UNIVERSITÀ DEGLI STUDI DI MILANO
Department of Food, Environmental and Nutritional Sciences (DeFENS),
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P-cycling and N-fixing bacteria of rice root compartments are affected by reduced P fertilization

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RICE CULTIVATION

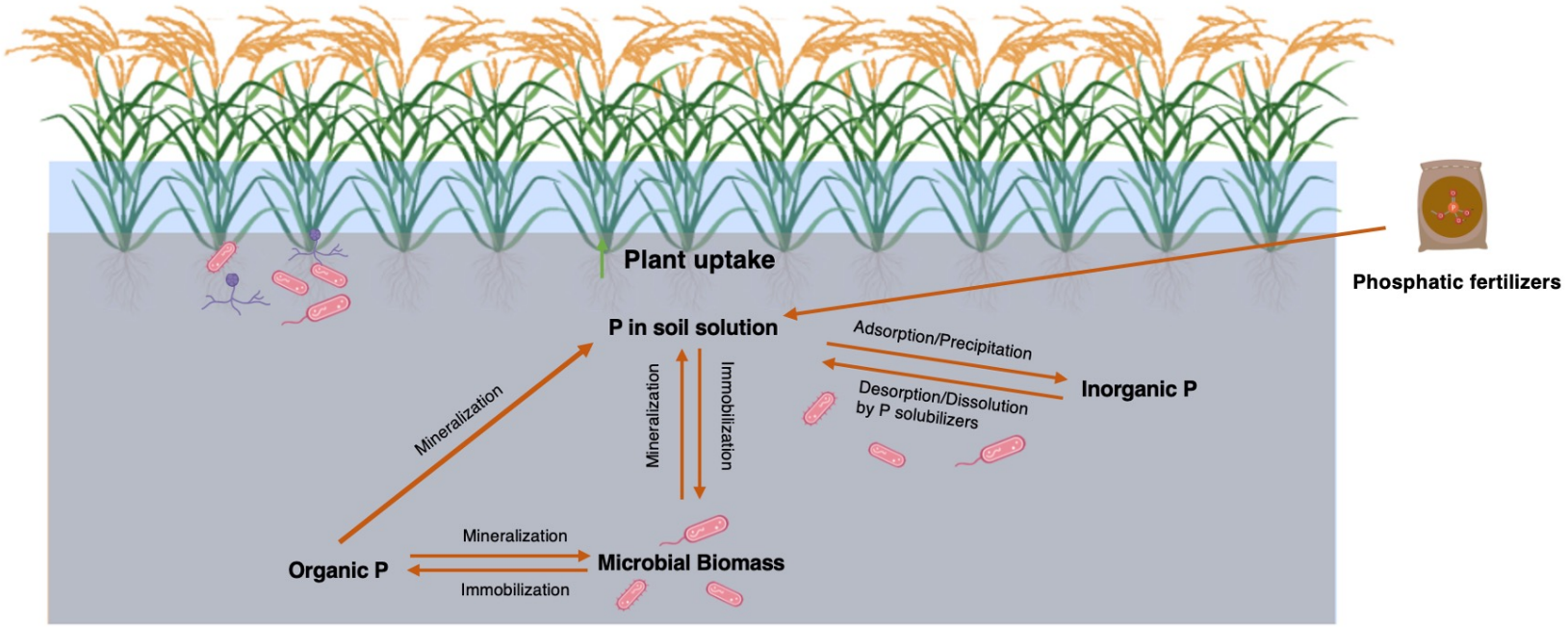
- **Rice is one of the cereal crops that requires a further increase in production** in the coming years due to the increase in the human population (Mayer et al., 2019).

- **Italy is the leading producer of rice** in Europe. In particular, in the regions of **Lombardy and Piedmont** is cultivated the 93% of the Italian rice (Ente Nazionale Risi).

Phosphorous in rice paddy

- Phosphorus (P) is an essential element for plant growth. It is uptaken by plant as orthophosphate.
- In rice paddy fields, available P increases but it can be re-adsorbed or co-precipitated when oxic conditions are established by mid-season field draining *.

Responses of microbial community to P availability

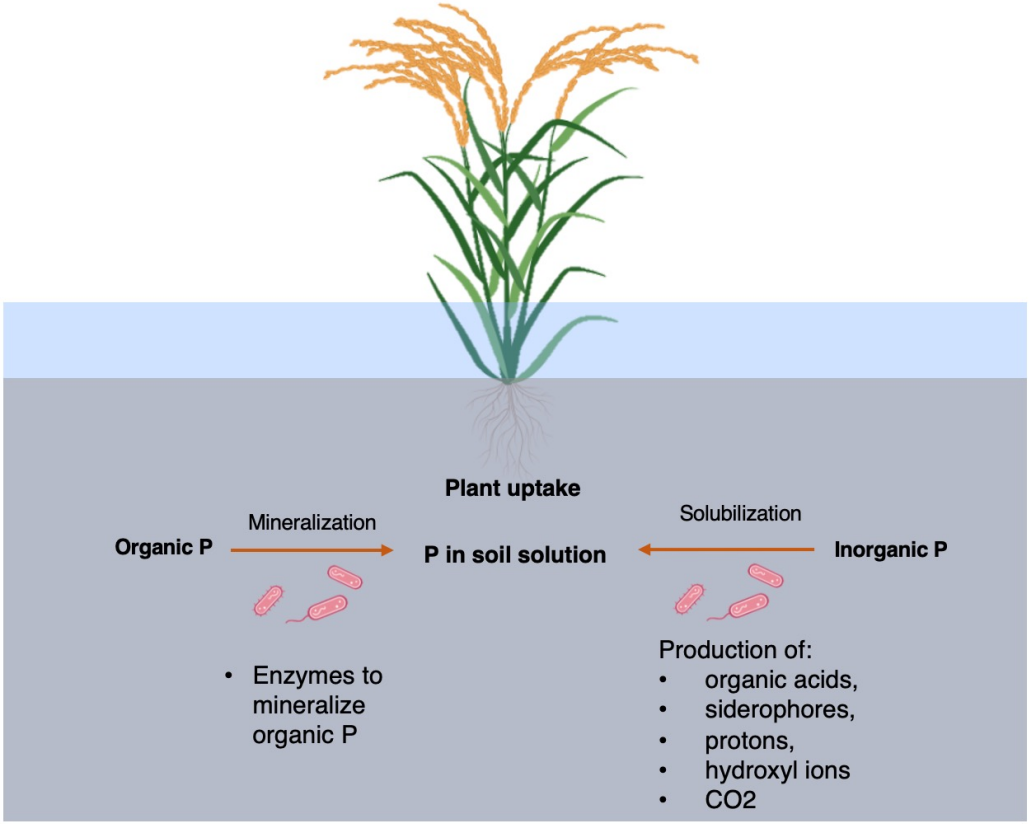


* Martinengo *et al.*, 2023

Microbial P dissolution

P dissolution processes are mainly mediated by :

- Inorganic P-solubilization
- Organic P-mineralization
- P-uptake and transport (high-affinity (pst) and low-affinity (pit) transporters)
- P-starvation response regulation

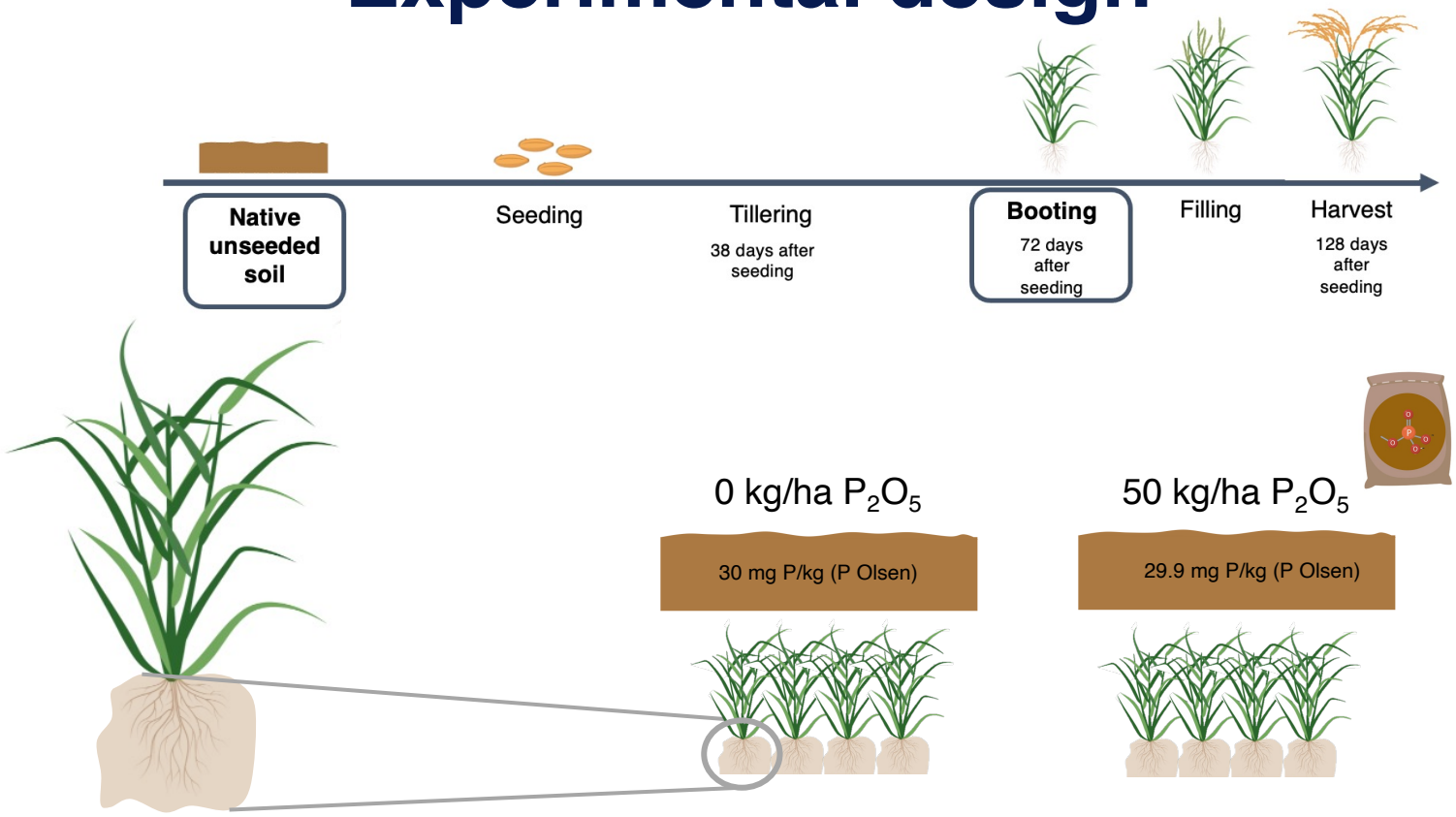


AIM THE STUDY

Assess the impact of P fertilization on PGP activities of rice rhizosphere microbiomes, a focus on:

- P dissolution
- N fixation

Experimental design



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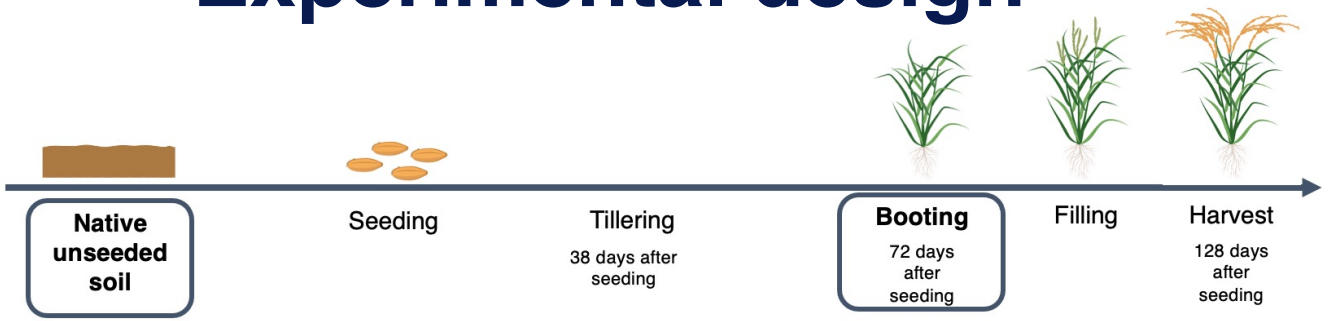
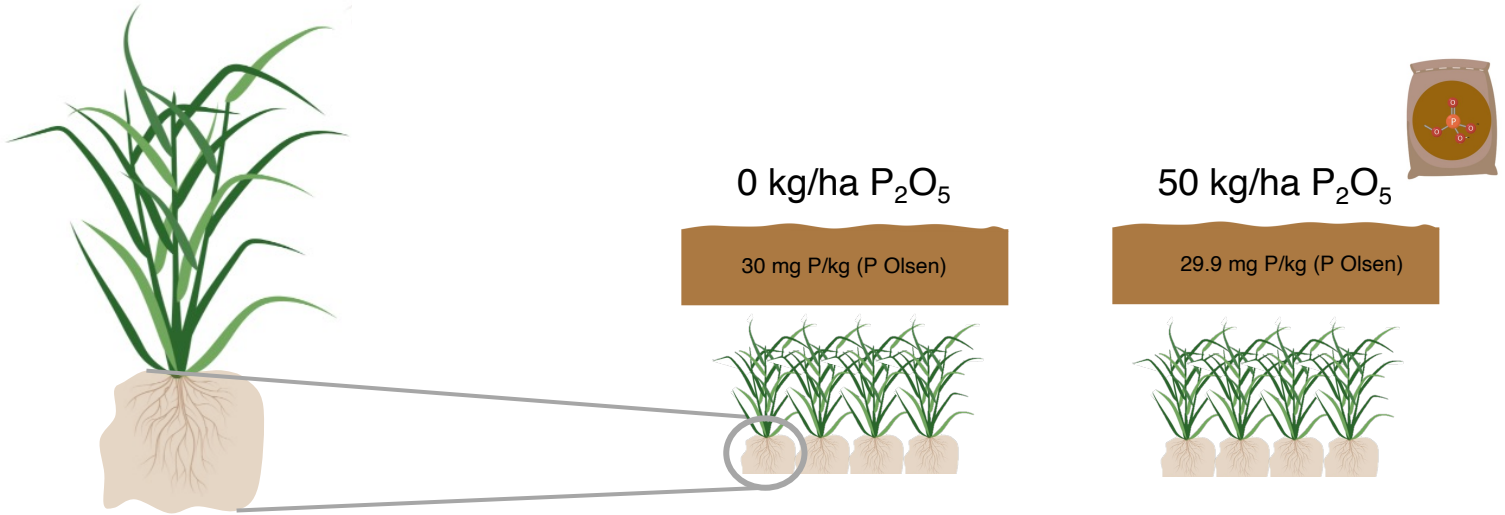
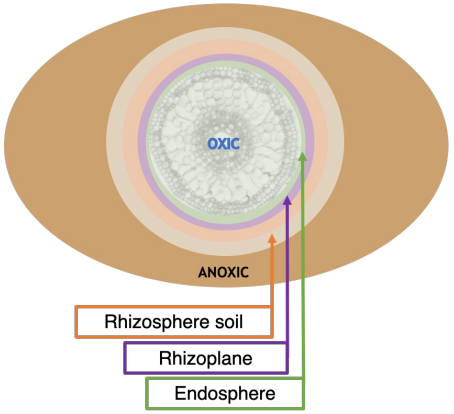




Separation of rhizosphere fractions

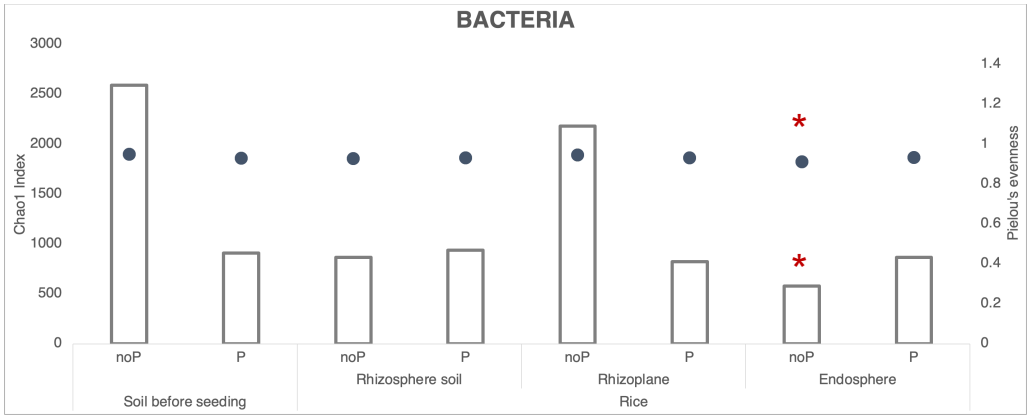


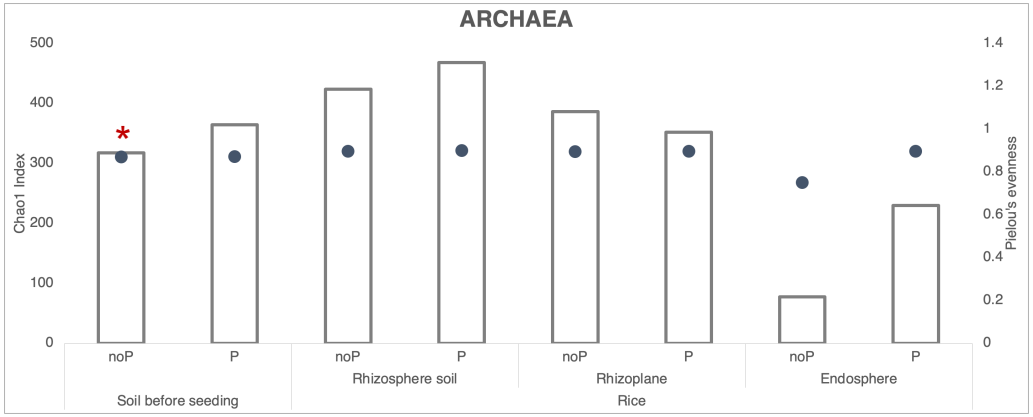
- Molecular Ecology (Illumina sequencing of 16S rRNA)
- Functional prediction
- Functional biomarker quantification (qPCR)

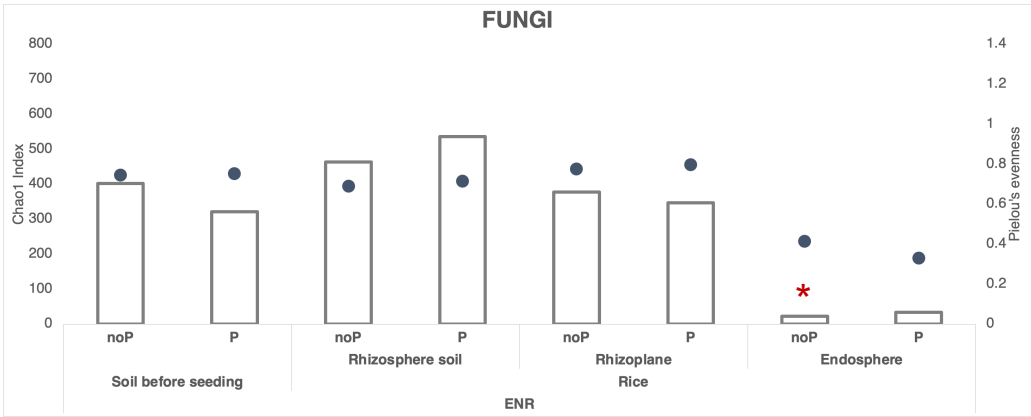
Molecular Ecology

Alpha diversity

- Chao1 Index
- Pielou's Evenness Index





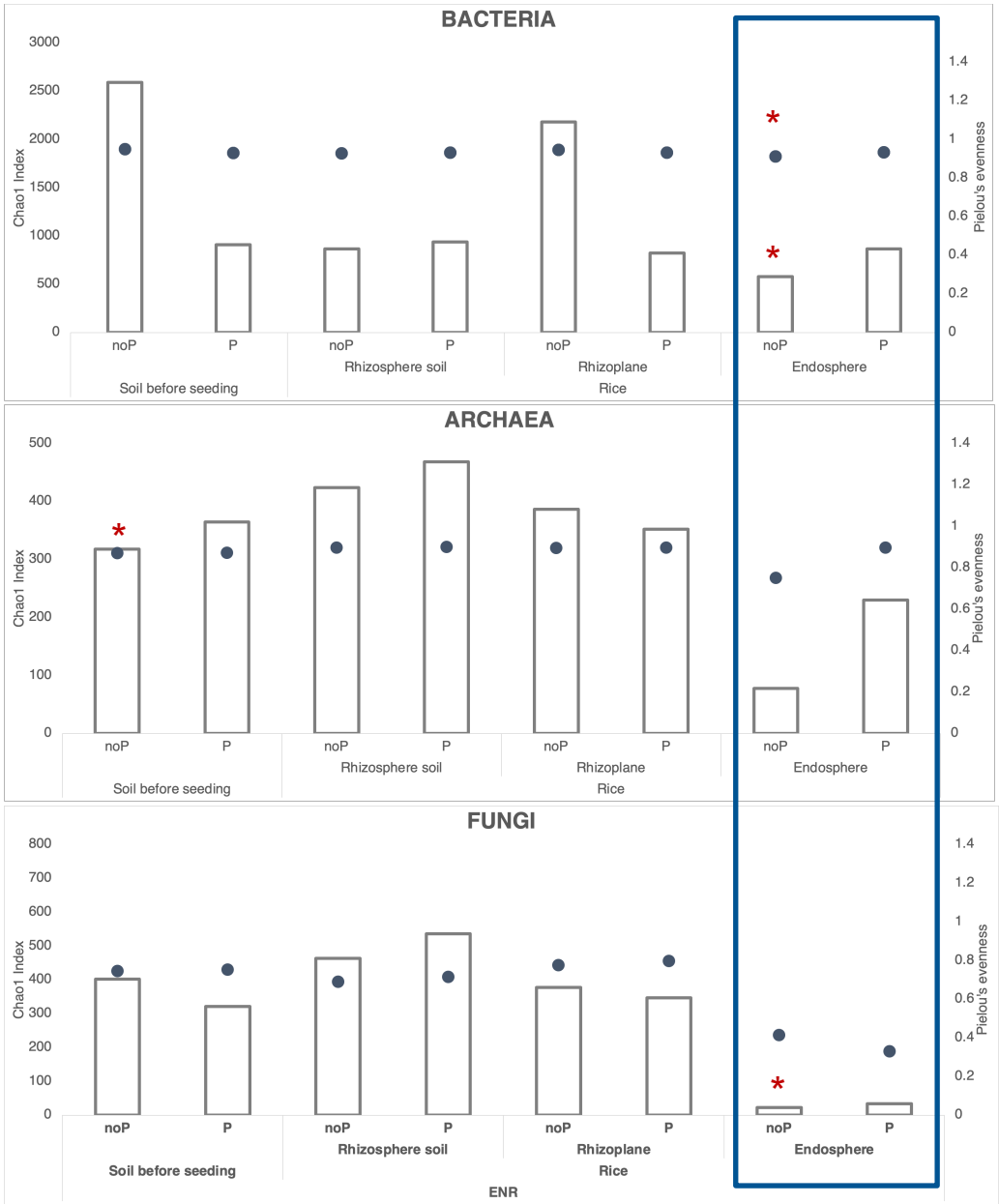


t-student, *p-value* *<0.05; **<0.01; ***<0.001

Molecular Ecology

Alpha diversity

- Chao1 Index
- Pielou's Evenness Index



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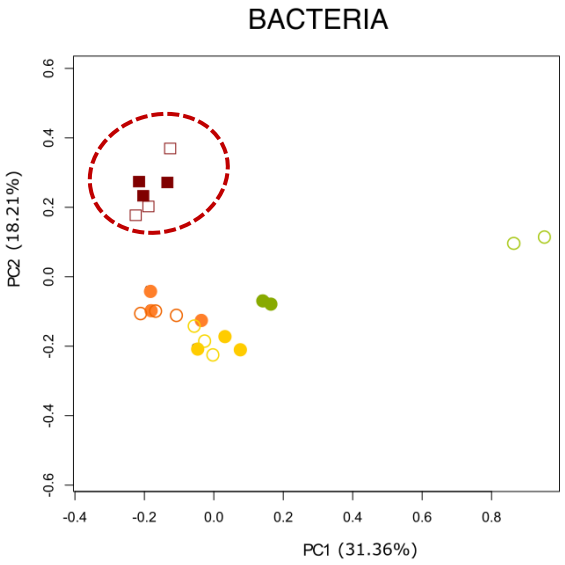
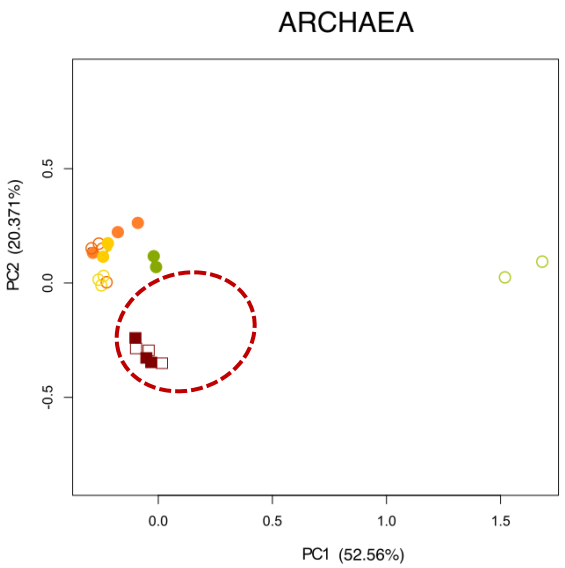
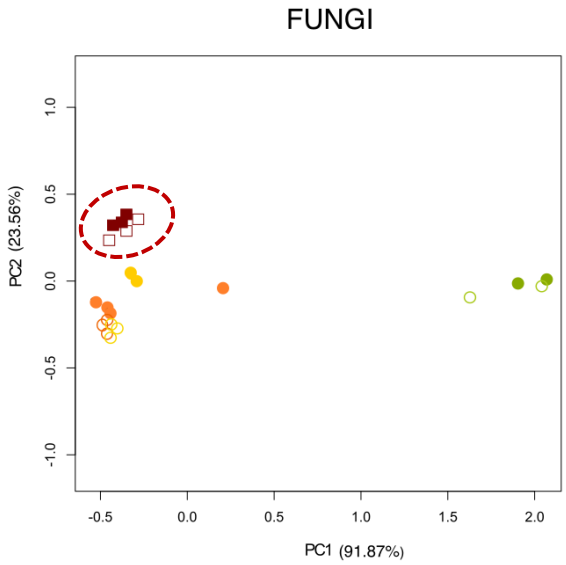
Molecular Ecology

Beta diversity

Plant effect







Soil before seeding
- noP
- P

Rice

Rhizosphere soil
- noP
- P

Rhizoplane
- noP
- P

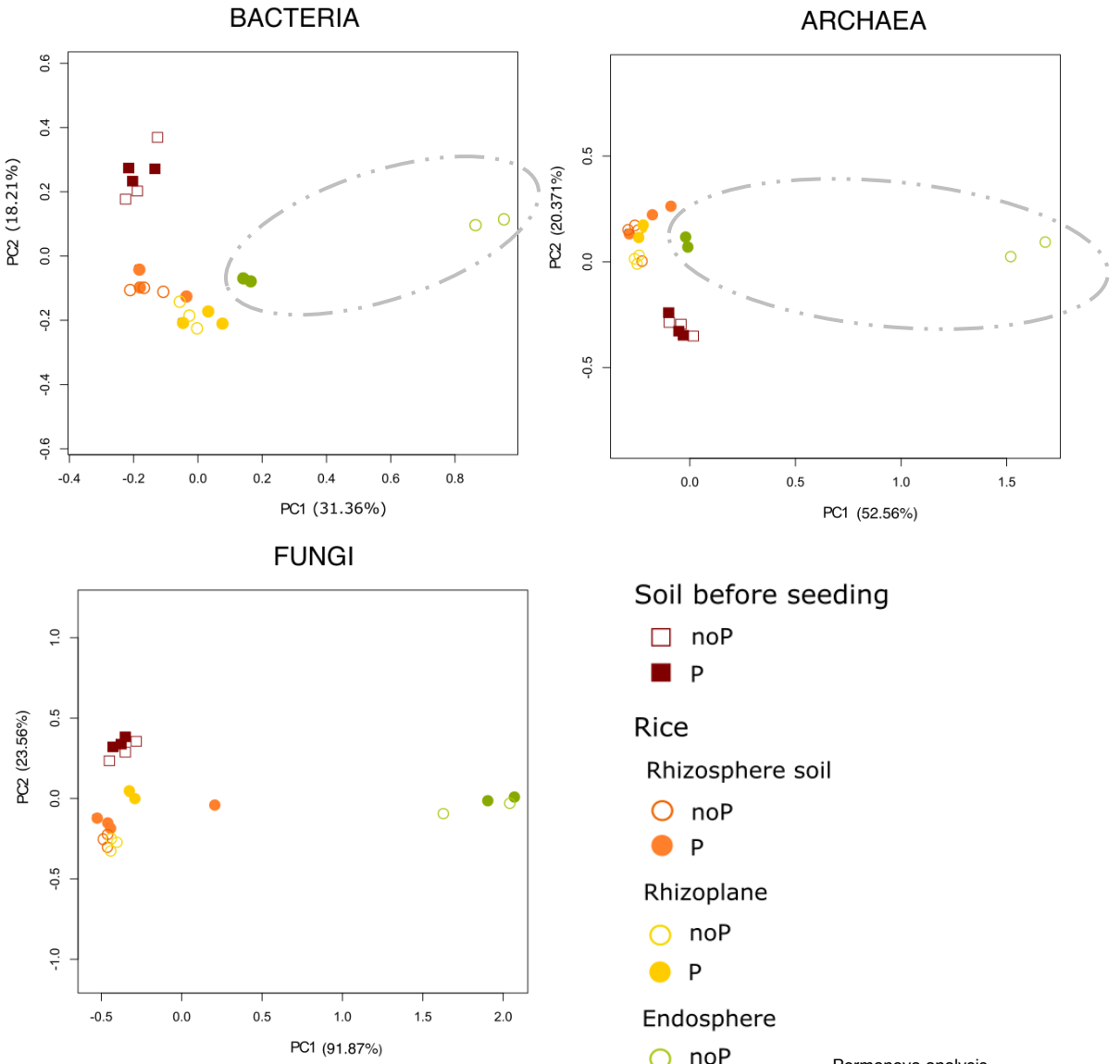
Endosphere
- noP
- P

Permanova analysis
Host *P-value* < 0.01
Compartment *P-value*<0.01

Molecular Ecology

Beta diversity

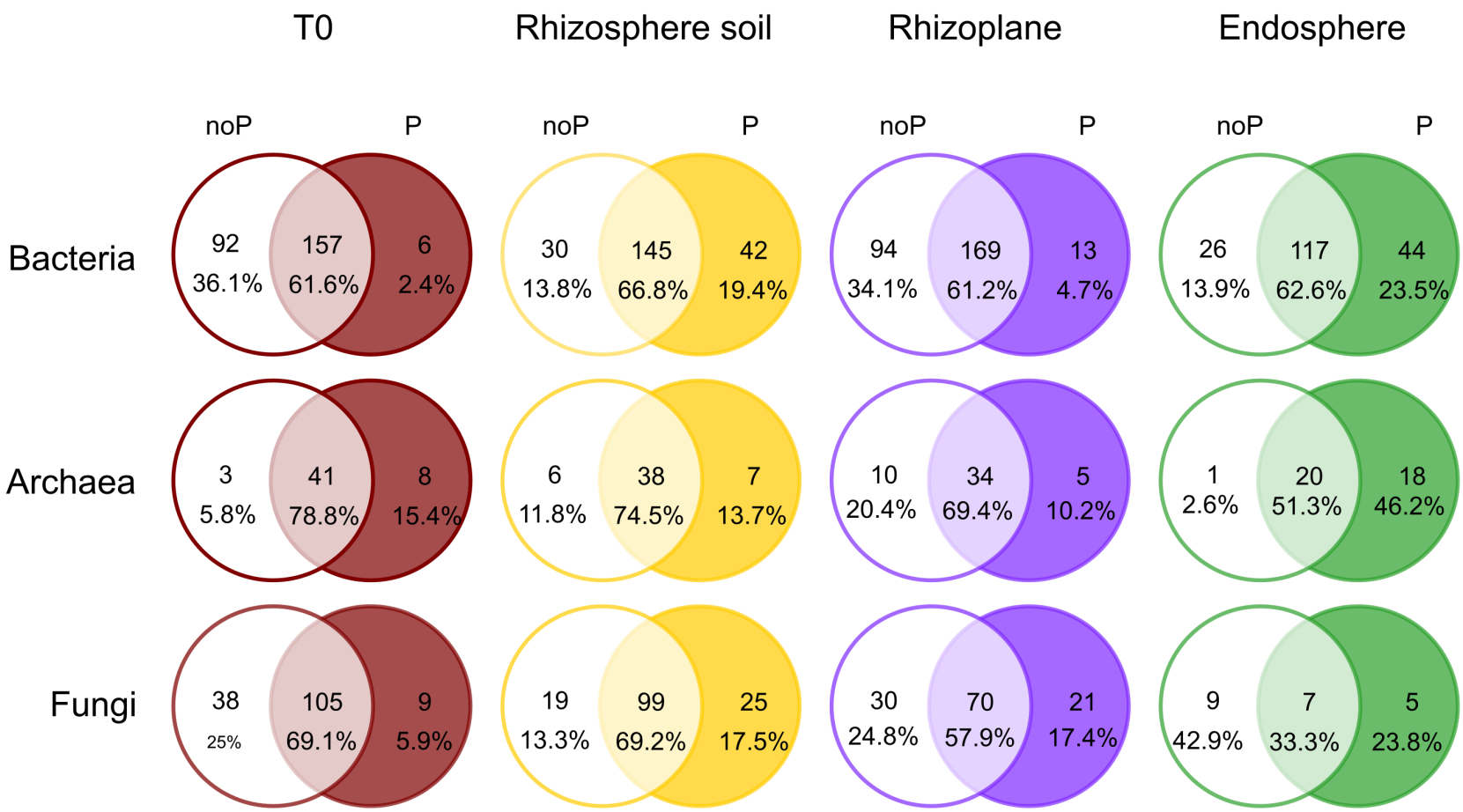
Effect of P fertilization



Permanova analysis
Agronomic condition *P-value*<0.01

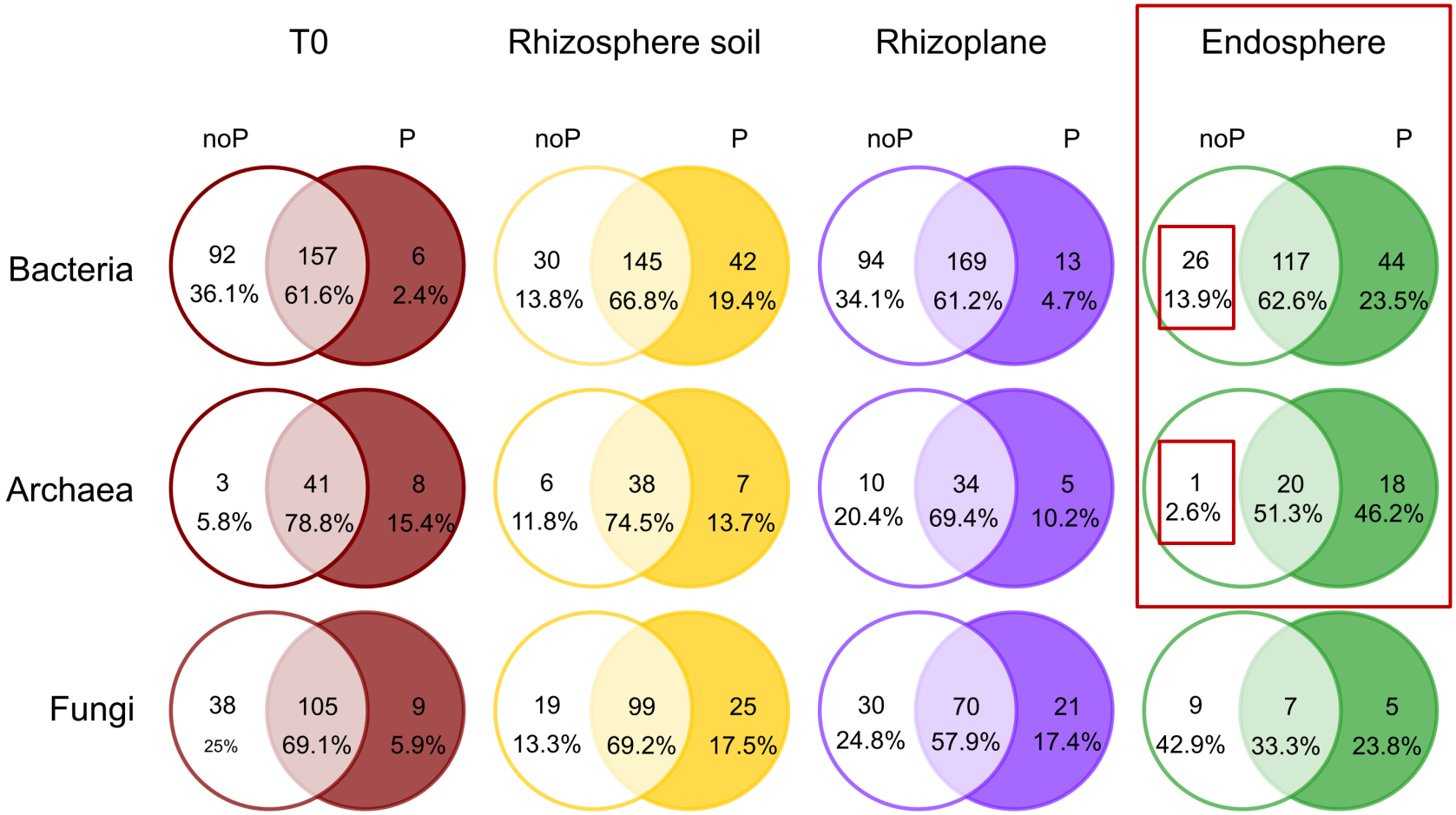
Molecular Ecology

Core rice microbiome



Molecular Ecology

Core rice microbiome

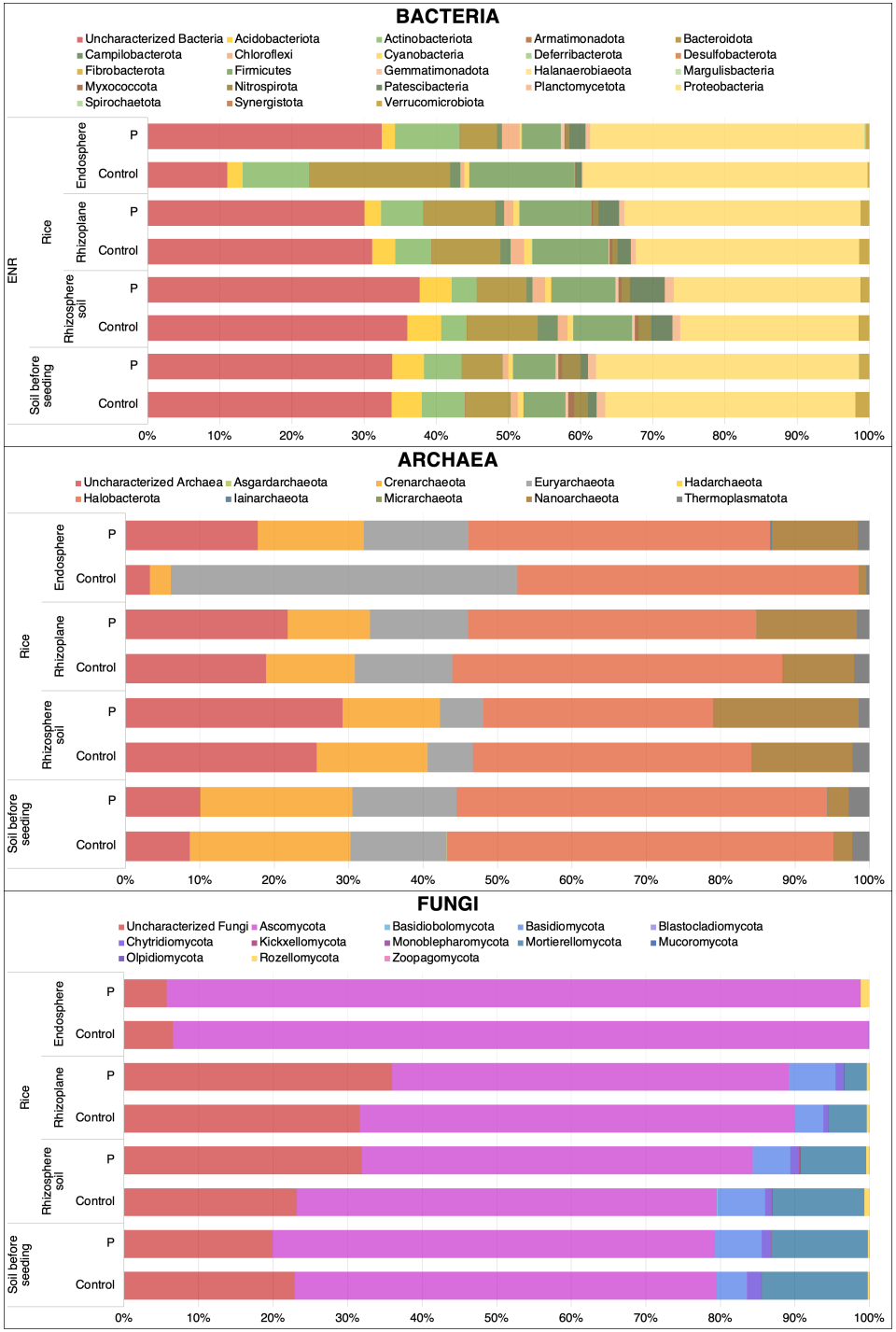


Molecular Ecology

Phyla

The most abundant **Bacteria** genera are:

Proteobacteria,
Firmicutes,
Bacteroidota



Molecular Ecology

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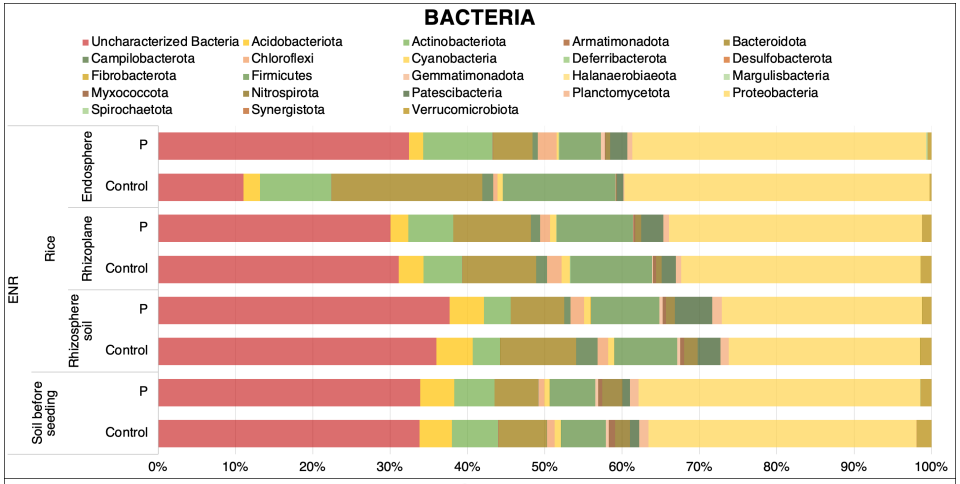
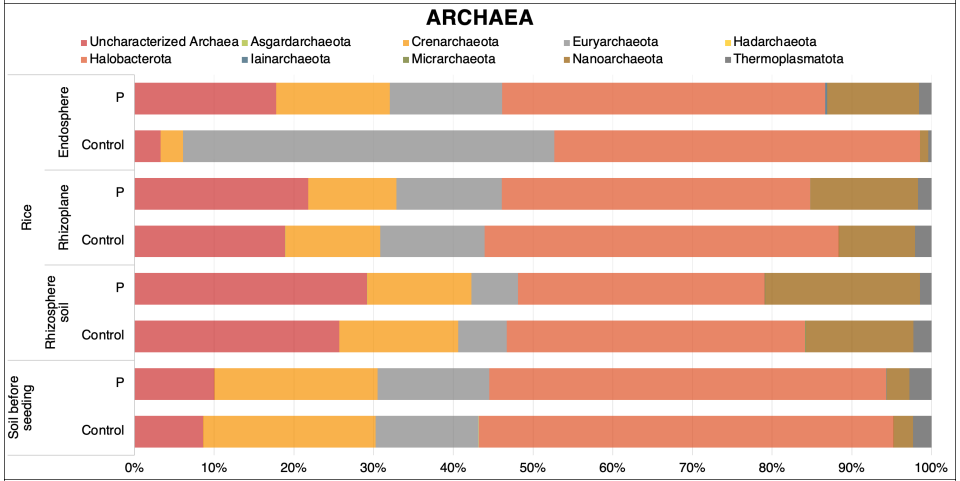
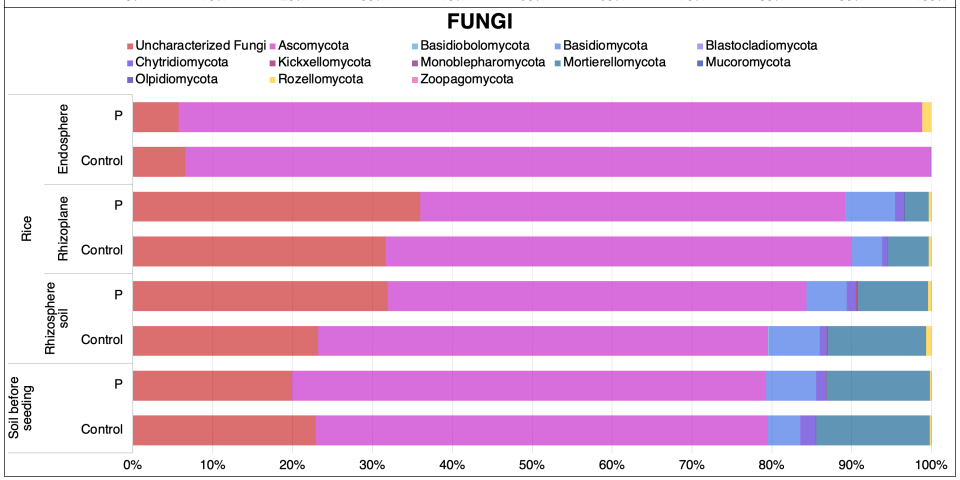
The most abundant **Archaea** genera are:

Halobacterota,
Euryarchaeota,
Crenarchaeota







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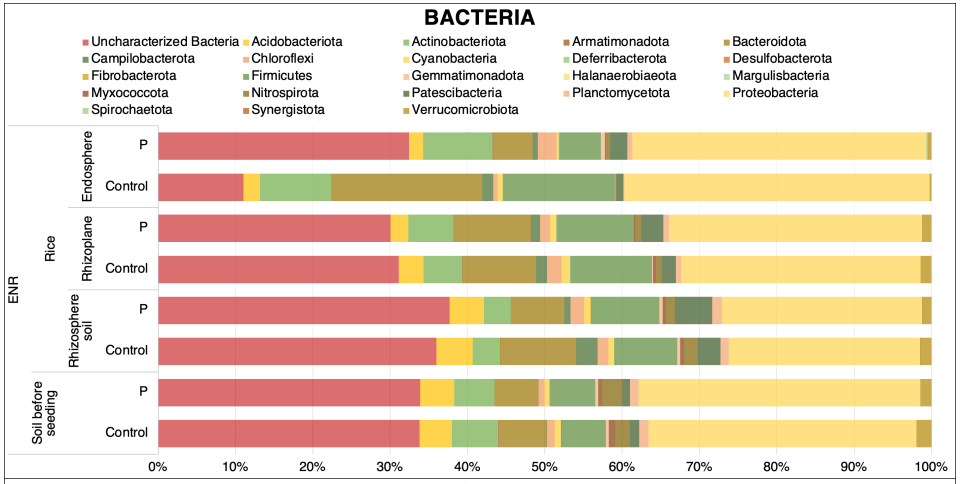
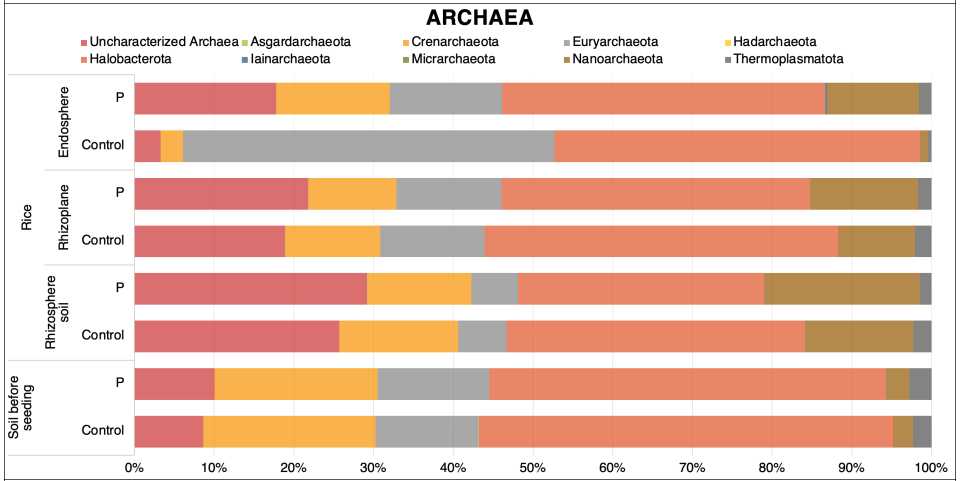
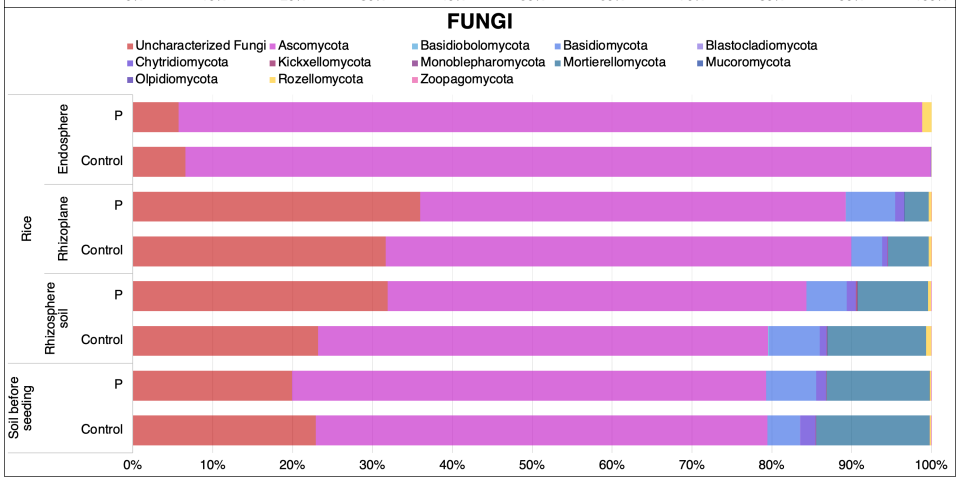
Crenarchaeota

The most abundant **Fungi** genera are:

Ascomycota
Mortierellomycota

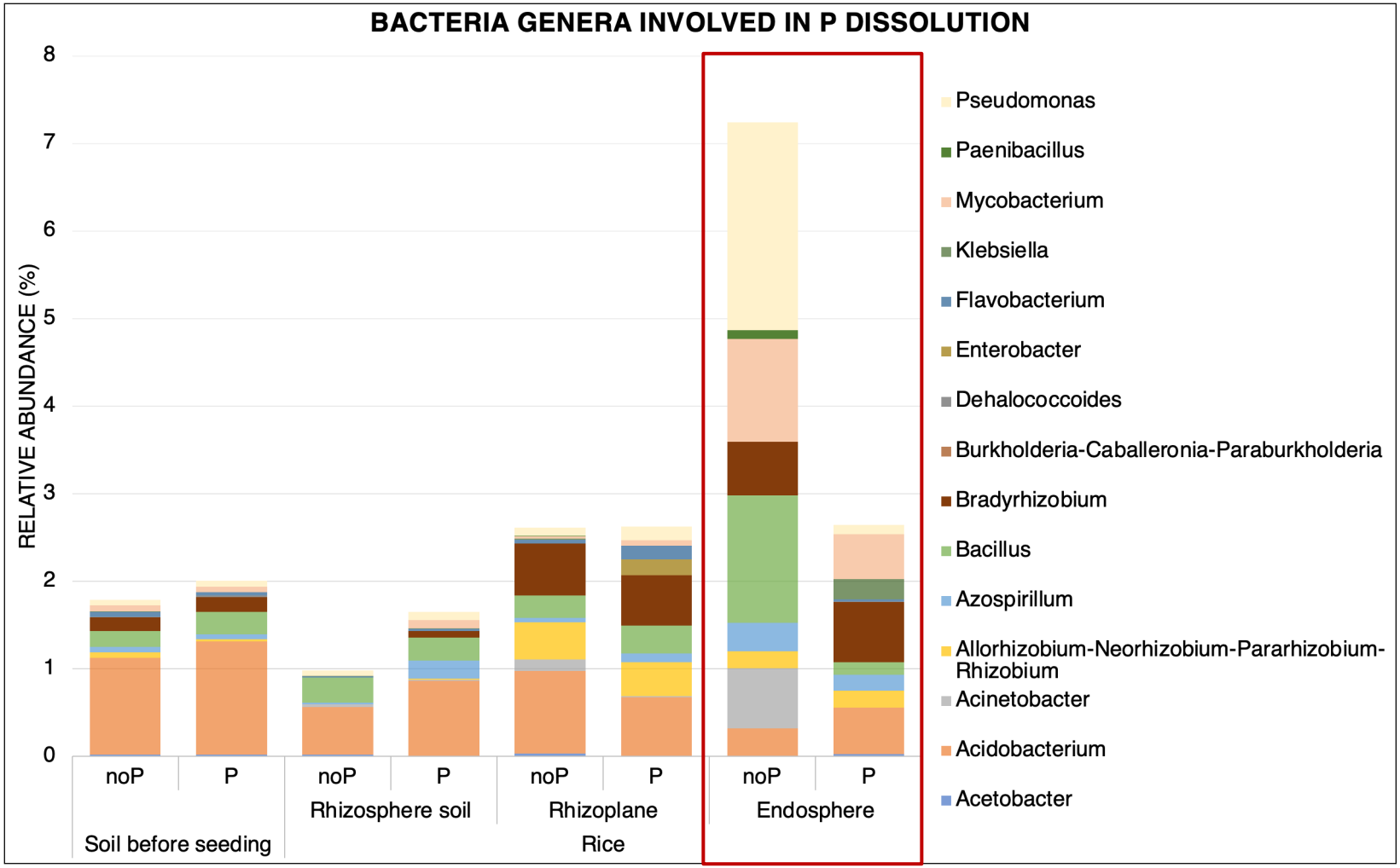






Functional prediction
P dissolution

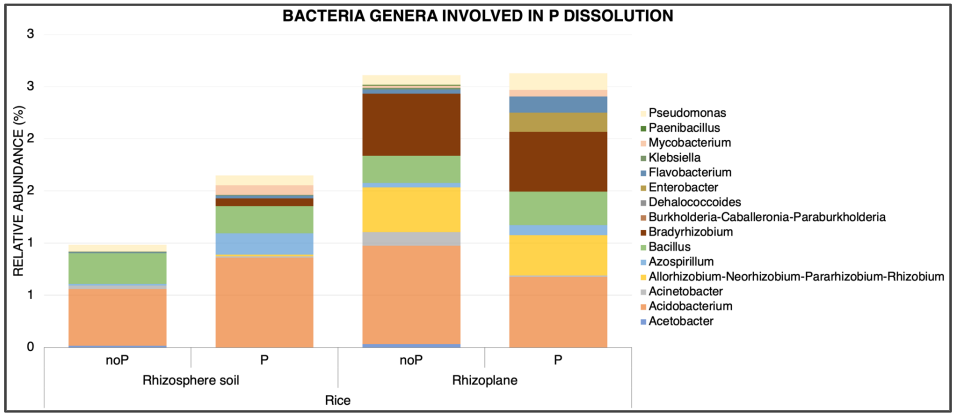
- The absence of P fertilization increase the relative abundance of *Pseudomonas, Bacillus, Acinetobacter* and *Mycobacterium* in the endosphere.

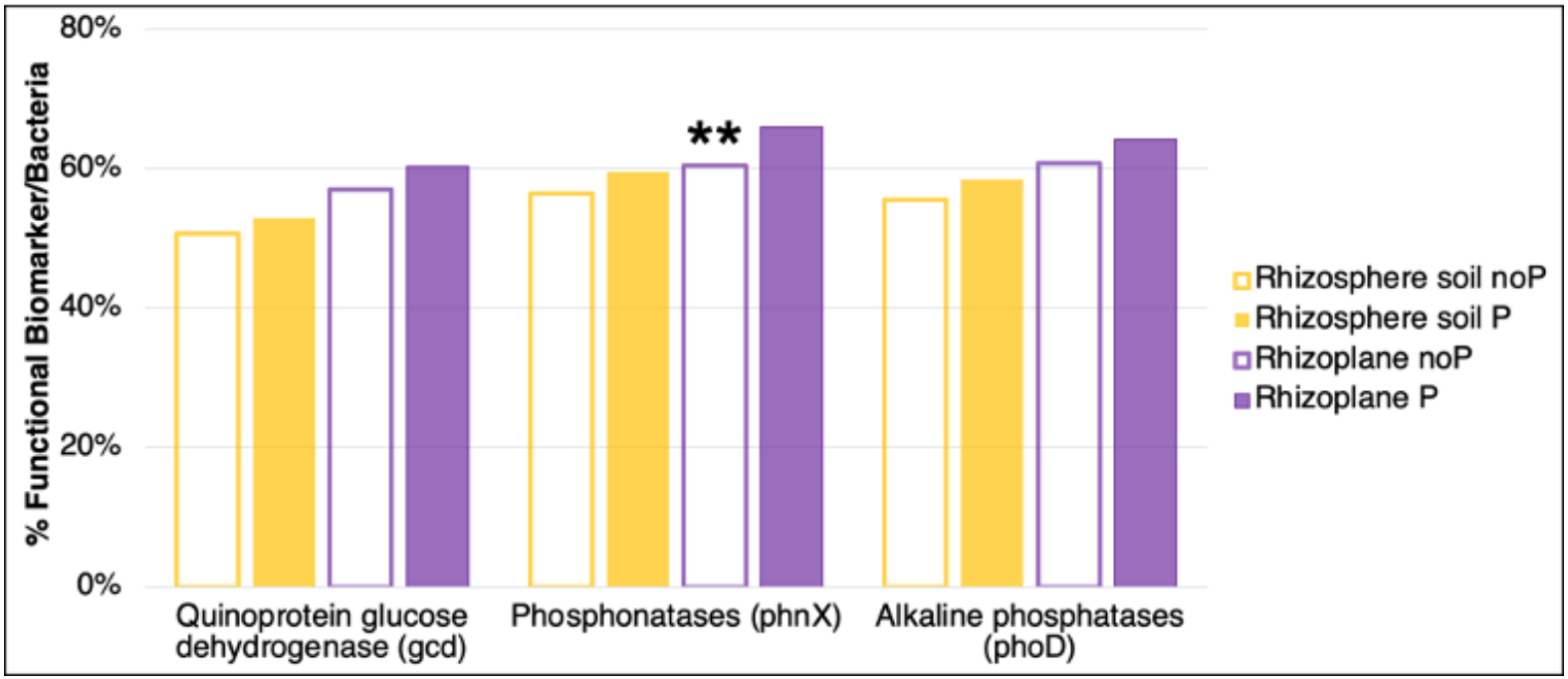


Classification based on a personal database

Functional biomarker quantification

P dissolution



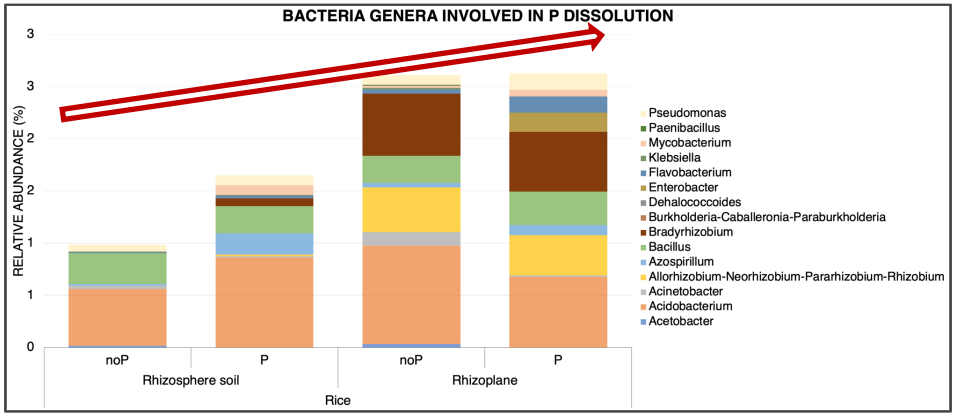


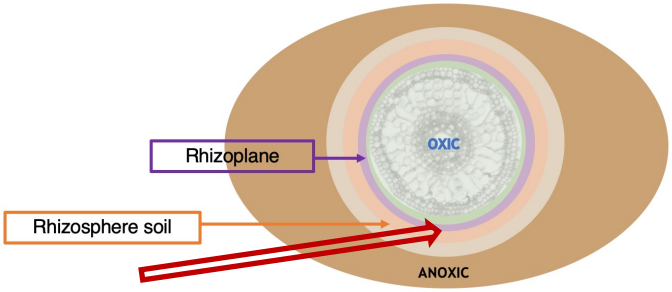
P Solubilization **P Mineralization**

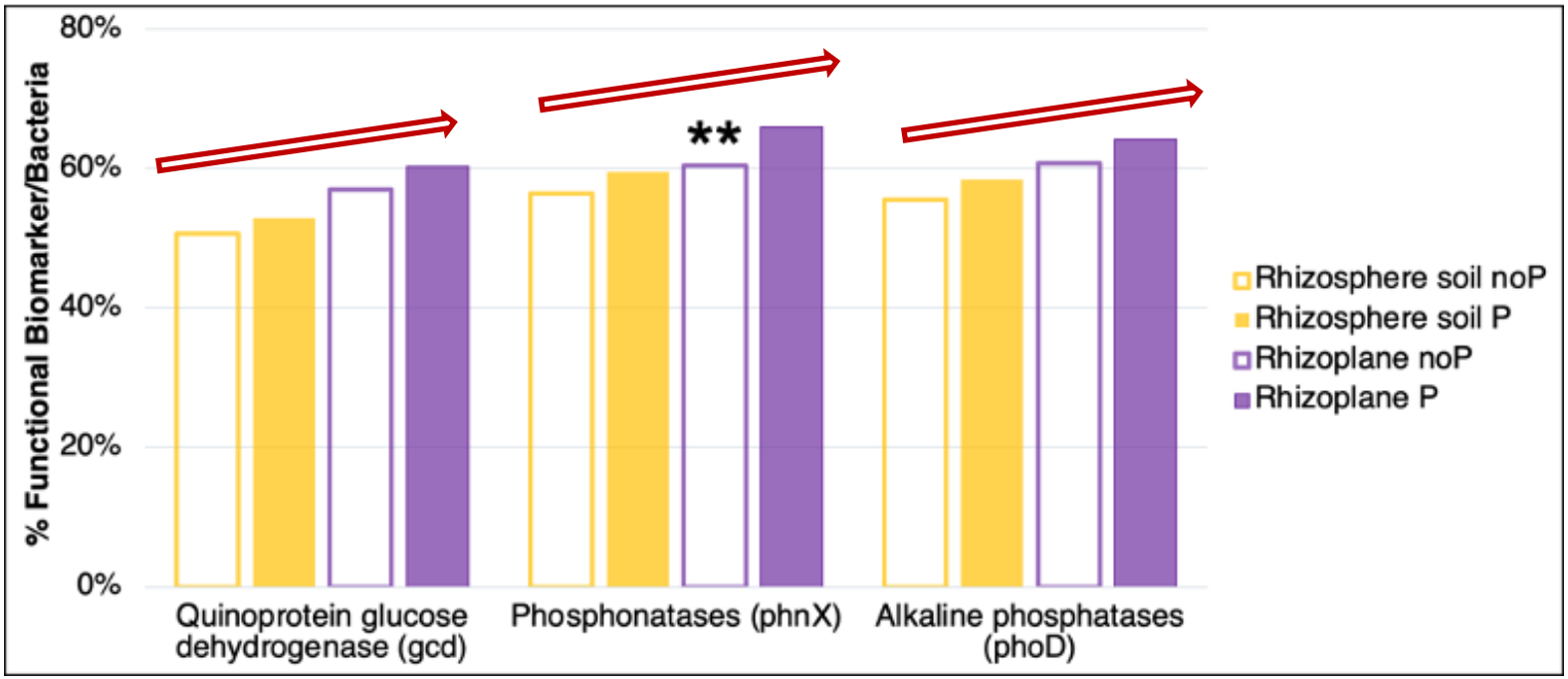
t-student, *p-value* *<0.05; **<0.01; ***<0.001

Functional biomarker quantification

P dissolution







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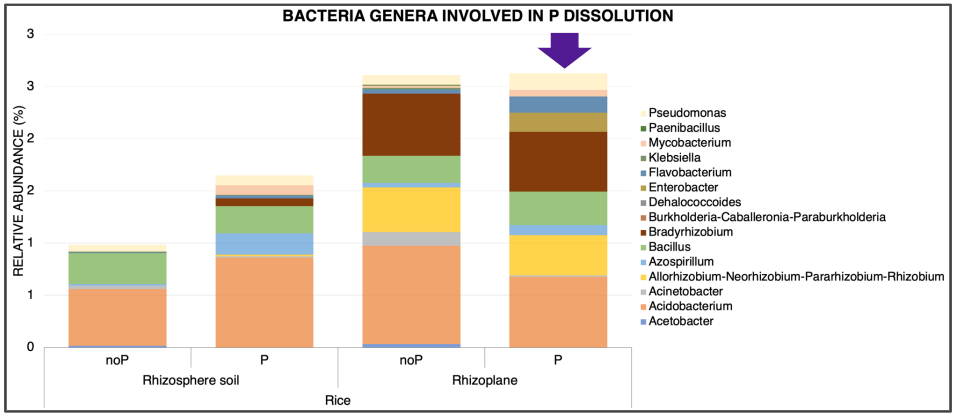
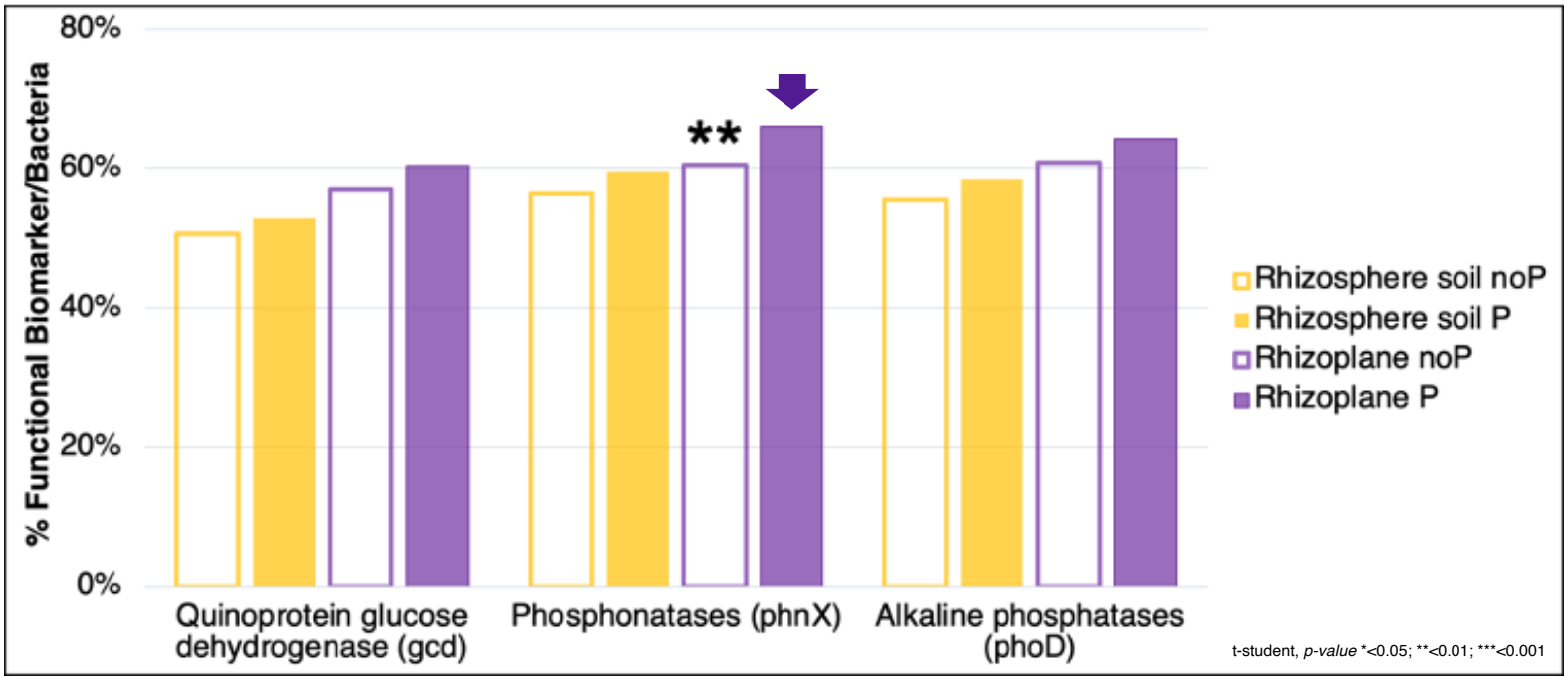
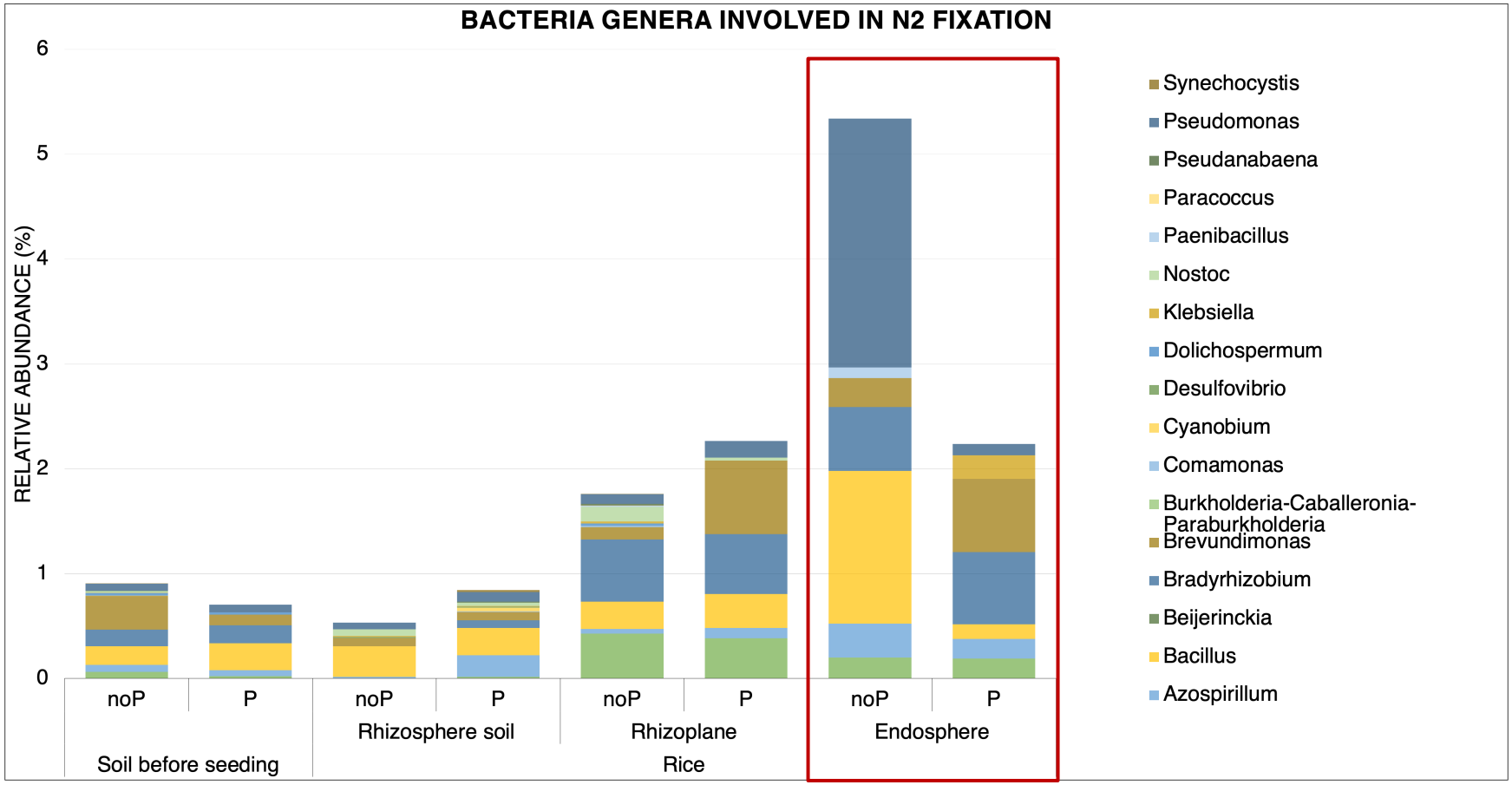




P Solubilization **P Mineralization**

Functional prediction
N fixation

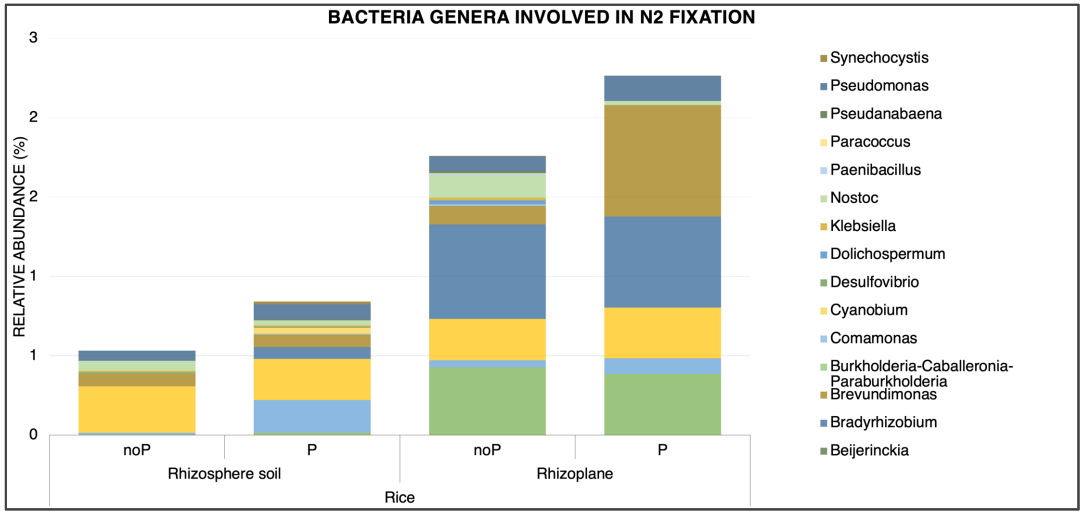
- The absence of P fertilization increase the relative abundance of *Pseudomonas* and *Bacillus* increase in the endosphere.

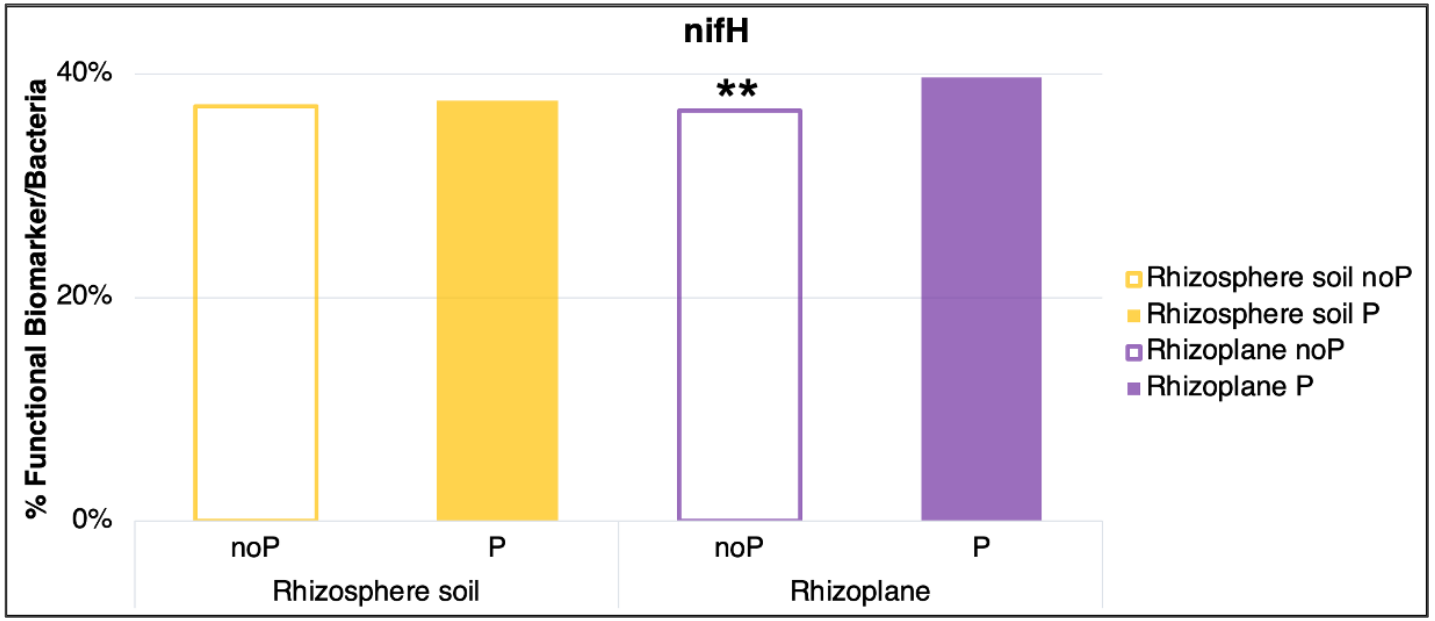


Classification based on a personal database

Functional biomarker quantification

N fixation





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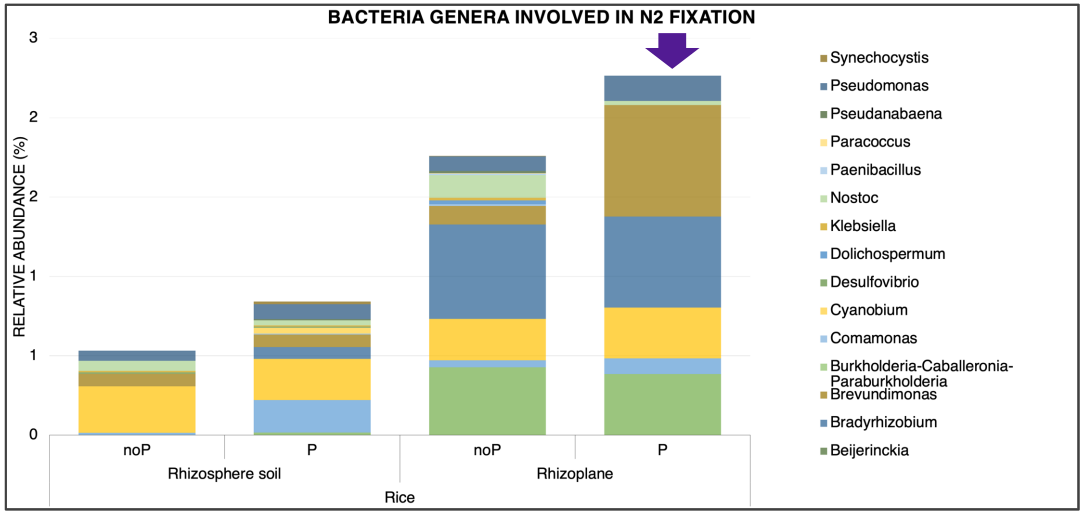
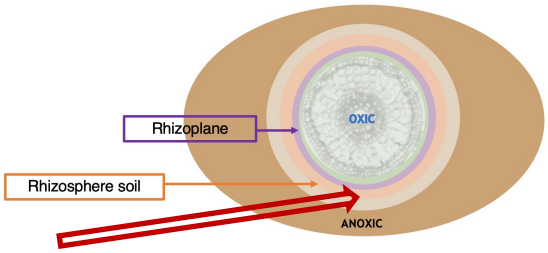
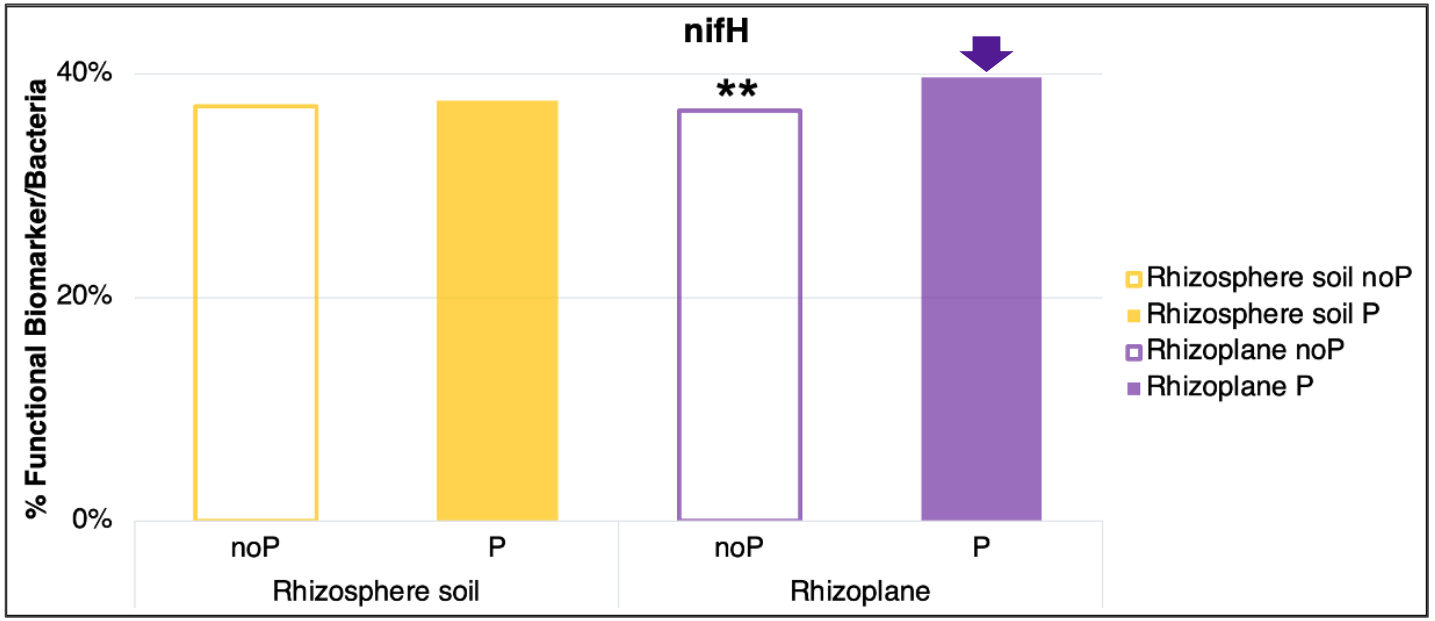
Functional biomarker quantification

N fixation







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CONCLUSIONS

- **The presence of the rice plant** and the **distance from the plant** influenced significantly microbial communities.
- The absence of P fertilization causes:
  - Significant differences in bacterial and archaeal communities
  - Lower presence of P-solubilizing and N-fixing bacteria in root esosphere
  - Specific selection of P-solubilizing and N-fixing bacteria within the root endosphere.

THANK YOU FOR YOUR ATTENTION

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