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Under which conditions are biofertilizers effective?

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Overview

- Overview biofertilizers
- Indo-Swiss collaboration in biotechnology (ISCB): Target crops wheat and finger millet & pigeon pea
- Meta-analysis Schütz et al. (literature review)
- Meta-analysis EU project BIOFECTOR

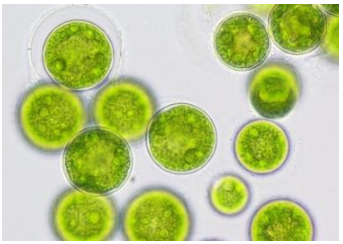
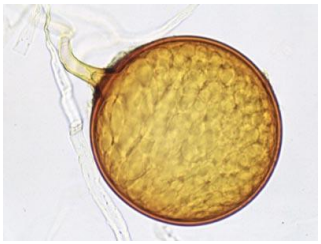
Biofertilizers

Definition

Preparations containing living cells of efficient strains of microorganisms improving nutrient uptake

Microorganisms



Potential beneficial effects of biofertilizers

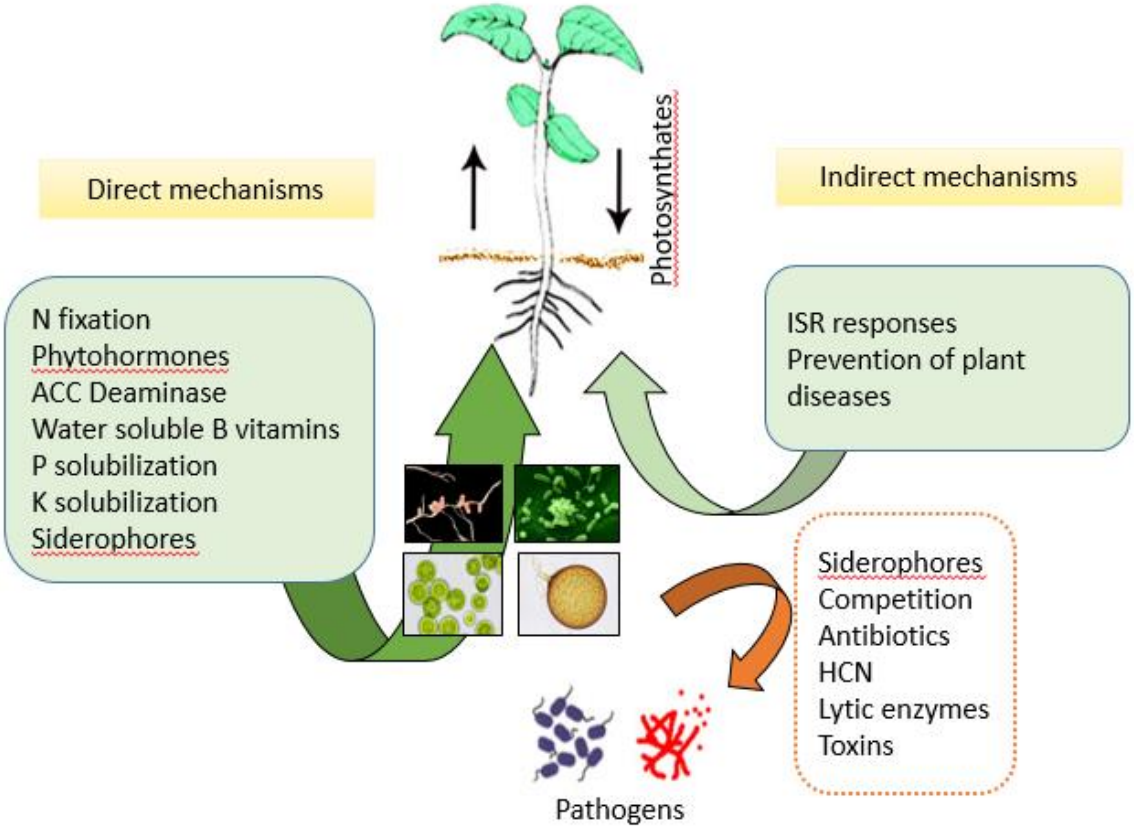


Figure adopted from Fraile et al. (2015) Bioengineering Journal

- **Nitrogen fixation**
- **Facilitated nutrient access from fertilizers and soil stocks**
- **Improved water availability**
- **Improved plant health**

Under which conditions are biofertilizers effective?

- **Pedo-climatic conditions (soil, climate)**
- **Soil properties (soil P, pH, soil organic carbon SOC)**
- **Crop**
- **Direct sawn – transplanted crops**

ISCB
Indo-Swiss Collaboration in Biotechnology

1 project

1974 - 1984

5 projects

1988 - 1999

10 research networks

Phase I

1999 - 2004

6 research networks

Phase II

2004 - 2007

3 research networks

Phase III

2007 - 2011

4 research networks

Phase IV

2014 - 2017

Technical and human capacity building

Development of biotechnological products

Chick pea

Wheat

Rice

Cassava

Blackgram

Pigeon pea

Finger millet

FOCUS CROPS

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Redrawn from Schachermayr, 2006, BIOforum Europe

http://iscb.epfl.ch

Wheat in Salary (North India)

> Himalayan Foot hill

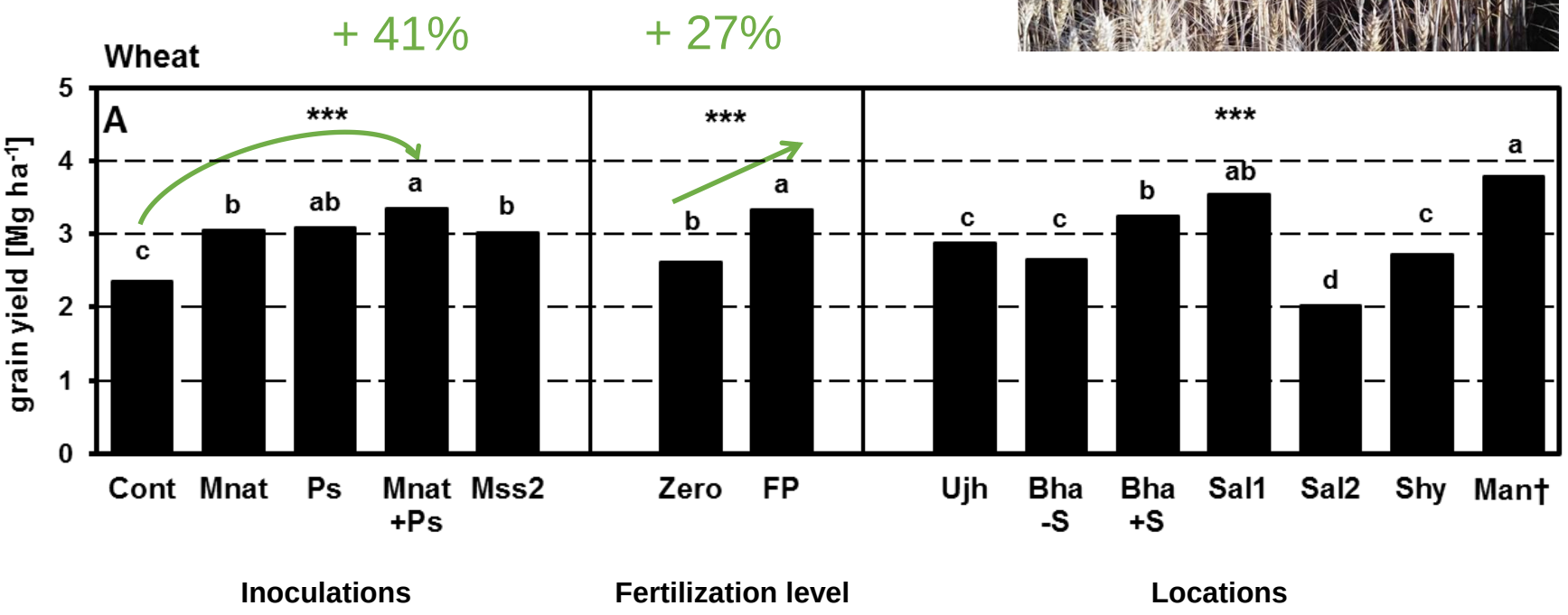
> Moderate soil fertility

> Irrigated

> Accurately managed FYM-recycling


Wheat in Mandory
(North India)
> Haryana
> High inherent soil fertility
> Irrigated

Wheat grain yield as affected by inoculation, fertilization and location (North India)

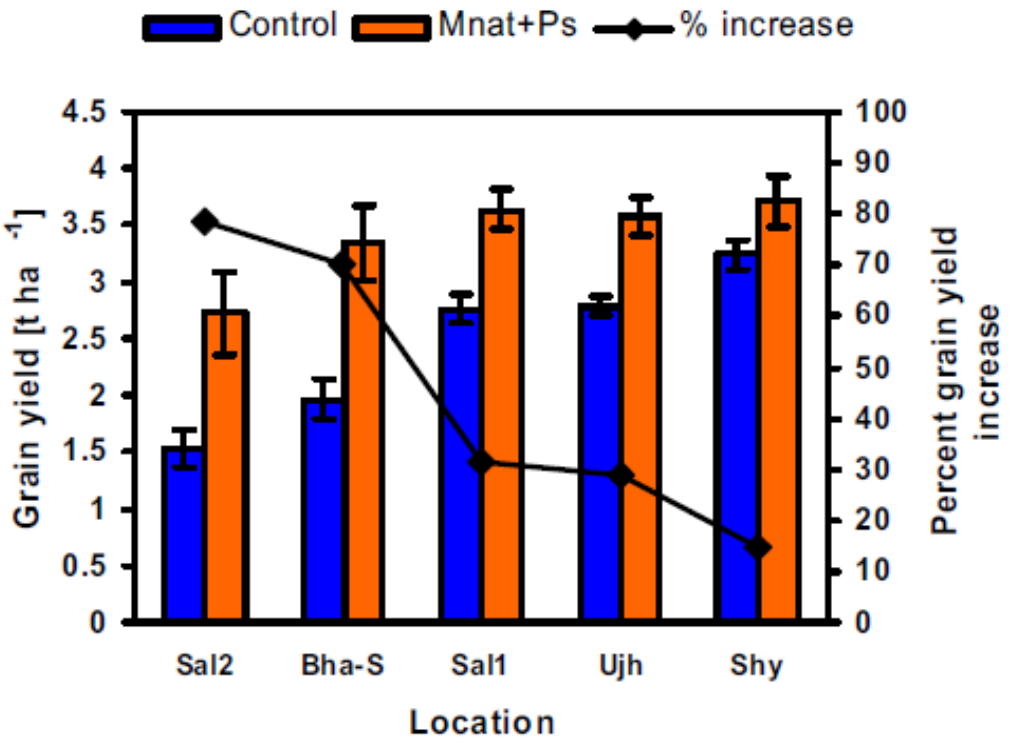


4-Way-ANOVA: Inoculation treatment*Fertilizer level*Location*Cropping season

Analysis of variance: *=p<0.05; **=p<0.01; ***=p<0.001; Tukey Test: Alpha: 0.050

Treatments: **Cont**= Control; **Mnat**= LL2nat; ***Ps***= R62+R81; **Mnat+*Ps***= LL2nat+R62+R81; **Mss2**= commercial AMF

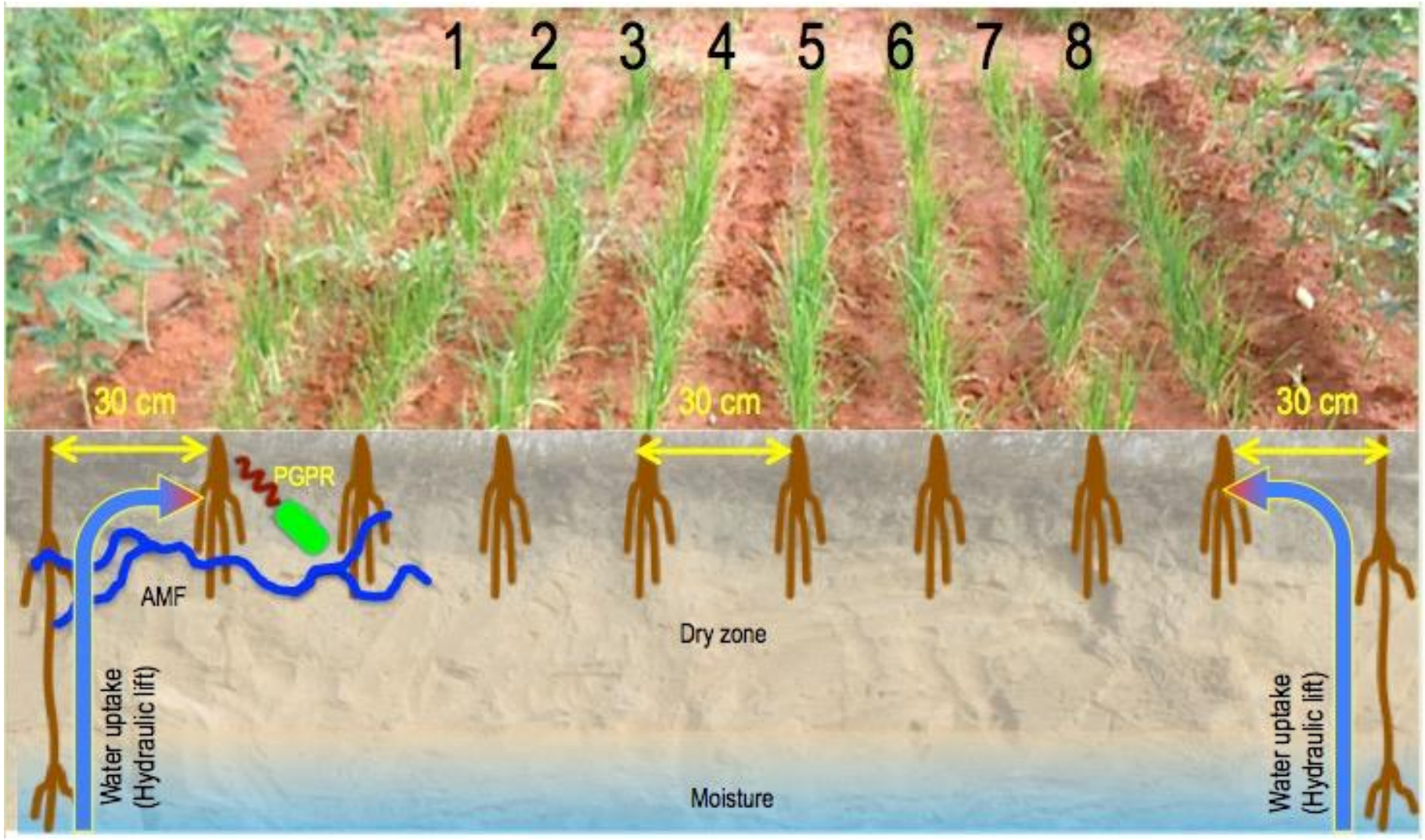
Wheat yield: Inoculation success depends on location



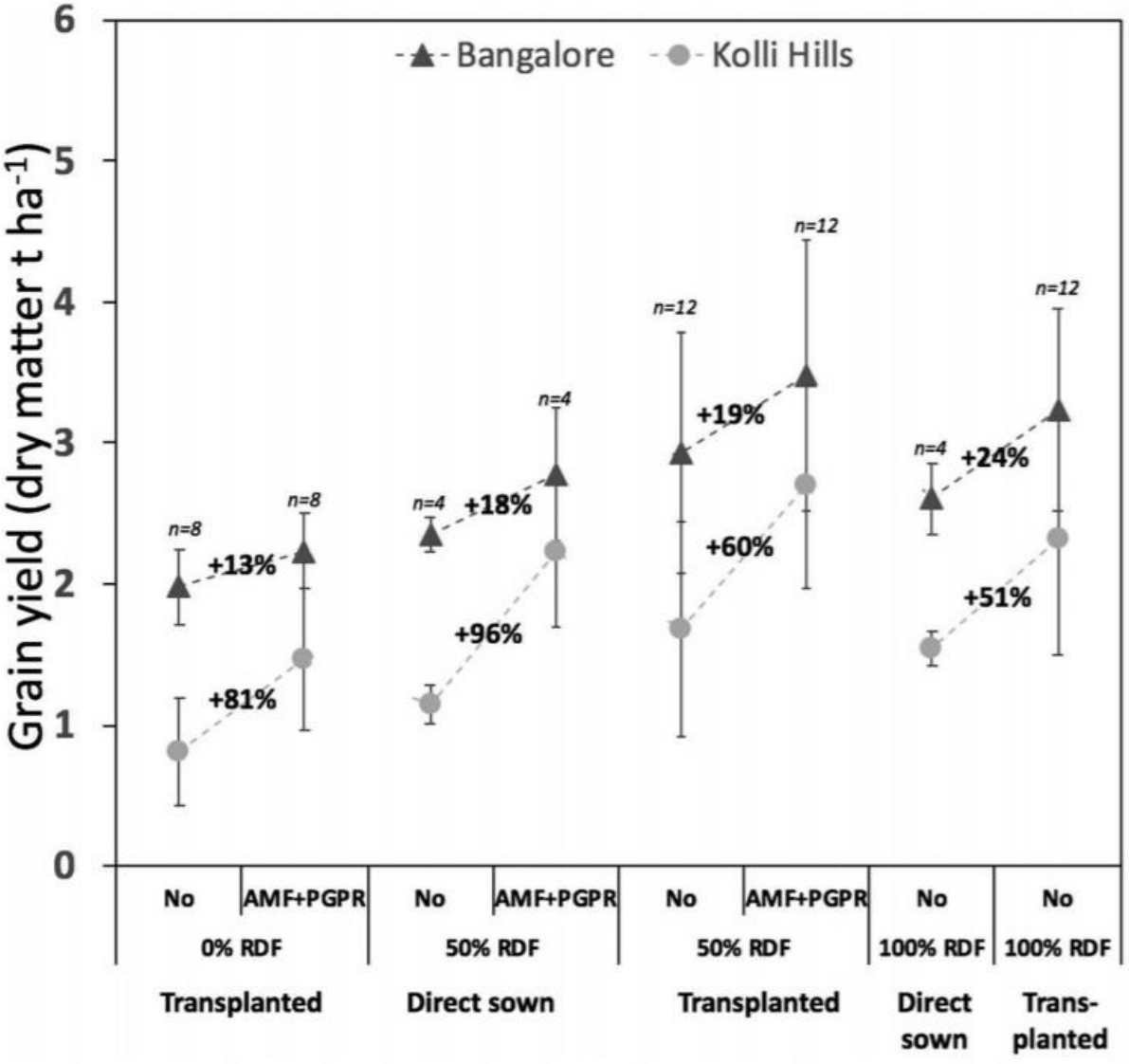
- Higher wheat yields Ø 41%
- Increased nutrient uptake up to 53 %
- Increased P use efficiency up to 95%

Mäder et al., Soil Biology & Biochemistry 43: 609-619

A field plot with finger millet – pigeon pea intercropping system (South India)

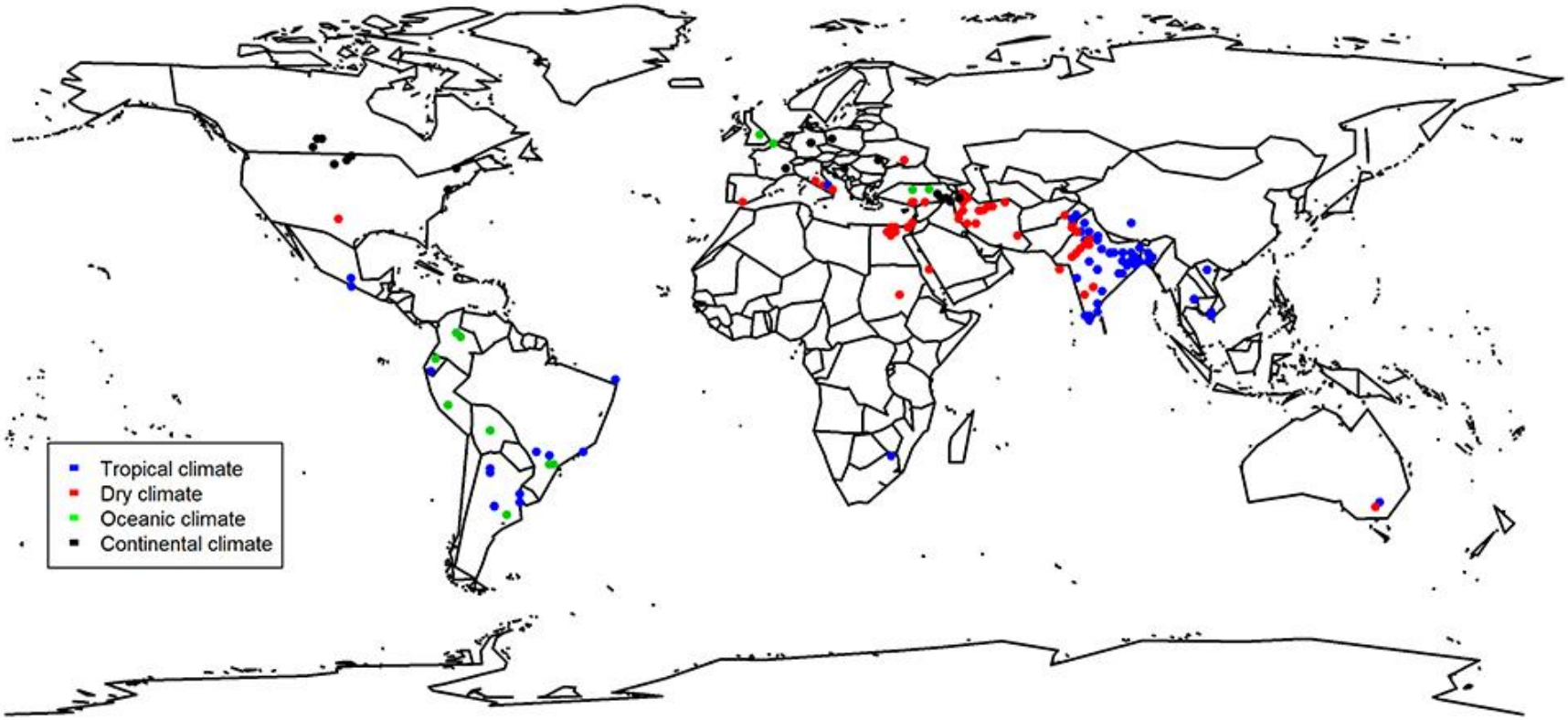


Yield response of pigeon pea and finger millet to inoculation, transplanting and fertilisation (South India)

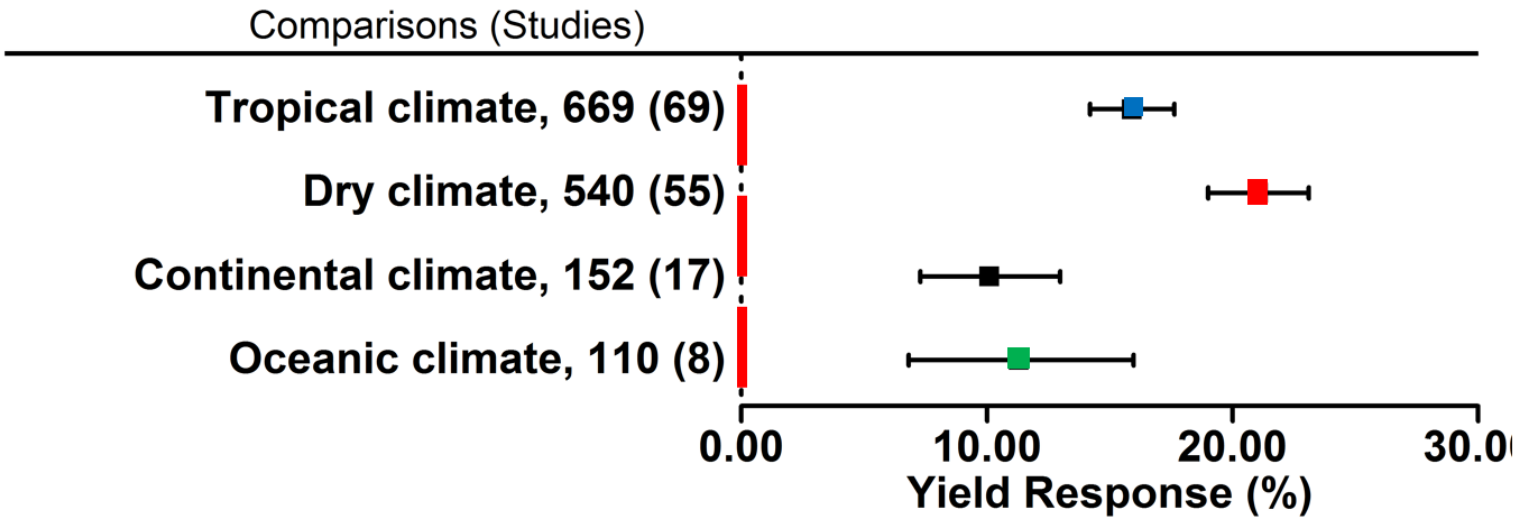


Mathimaran et al., 2020, Frontiers in Sustainable Food Systems

Improving crop yield and nutrient use efficiency via biofertilization — A global meta-analysis

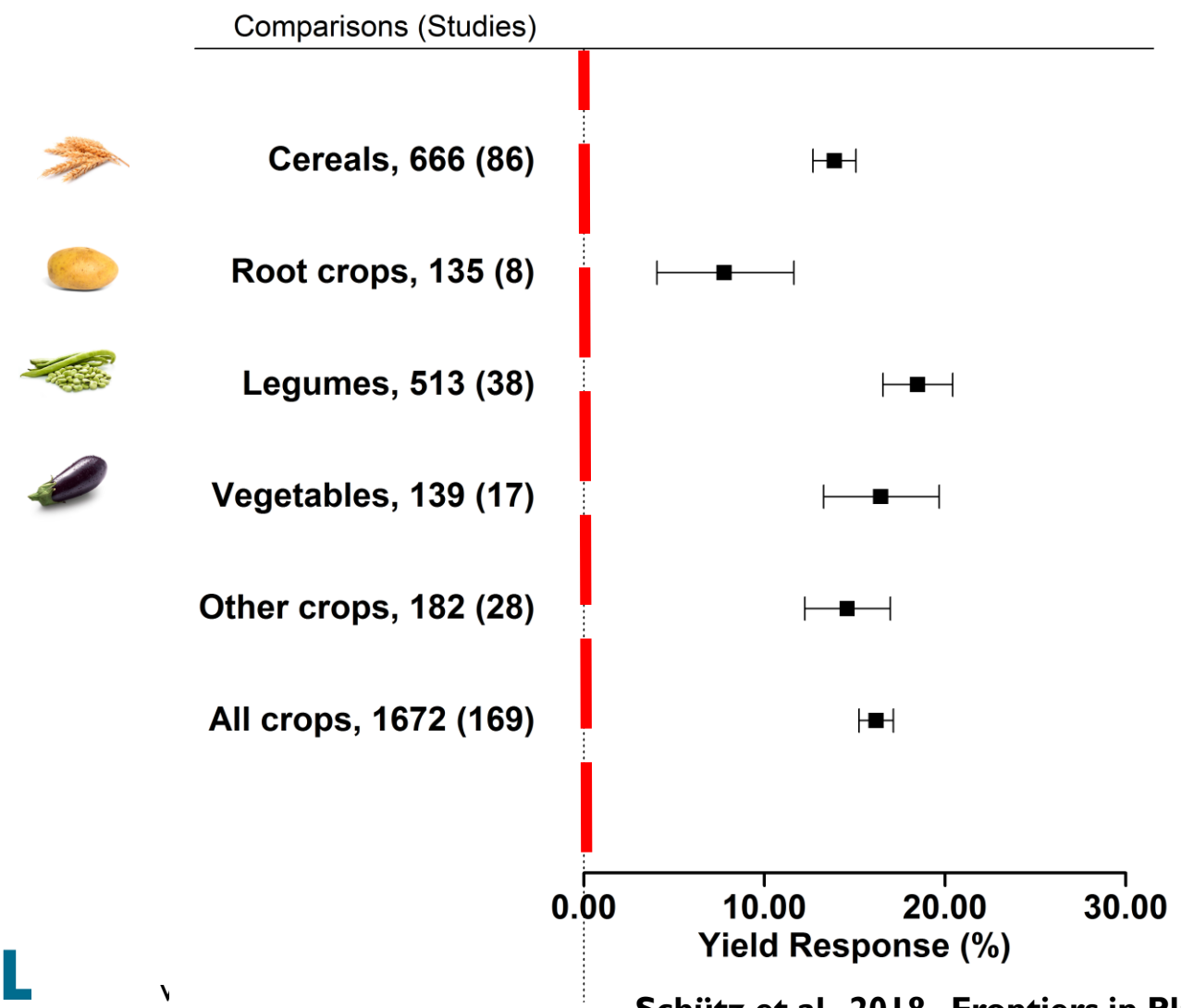


Percentage change of yield as affected by climate



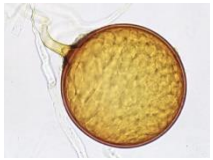
Schütz et al., 2018, Frontiers in Plant Science

Impact on Crop Type - Yield Response



Schütz et al., 2018, Frontiers in Plant Science

Characterizing types of biofertilizers



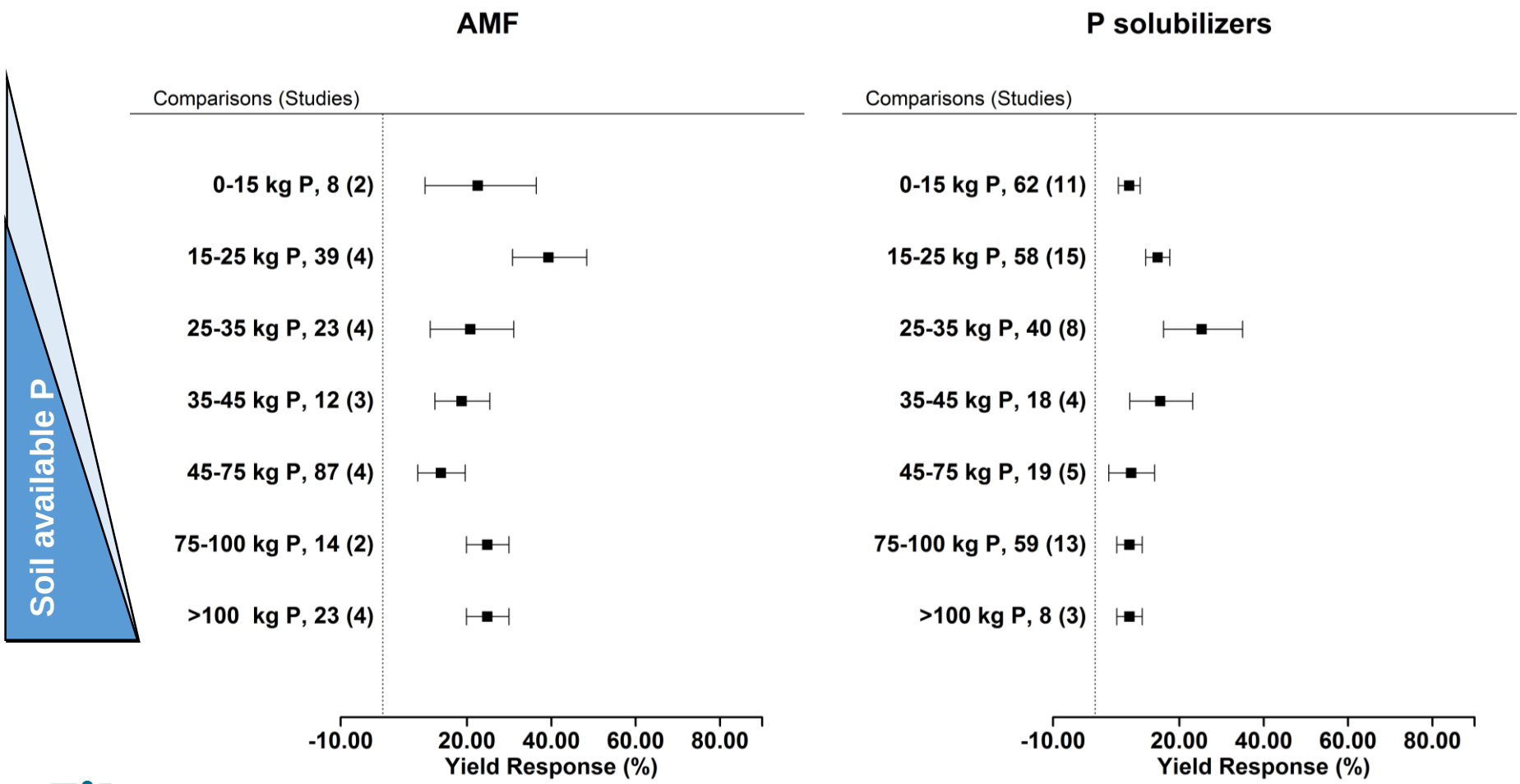
- AMF

- N fixers

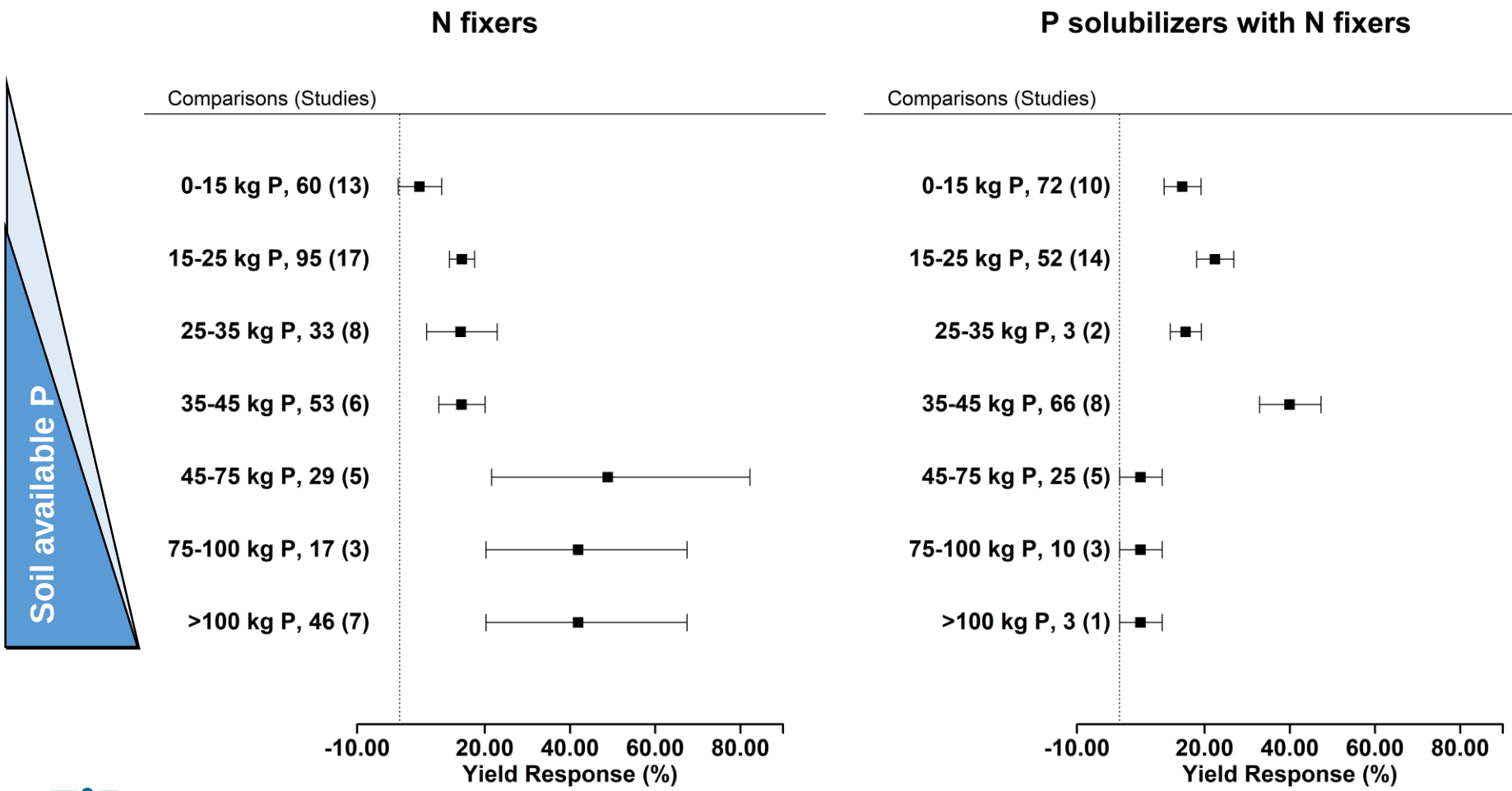
- P solubilizers

- Combined N fixers and P solubilizers

Response to soil available P



Response to soil available P



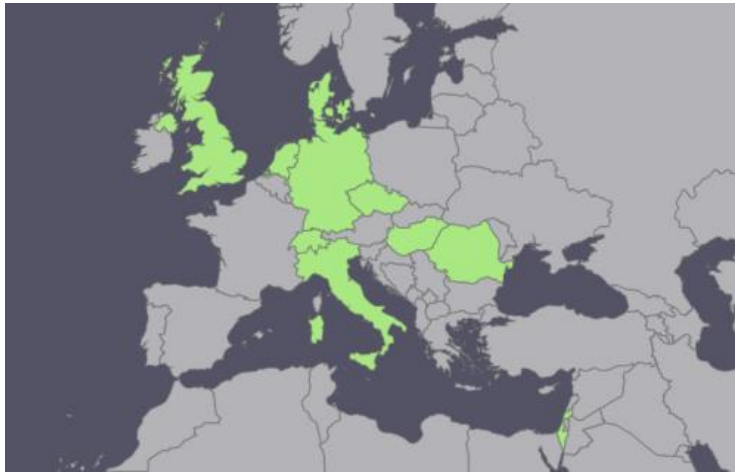
Schütz et al., et. al, 2018, Frontiers in Plant Science

The project BIOFECTOR
Lead G. Neumann Univ. Hohenheim

Overall aim

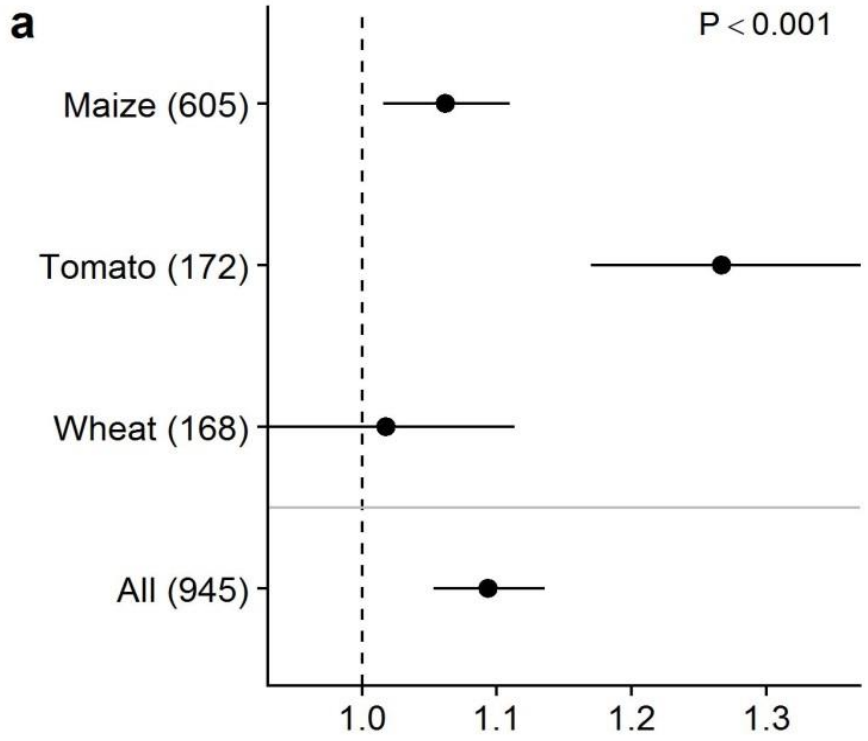
- To reduce the input of mineral fertilizers in European agriculture
- Development of adapted bioeffectors to improve the efficiency of alternative fertilisation strategies

Partners → 21 institutions across 11 countries



Meta-analysis of BIOFECTOR experiments: yield of different crops

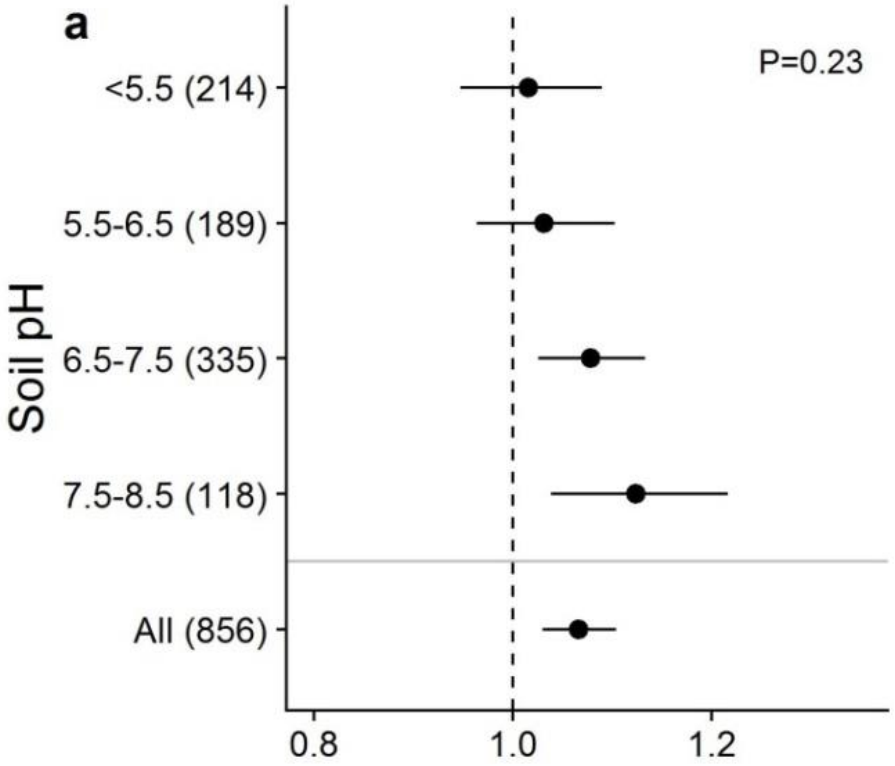
The effect of BE addition in different crops on either: grain DM, fruit DM, fruit FW or shoot DM

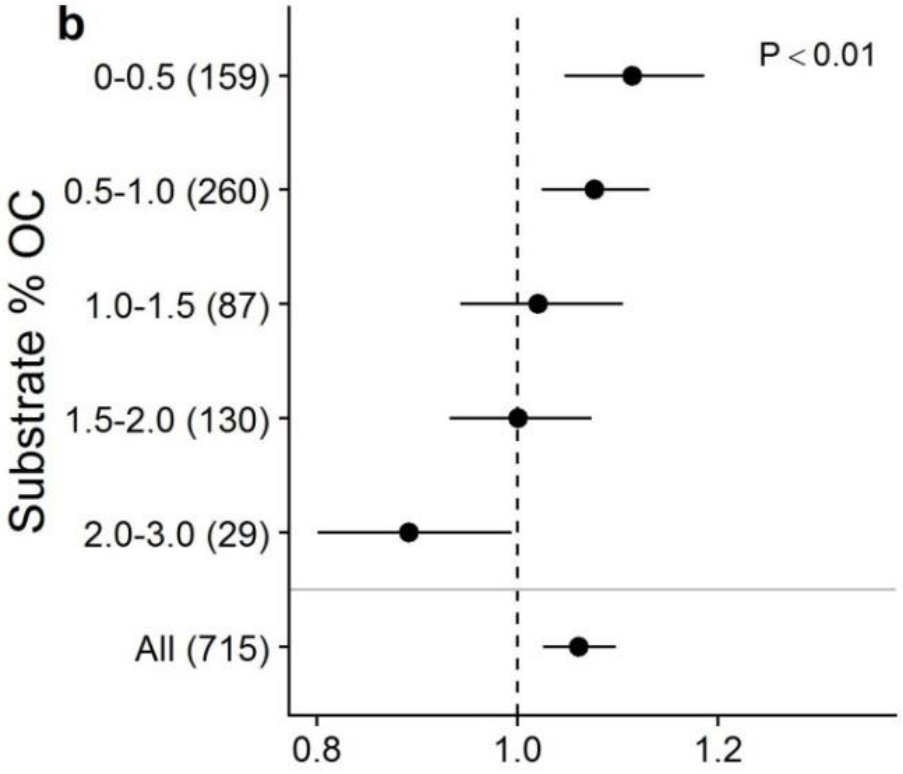


Results based on 94 pot experiments and 47 field trials

Lekfeldt, Nkebiwe et al., in preparation

Meta-analysis of BIOFECTOR experiments: yield under various soil pH and soil organic carbon levels





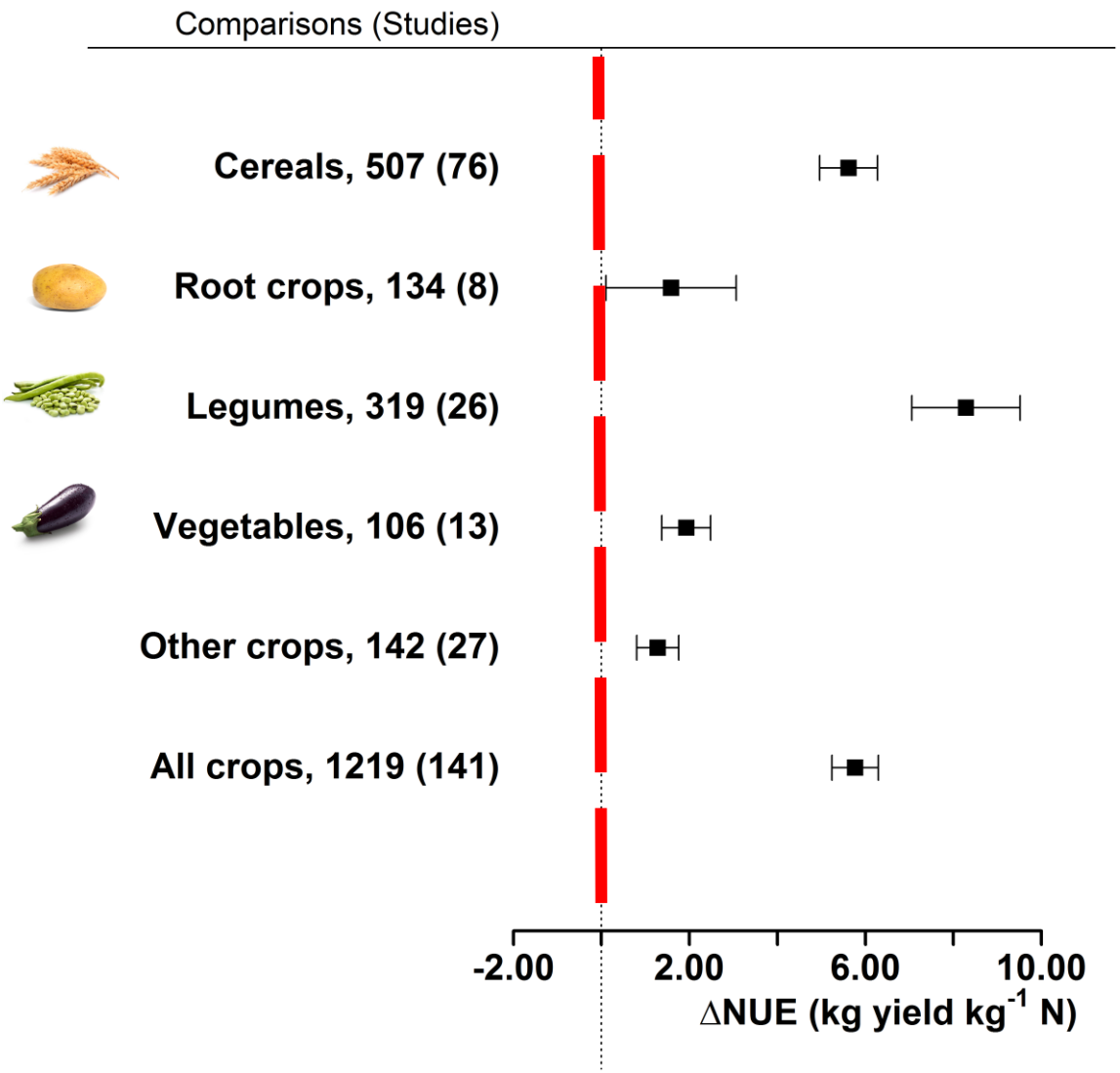
Lekfeldt, Nkebiwe et al., in preparation

Summary

- Biofertilizers are a viable option to make farming systems more sustainable
- Biofertilizers are more efficient
  - at locations with initially low yields
  - under dry and tropical climate
  - with low soil organic carbon SOC
  - moderate available P in soil (N fixers high P)
  - Neutral to slightly alkaline pH
- Effects are crop dependent: high potential in transplanted crops

Additional information

Impact on crop type - Nitrogen Use Efficiency



Schütz et al., et. al, 2018, Frontiers in Plant Science

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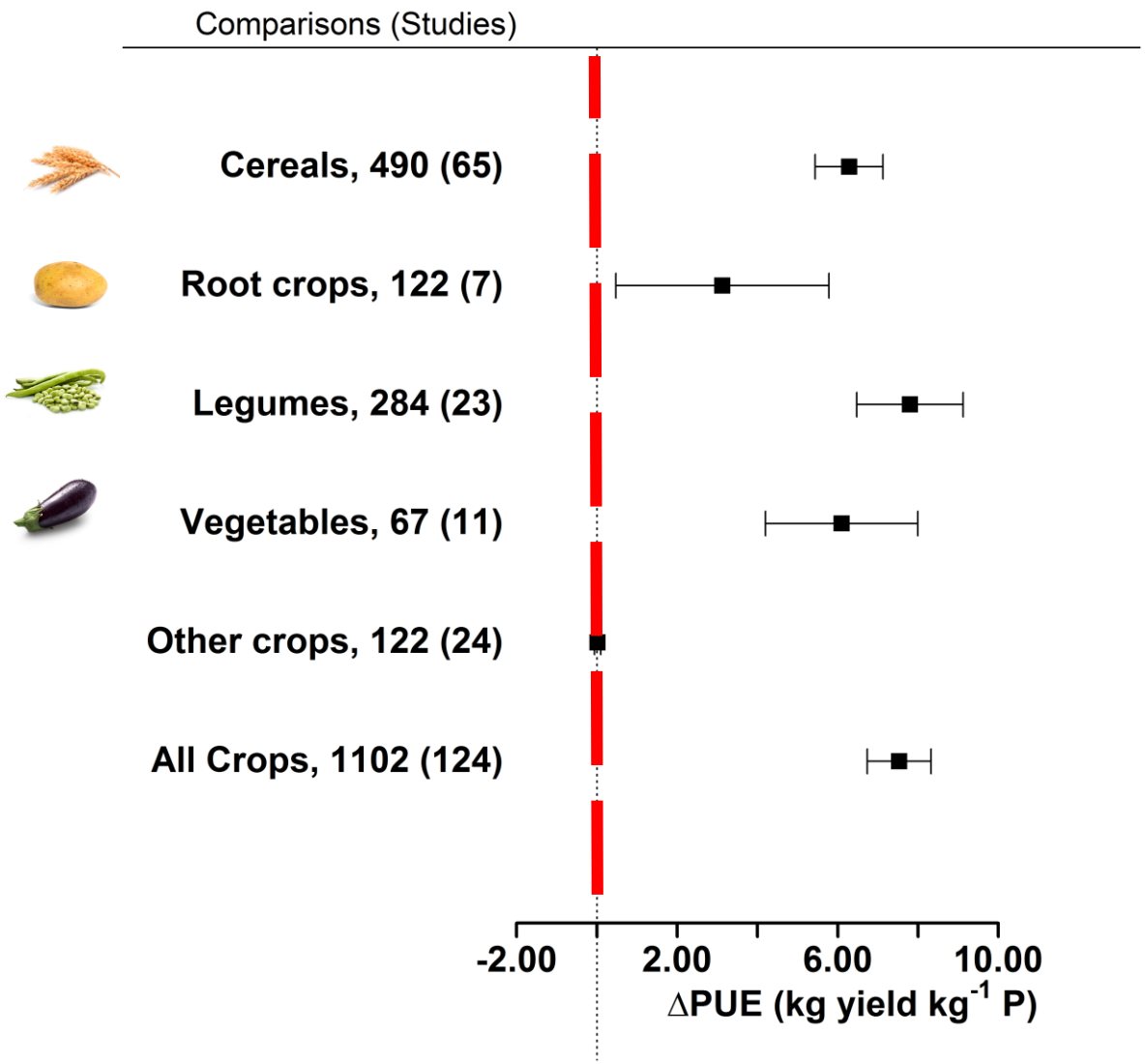
Impact on Crop Type - Phosphorus Use Efficiency



Schütz et al., et. al, 2018, Frontiers in Plant Science

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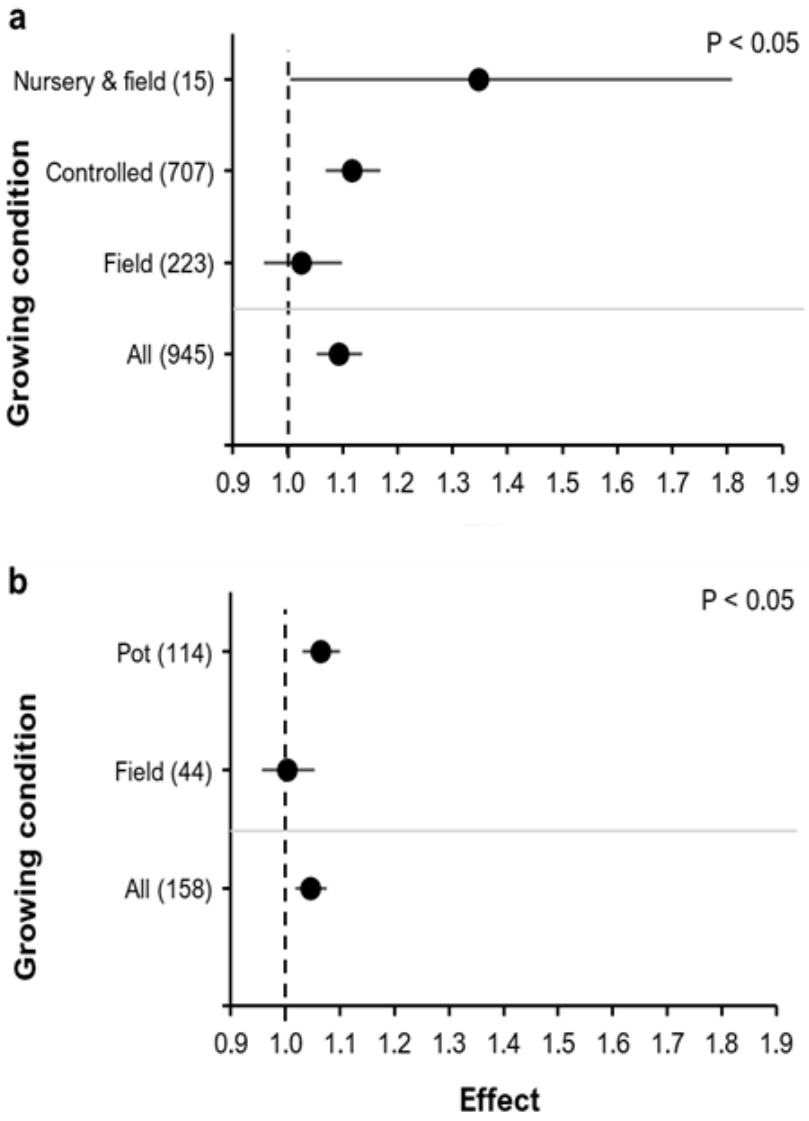
Meta-analysis BIOFECTOR



The effect of BE addition according to the growing conditions.

The analyses included all observations (controlled means pot) (a) or only maize in combination with the BE Proradix (b).

In (a) the combination "Nursery & field" is included which was only included in experiments with tomato. The p-value indicates whether or not there was a significant effect of the moderator in question.

Lekfeldt, Nkebiwe et al., in preparation

Alternatives…

PLOS ONE

RESEARCH ARTICLE

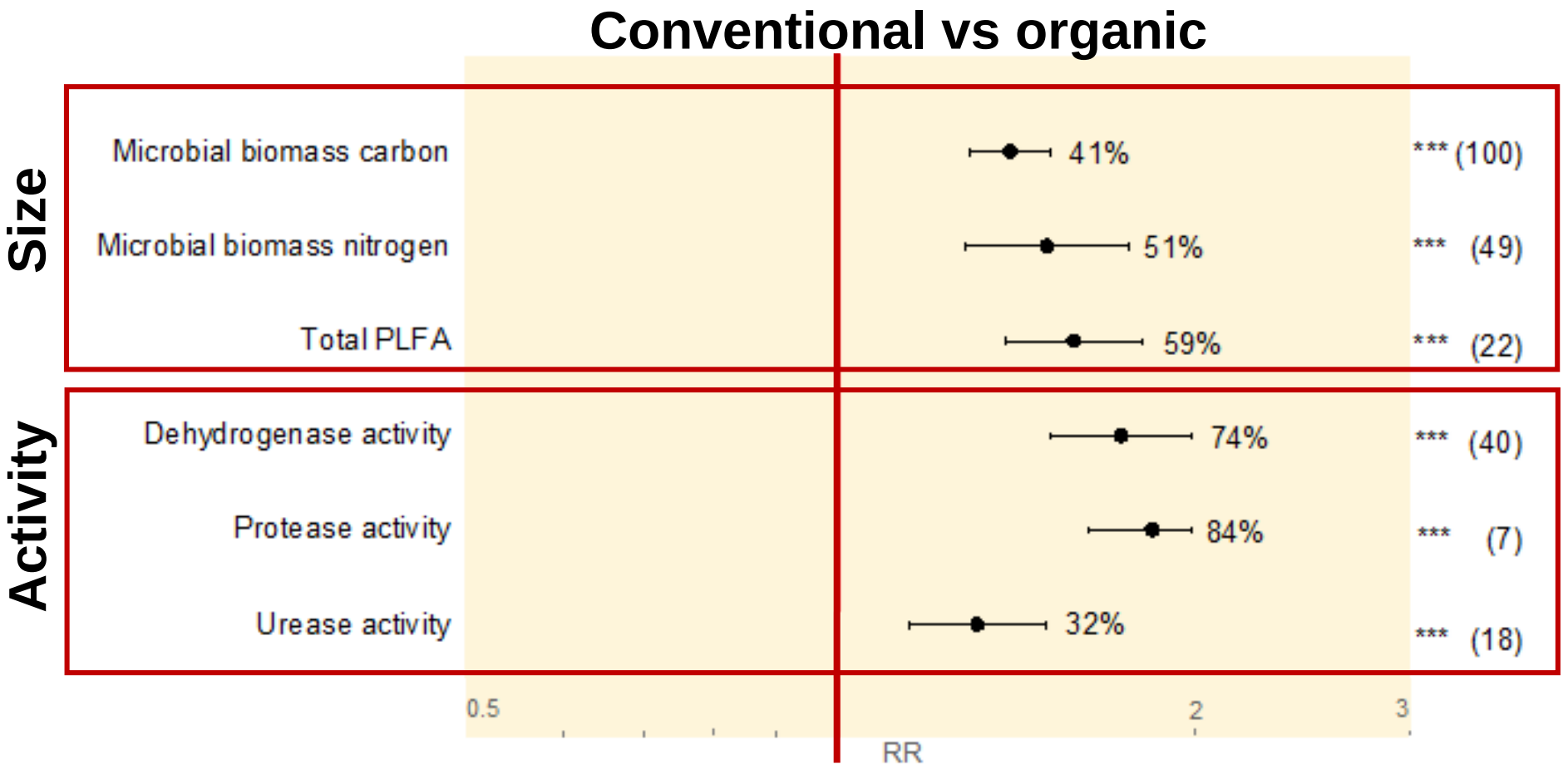
Organic farming enhances soil microbial abundance and activity—A meta-analysis and meta-regression

Martina Lori[1,2]*, Sarah Symnaczik[1], Paul Mäder[1], Gerlinde De Deyn[3], Andreas Gattinger[1,2]

1 Department of Soil Sciences, Research Institute of Organic Agriculture (FiBL), Frick, Switzerland, **2** Karl-Glöckner-Str. 21 C, Justus-Liebig University Giessen, Giessen, Germany, **3** Department of Soil Quality, Wageningen University, Wageningen, The Netherlands

→ Organic soil management

Results: Positive impact of organic management on size and activity of microbial communities



Selected “practices” and soil characteristics affect microbial communities

Categorical meta-analysis
→ Crop rotation, legumes, organic fertilizers increase microbial biomass and activity

Meta-regression
→ Increased soil organic matter contents positively affect microbial biomass

Lori et al., 2017, PLOS ONE