



Are culturable Phosphate Solubilizing Bacteria diversity and efficiency shaped by plant cover requirements?

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Charlotte AMY^{1,2}, Mélanie BRESSAN², Jean-Christophe AVICE¹ & Karine LAVAL²

Normandie Université, SFR Normandie Végétal.

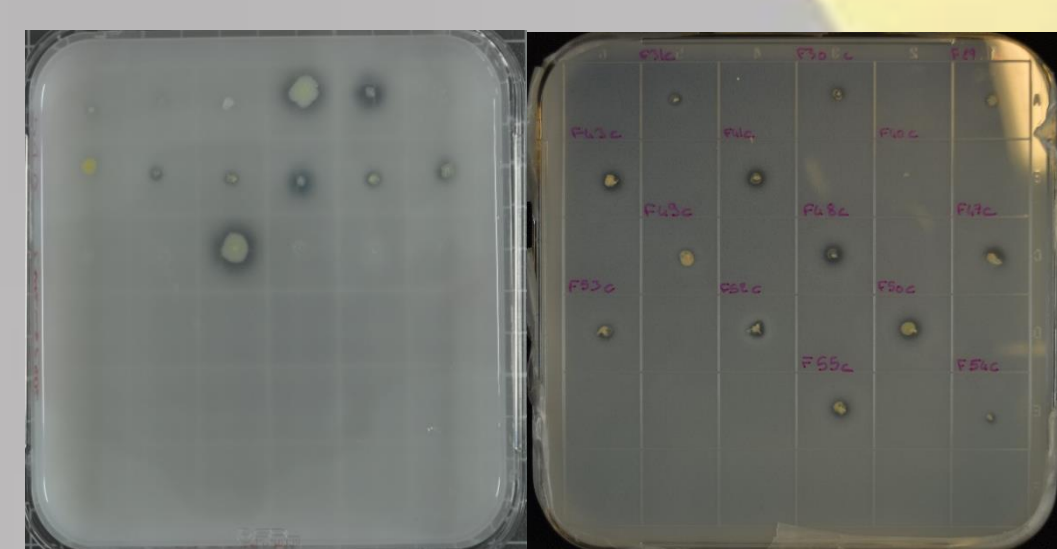
¹ UNICAEN, INRA, UMR INRA/UCN 950 Ecophysiologie Végétale et Agronomie (EVA), Université de Caen Normandie, Caen² UniLaSalle, Unité de recherche AGHYLE, UP 2018.C101, Mont-Saint- Aignan

Introduction :

As primary producers, plants need mineral elements to sustain their growth and life cycle. Nutrients are principally provided through soil microbial processes, such as degradation of soil organic matter or nitrogen (N) fixation⁽¹⁾. Phosphorus (P) is an essential but scarce nutrient in soils. Some microorganisms are described as « Phosphate Solubilizing Microorganisms » (PSM) and can turn P into an available form for plants⁽²⁾. They could represent an alternative to inputs of mineral fertilizers.

It is well known that plants can recruit beneficial microorganisms through their root exudation⁽³⁾. As different crops have different nutritional requirement and allelopathic specificities, we assume that both P solubilization efficiency and PSM diversity differ according to plants species and so specific P requirements.

PSM screening



Pikovskaya and Phytate Screening Media

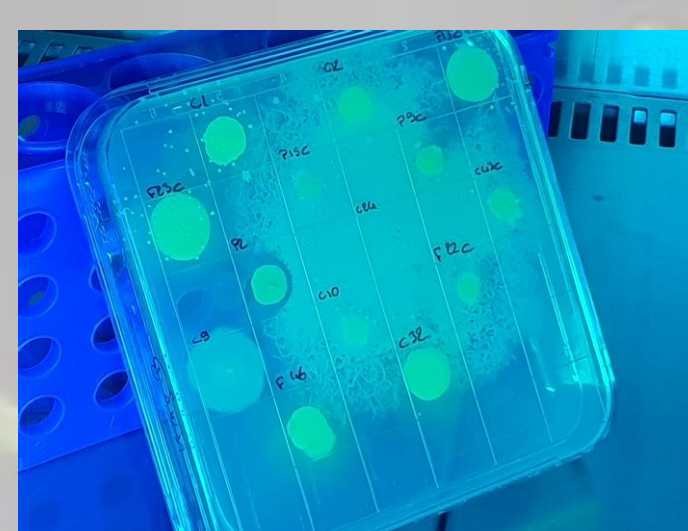
PSM were tested on two media, with inorganic and organic P forms

Solubilization index (SI) was calculated as follow :

$$SI = \frac{\text{Solubilisation halo diameter}}{\text{Colony diameter}}$$

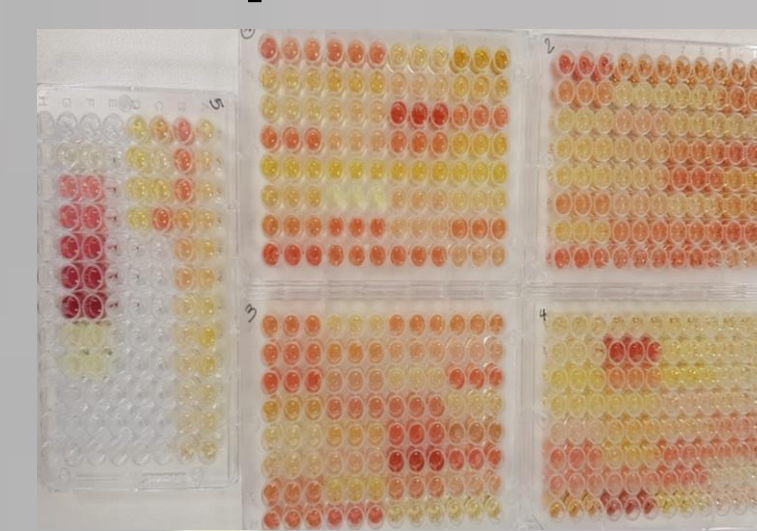
Isolation of culturable soil bacterial strains

Siderophore production

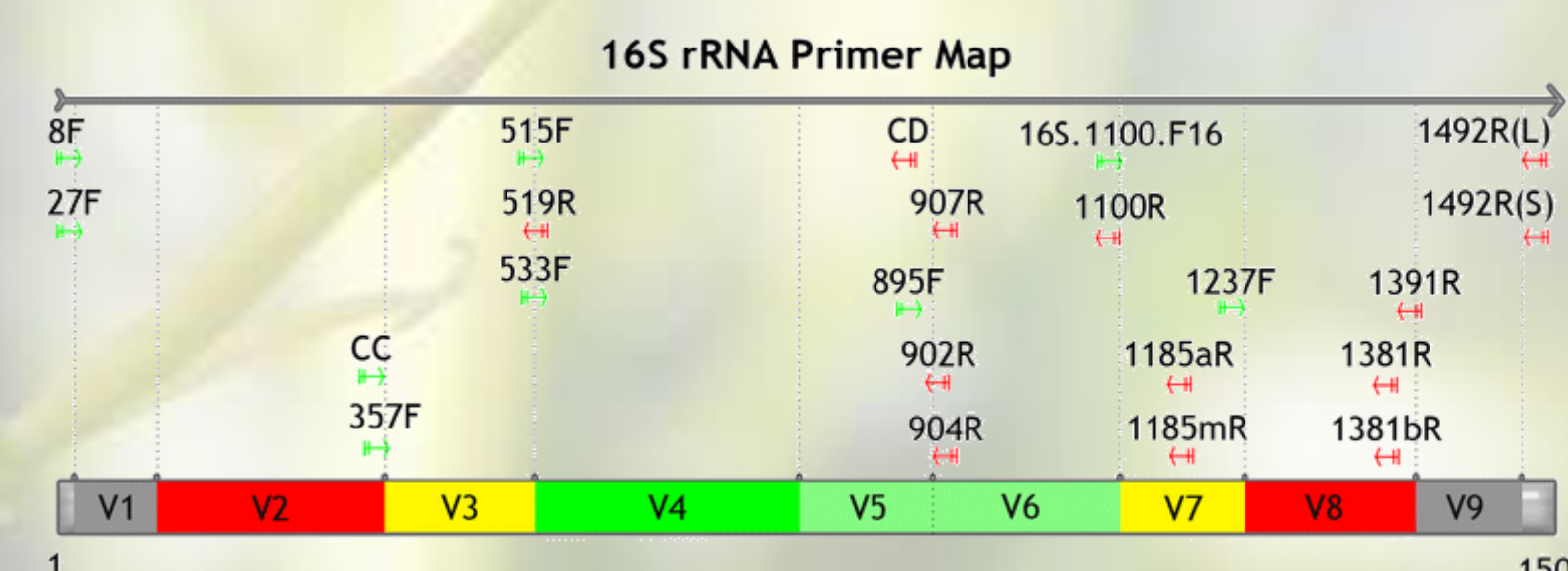


Culture on King B medium

IAA* production



Molecular identification

Yang et al., 2016⁽⁴⁾

Sanger sequencing of ADNr 16S

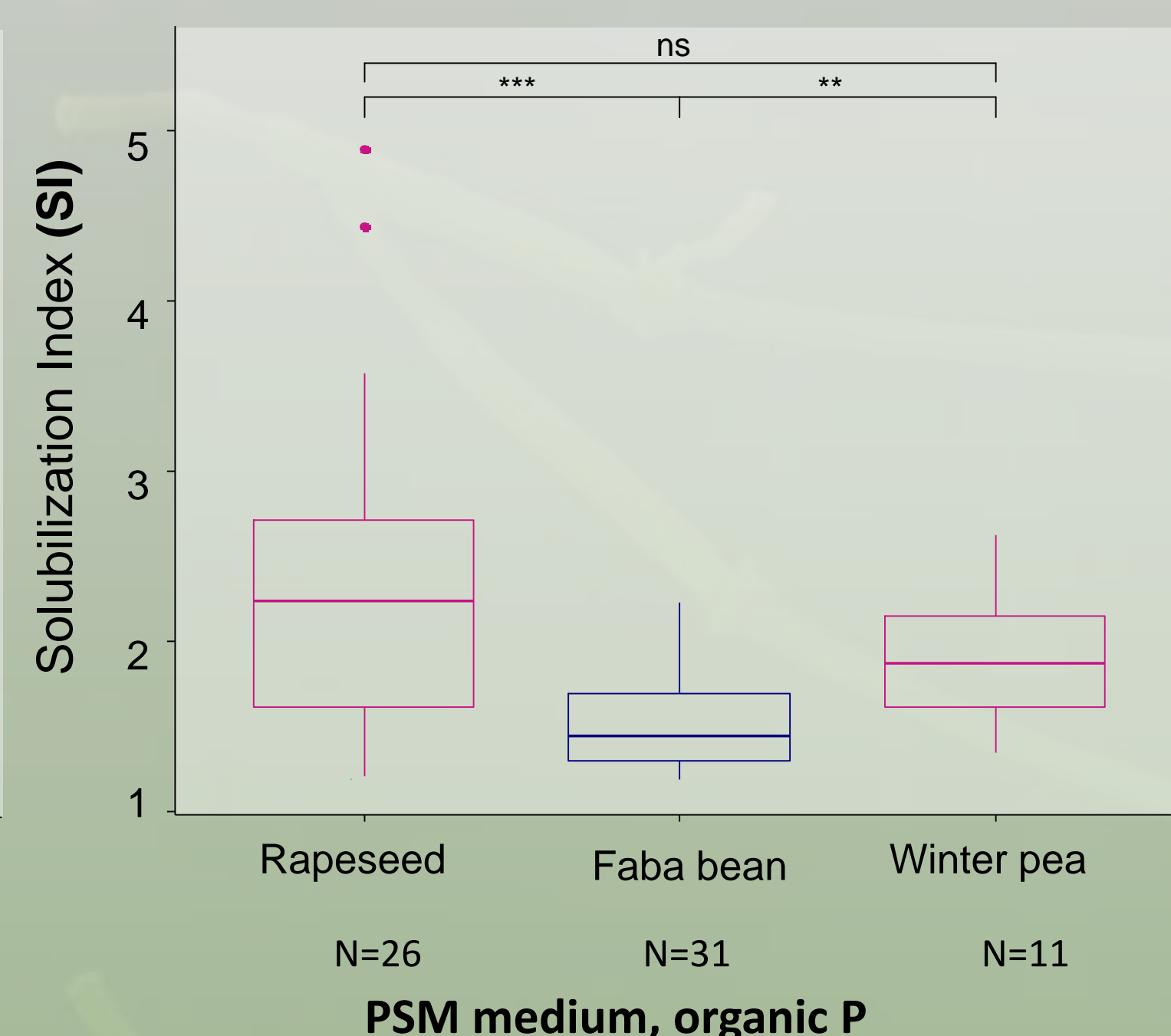
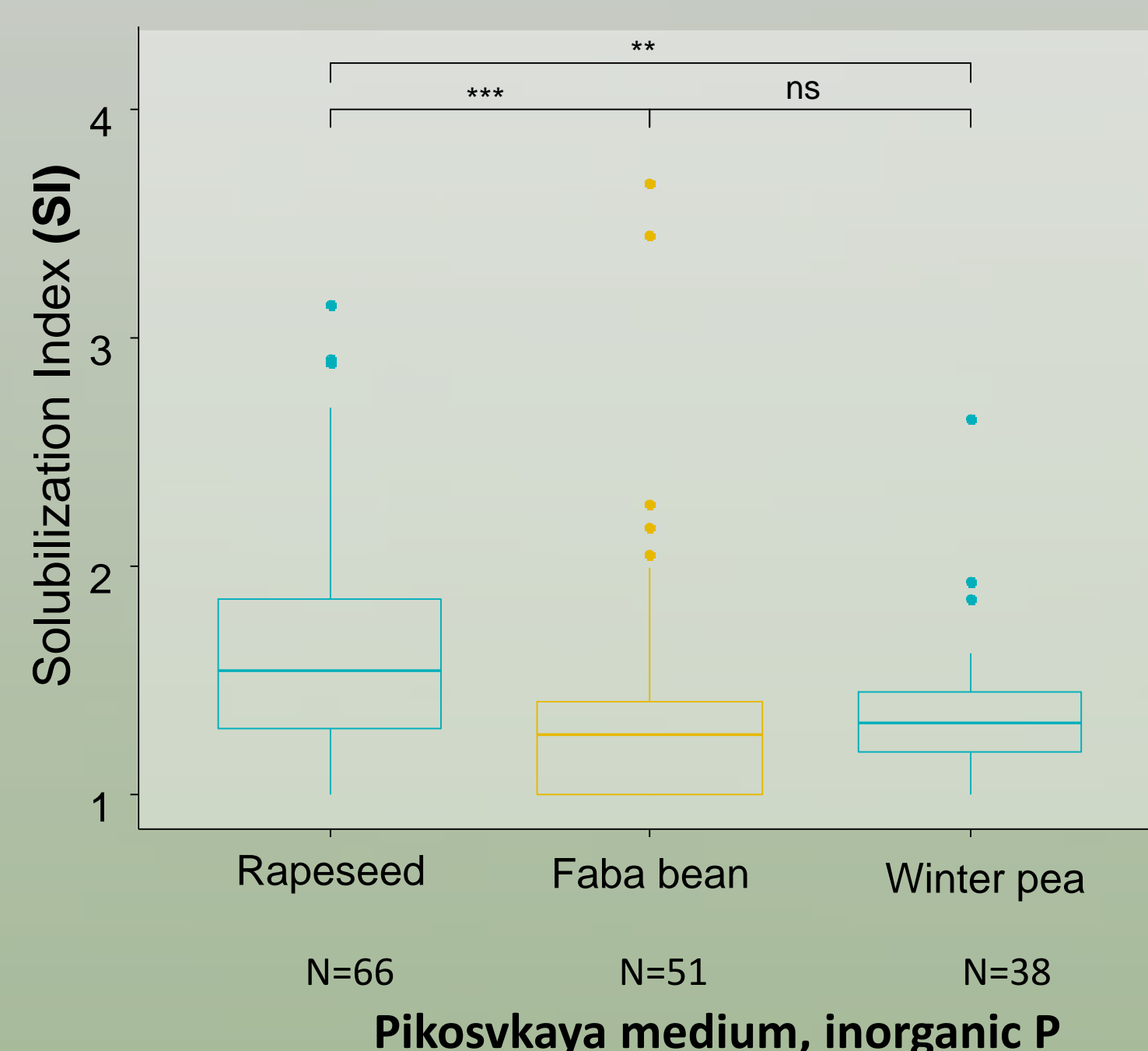
Strains characterization

IAA = IndoleAcetic Acid

P solubilization efficiencies of the isolated PSM community

Statistical test = Wilcoxon

Plot 1 Plot 2



- For inorganic and organic forms, higher ratios were found for PSM isolated under rapeseed
- For inorganic P (Pikovskaya medium), SI were different for rapeseed and legumes, while no inter-plot differences were observed for legume crops
- Differences in global inorganic P solubilization efficiencies seem to follow crops specific requirements, described in the following table⁽⁵⁾.
- For organic P (phytate) SI no such patterns were found. Differences exist between PSM isolated in plot 1 and plot 2 suggesting environmental influences on mineralization.

	N requirement	P requirement
Rapeseed	High	High
Winter Pea	Low	Medium
Faba Bean	Low	Medium

- Percentage of strains producing siderophore among PSM are close for legume crops while rapeseed seems to recruit more PSM producing siderophore.
- No such pattern is observed concerning PSM strains producing IAA
- Higher level of IAA production is measured in Rapeseed rhizosphere when considering only IAA producing strains

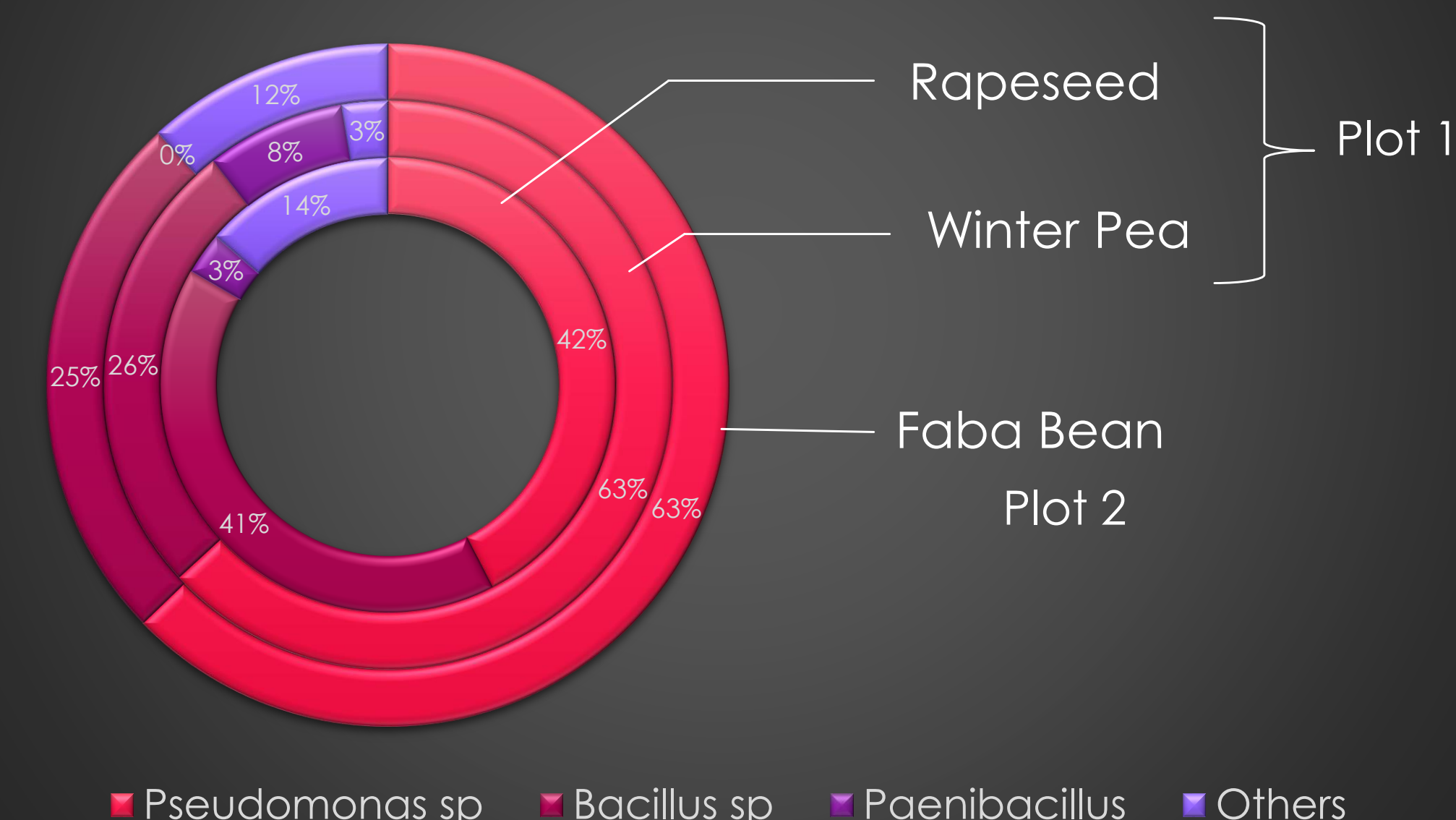
	siderophore producing strains (%)	IAA producing strains (%)	Average IAA production (all PSM strains) (µg/mL)	Average IAA Production (producing strains) (µg/mL)
Rapeseed	30,3 (20/66)	24,2 (16/66)	19,9 ± 6,4	74,0 ± 20 (7,7 - 297,1)
Winter Pea	23,7 (9/38)	34,2 (13/38)	18,6 ± 6,4	54,3 ± 14,4 (2,6 - 147,6)
Faba bean	23,5 (12/51)	49,0 (25/51)	20,8 ± 4,6	46,5 ± 7,1 (3,5 - 208,4)

- Abundance of PSM strains is more important (in number as well as in proportion) in Rapeseed rhizosphere. PSM proportions are similar for legumes.
- Same bacterial genera were identified for the 3 crops.

	Rapeseed	Winter pea	Faba bean
<i>Pseudomonas sp</i>	28	24	32
<i>Bacillus mycoides</i>	5	3	3
<i>Bacillus pseudomycoides</i>	7	2	2
<i>Bacillus simplex</i>	11	2	6
<i>Bacillus sp</i>	4	3	2
<i>Paenibacillus</i>	2	3	0
Others	9	1	6
total PSM strains	66	38	51
PSM proportion in culturable bacteria (%)	62,86	42,70	48,57

- In Faba bean and Winter pea rhizospheres, same proportions of PSM isolates belonging to *Pseudomonas* and *Bacillus* genera were found, compared to those isolated in Rapeseed rhizosphere.
- Pseudomonas* and *Bacillus* genera are often described as PSM in the literature⁽²⁾
- PSM communities in Winter pea and Faba bean rhizospheres are more similar than those observed for the 2 crops present on the same plot (Winter pea and Rapeseed), confirming the key influence of crop on the recruitment of PSM community.

Partitionning of isolated PSM strains depending on crop cover



Conclusions :

Crop requirements seem to be a key factor to explain structure and efficiency of isolated PSM strains for inorganic P sources. Higher requirements in P may explain recruitment of beneficial bacteria with higher potentiality in P solubilization in Rapeseed rhizosphere. We assume root exudation is an important mechanism in this inter-kingdom communication. Crop rotation can be an important tool to manage and shape as necessary beneficial microbial community, and so to improve long-term fertility of soils.

Perspectives :

As a result of this screening, 3 strains were selected for further analyses. These PSM isolates will be tested *in planta* to assess their efficiency to sustain plant growth in complexed-P context.

Aknowledgements :

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References :

- (1) R. Jacoby, M. Peukert, A. Succurro, A. Koprivova, et S. Kopriva, Frontiers in Plant Science, vol. 8, sept. 2017.
- (2) E. T. Alori, B. R. Glick, et O. O. Babalola, Front. Microbiol., vol. 8, p. 971, juin 2017.
- (3) N. Romillac, Université de Lorraine, 2015.
- (4) B. Yang, Y. Wang, et P.-Y. Qian, BMC Bioinformatics, vol. 17, no 1, p. 135, mars 2016.
- (5) COMIFER, 1995.