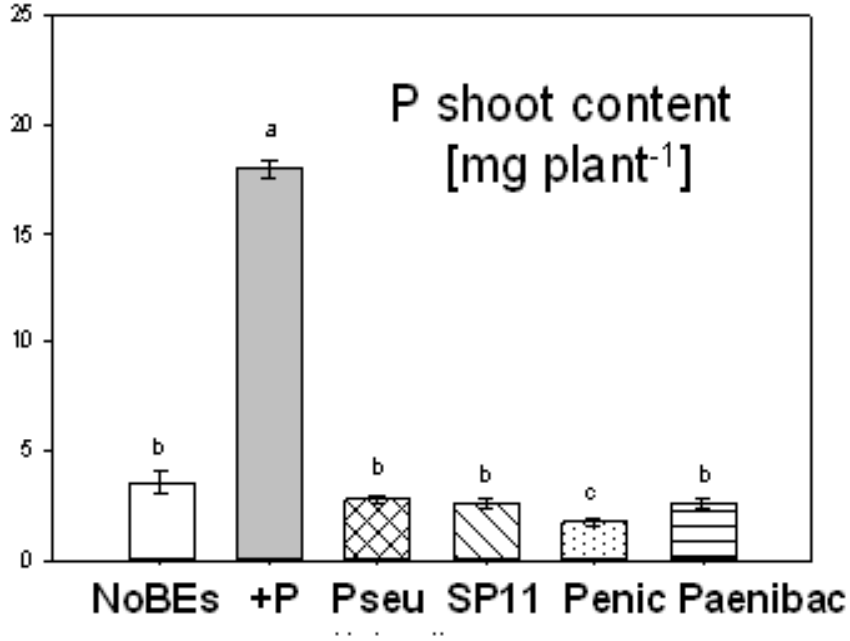
Vitalin SP11 ✓

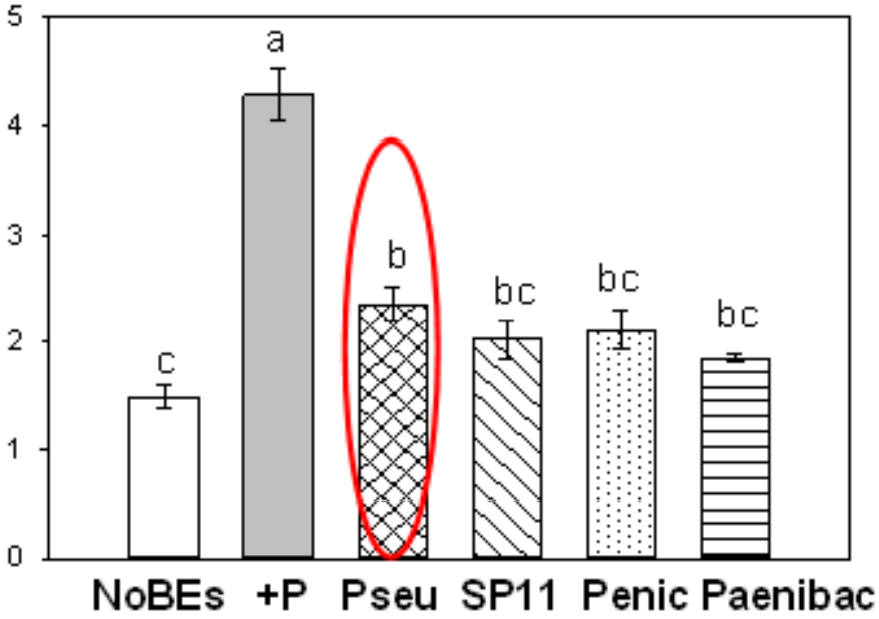
Case Study:

P-Solubilising Microorganisms

Efficiency Testing of P-solubilizing Microorganisms - Maize







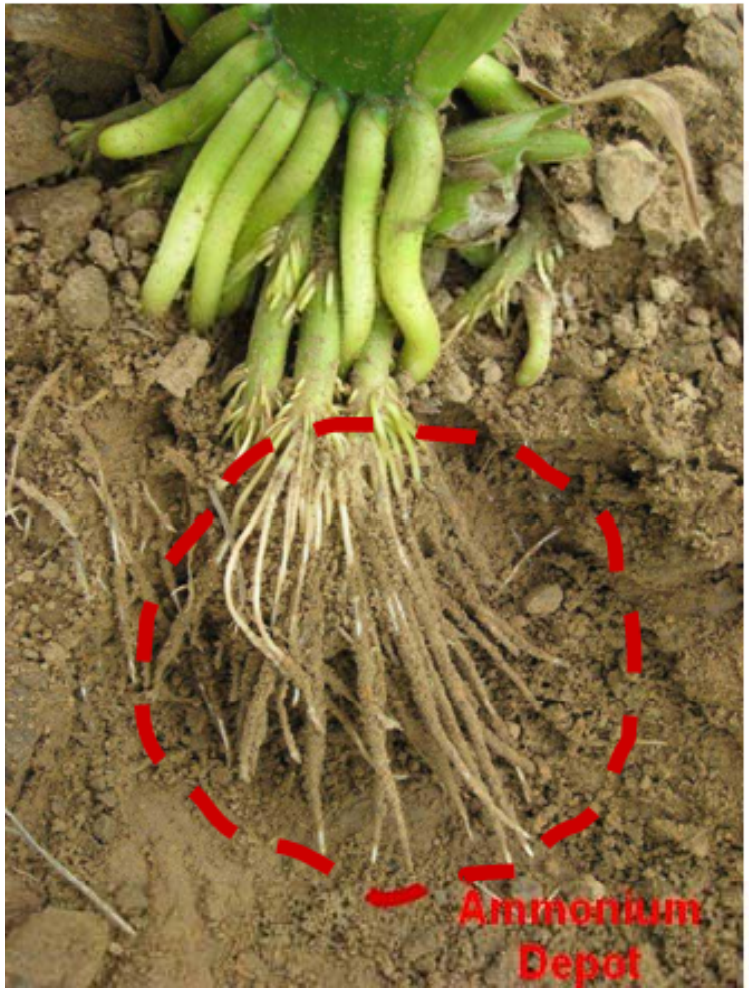
- No plant growth promotion via mobilisation by selected BEs on a substrate with Ca-P as exclusive P-source.
- Similar results in 10 experiments with 9 BEs in 8 countries at neutral soil pH

Lowering the substrate buffering capacity (+70% sand) promotes plant growth by microbial P mobilisation

No perpectives to lower the soil buffering capacity under field conditions

Alternative approach:

Boosting the P-mobilising potential of BEs and plant roots by NH_4^+ nutrition



FERTILIZER PLACEMENT

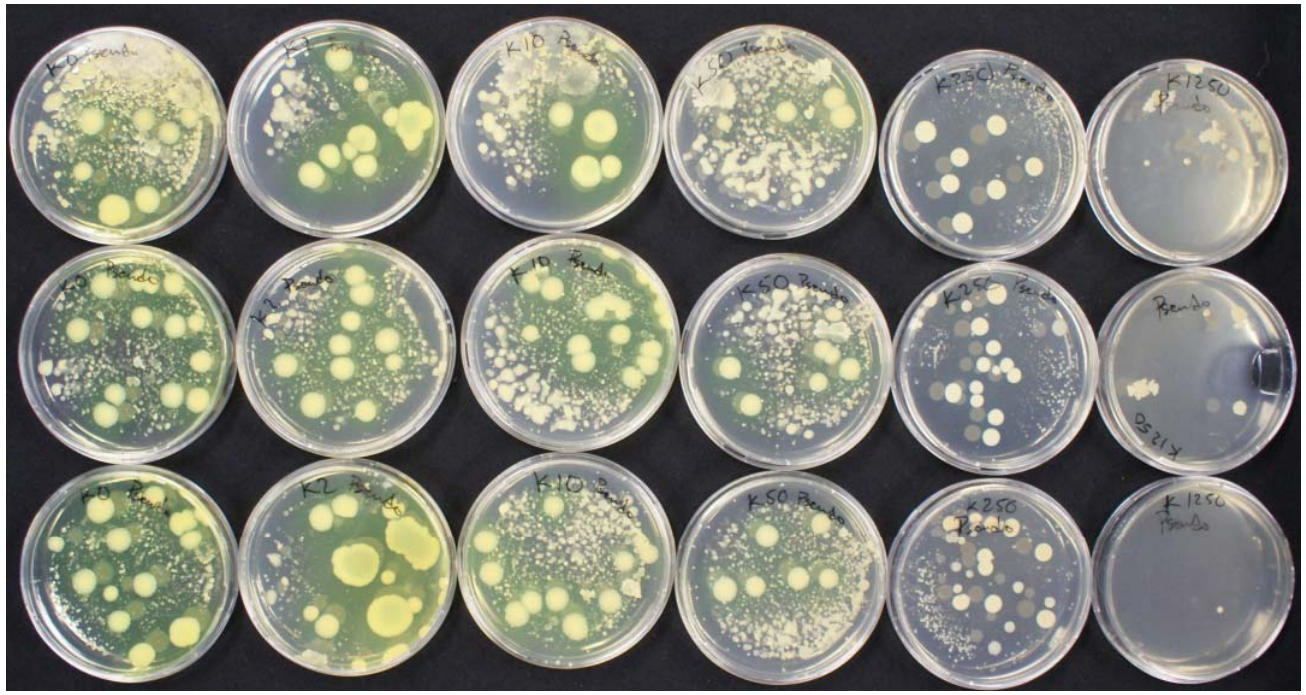
Amonium Depot Fertilisation

Potential BR benefits:

- BE-induced root proliferation in the depot zone (improved spatal depot exploitation)
- Root-induced nutrient mobilisation
  - by NH4-induced rhizsphere acidification
  - by increased exuation of organic chelators
- Ammonium-induced rhizosphere acidicfication by BEs

Ammonium tolerance of microbial BEs

0 mM NH_4^+	2 mM NH_4^+	10 mM NH_4^+	50 mM NH_4^+	250 mM NH_4^+	1250 mM NH_4^+



- Tolerance of a Pseudomonas–based BE to high ammonium concentrations (up to 50 mM). Also not affeced by the nitrification inhibitor DMPP
- Similar results observed also for Trichoderrma-based and Bacillus-based BEs

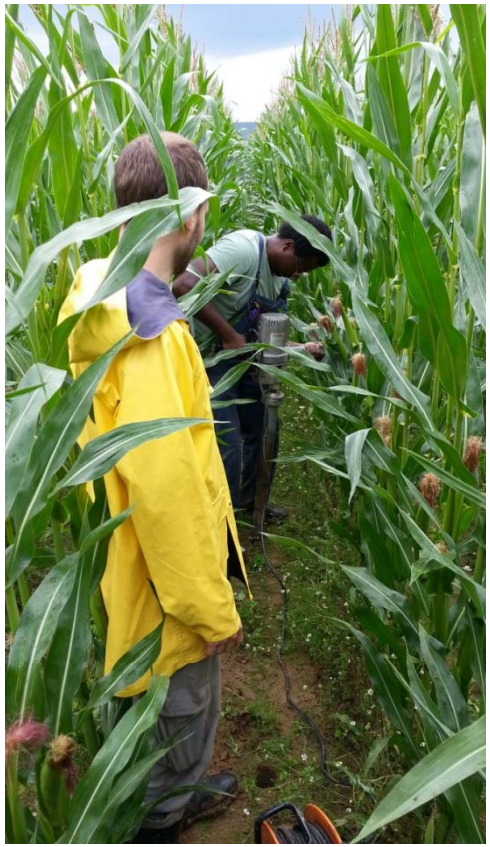
⇨ suitable for application in ammonium depot fertilisation

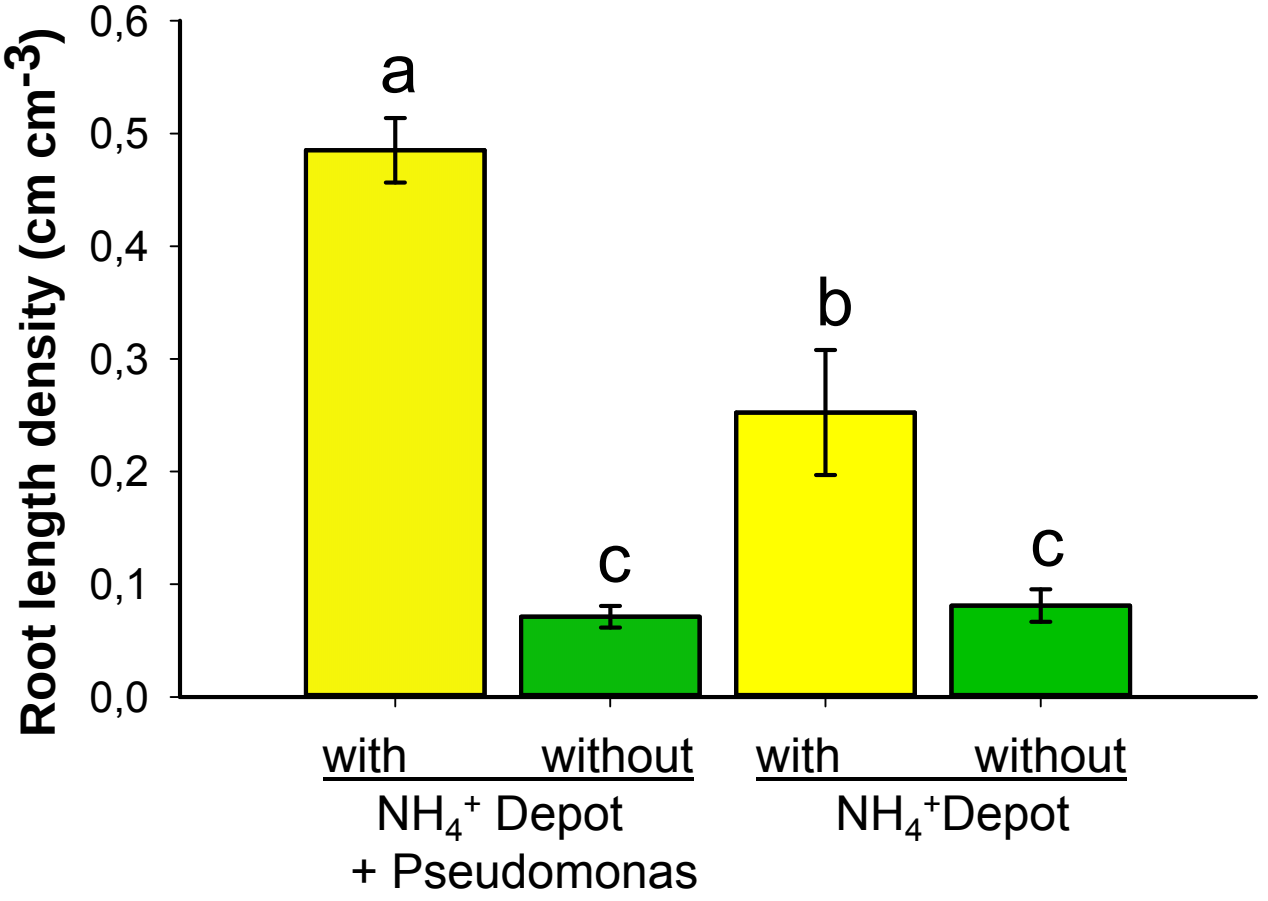
BE Effects associated with Ammonium-Depot Fertilisation

Nkebiwe, 2014

NH4-Depot

No Depot



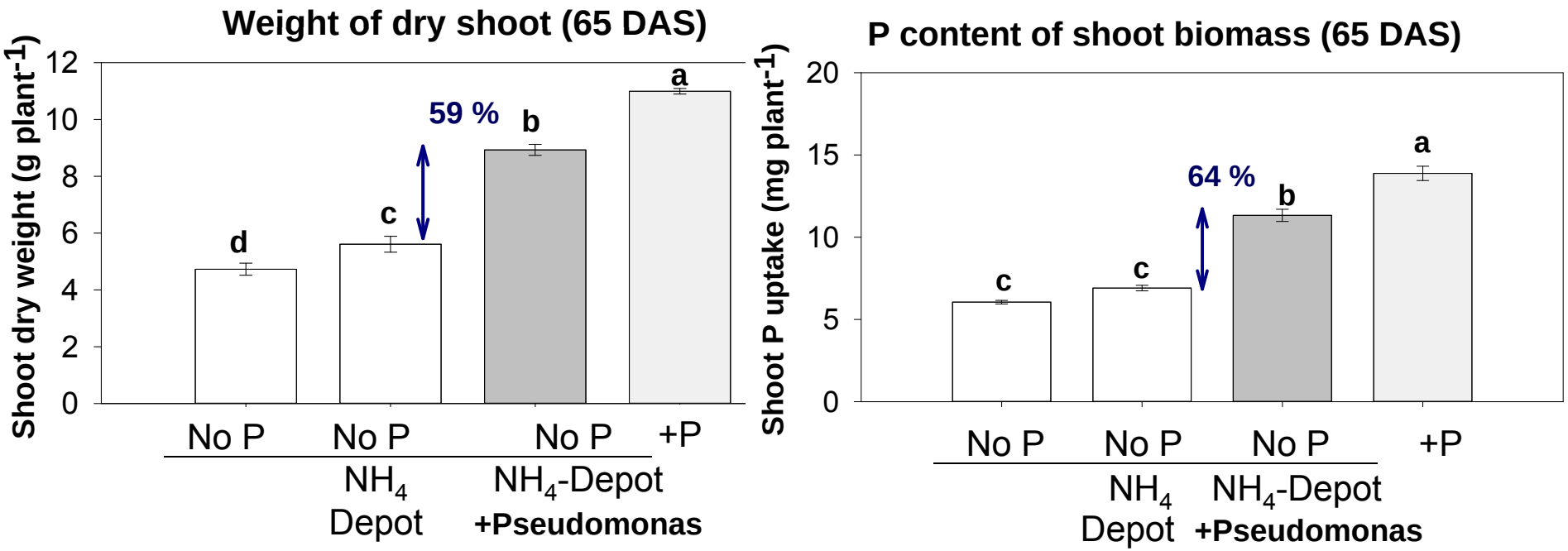


Increased root proliferation in the NH_4^+-depot in by a Pseudomonas-based BE.

No effects in the row without NH_4^+-depot

Nkebiwe, 2014

BE Effects associated with Ammonium-Depot Fertilisation



Combination of a Pseudomonas-based BE with Ammonium-depot fertilisation partially replaces P fertilisation of maize on a low-P soil

Nkebiwe, 2014

BIOFECTOR - Data Base

Open data base providing information on:

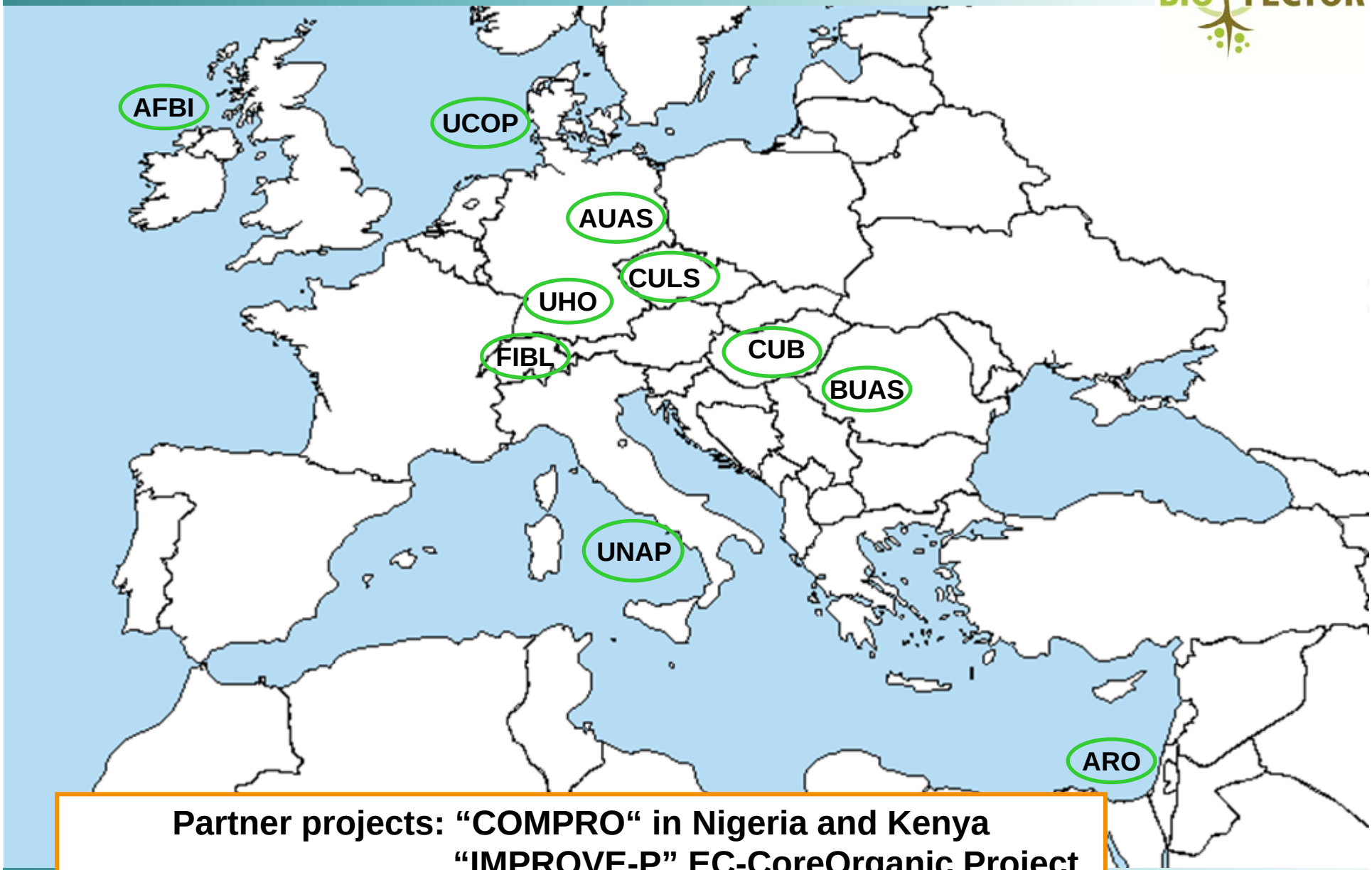
- **Commercial availability of Bio-effectors in Europe**
- **Application Modes**
- **Active Ingredients**
- **Mode of action**
- **Scientific evaluation** (literature)

Test Version: http://www.biofector-database.eu/en/biofectors-homepage.htm

Thanks for your attention…

…on behalf of the whole BIOFECTOR Consortium

Geographical distribution of project partners



Partner projects: "COMPRO" in Nigeria and Kenya
"IMPROVE-P" EC-CoreOrganic Project

BIOFECTOR is funded by the European Commission within the 7th Framework Programme, Grant Agreement No. 312117

Potential Benefit of Bioeffectors

Yield and output growth in tomato

Tomato		Tomato price (€/kg)		
		1	1,5	2
Yield growth*		Output growth		
%	kg/plant	€/plant	€/plant	€/plant
5	0,52	0,52	0,78	1,05
10	1,05	1,05	1,57	2,09
20	2,09	2,09	3,14	4,18
100	10,45	10,45	15,68	20,91

* Assumptions

Tomato		Tomato price (€/kg)		
		1	1,5	2
Yield growth*		Output growth		
%	kg/ha	€/ha	€/ha	€/ha
5	9800	9800	14700	19600
10	19600	19600	29400	39200
20	39200	39200	58800	78400
100	196000	196000	294000	392000

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