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# Optimization of phosphorus availability in soil: impact of Phosphate-Solubilizing Microorganisms on rapeseed growth and nutrient use efficiency

Charlotte AMY<sup>1,2</sup>, Mélanie BRESSAN<sup>2</sup>, Karine LAVAL<sup>2</sup>, Jean-Christophe AVICE<sup>1</sup>

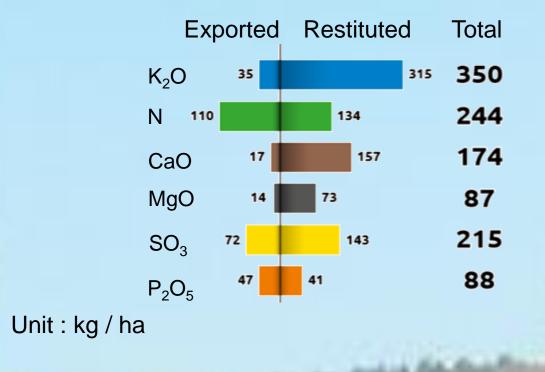
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## **Context and Hypotheses :**

Available Phosphorus (P) is a scarce element in soils for plants and micro-organisms growth due to its quick complexation in soils to organomineral particles such as clay, Iron or Aluminium<sup>[1]</sup>. P-Solubilizing Microorganisms (PSM) are able to solubilize complexed P. To face nutrient limitations, plants and micro-organisms interact through rhizodeposition for instance to enhance availability of limiting elements<sup>[2]</sup>. Rapeseed (*Brassica napus* L.) is a major oleoproteaginous crop which requires high Nitrogen (N) <sup>[3]</sup> and P inputs and presents a low N and P use efficiencies. Furthermore, little is known concerning rapeseed interactions with soil micro-organisms in relation with P and N availabilities in soils.

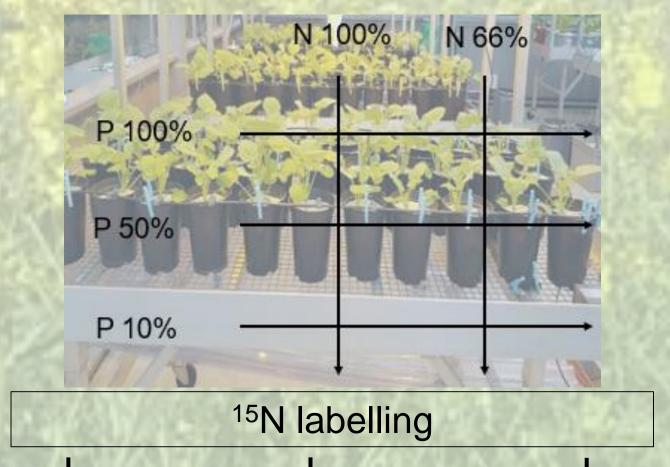
Our hypotheses are : i) Optimisation of P nutrition in rapeseed can enhance P and N use efficiency, ii) Rapeseed can recruit PSM through rhizodeposition iii) Changes in P availability in soils can modify N cycle dynamics.

#### Nutrients required for a yield of 35 q/ha<sup>[4]</sup> :



# **Objectives, experimental design and preliminary results**

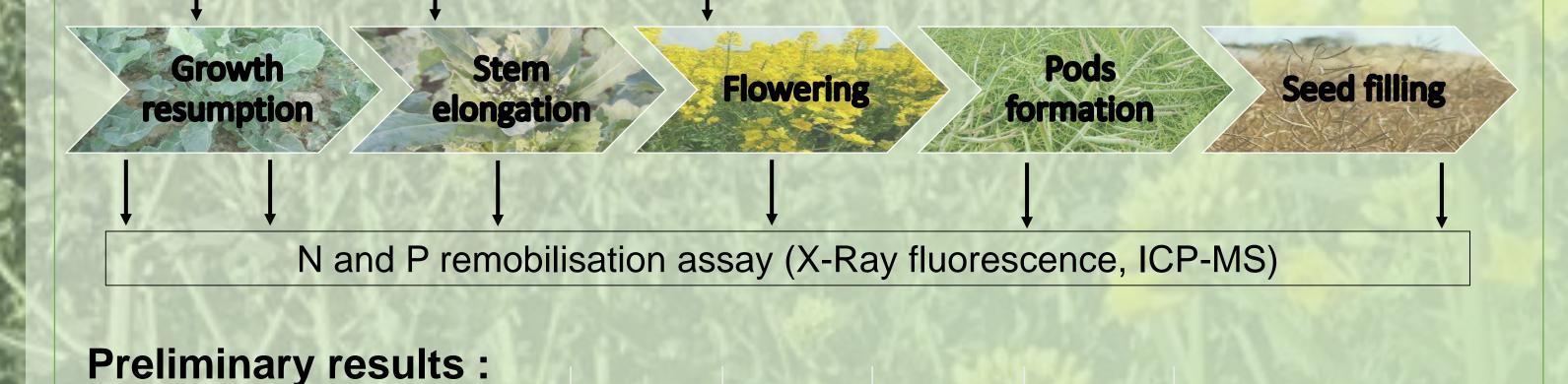
## **Objective 1: Interactions of N x P nutrition in rapeseed**



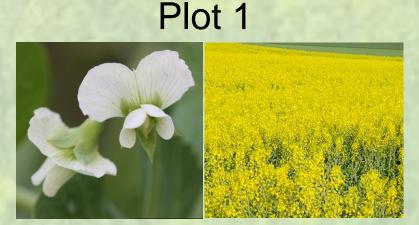
Several N and P treatments are applied after vernalization to mimic conventional fertilization inputs.

N treatments correspond to 100% and 66% of optimal N fertilization

P treatments correspond to 100, 50 and 10% of optimal P fertilization



### **Objective 2: Crop effect on potential beneficial soil microorganisms**

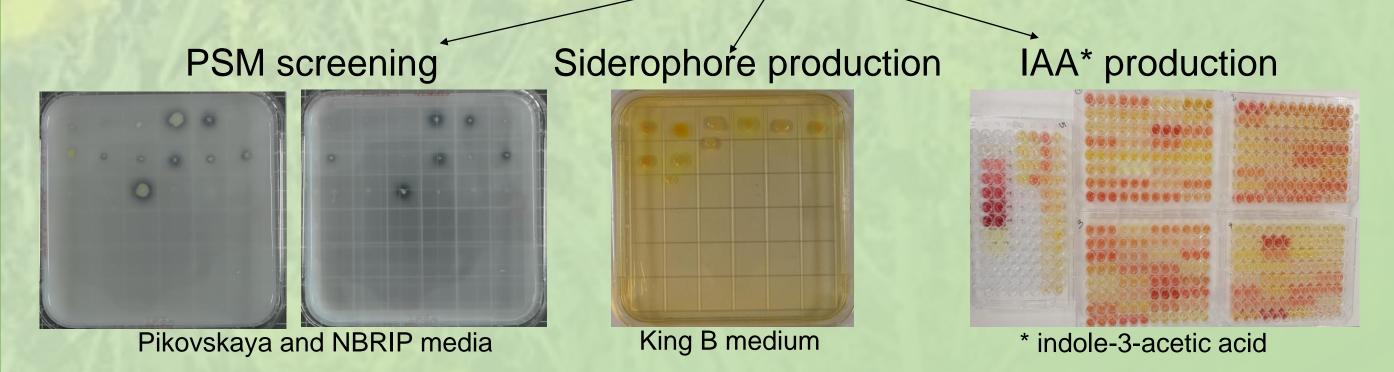




Pisum sativum Brassica napus

Vicia faba

Culturable soil microbial communities



## **Preliminary results :**

 299 strains were isolated from soils under winter pea (*Pisum sativum*), rapeseed (*Brassica napus*) and faba bean (*Vicia faba*)

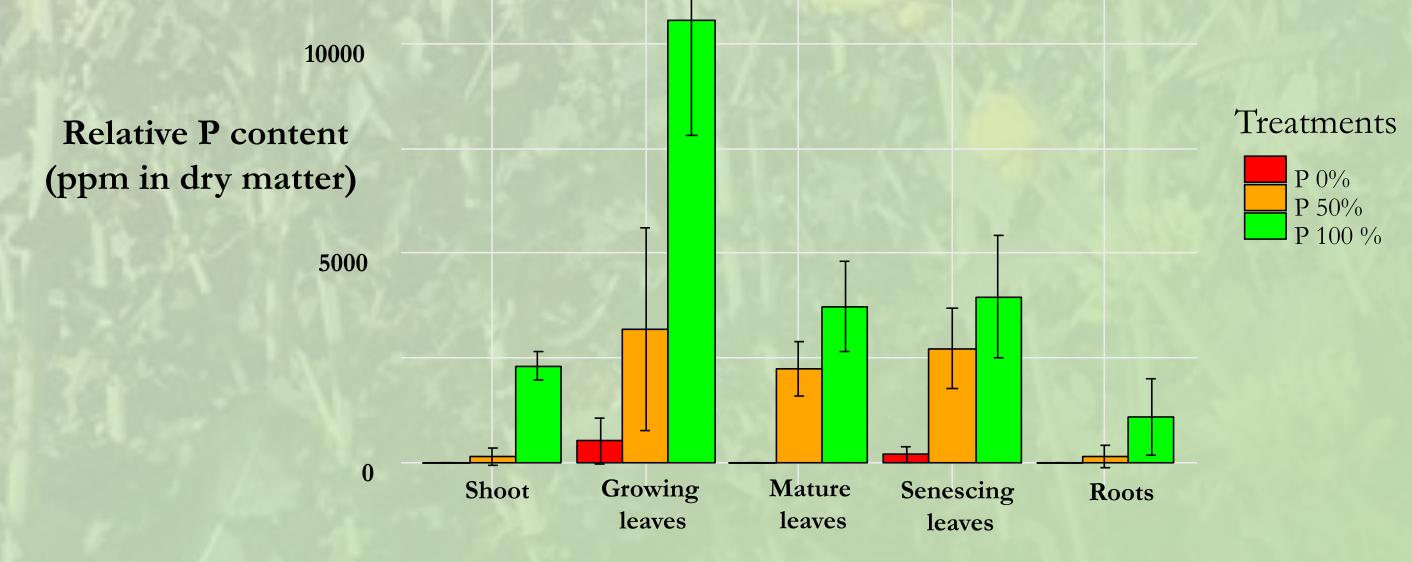


Figure 1 : P content in organs of rapeseed at vegetative stage in response to various P treatments. Plants were grown on Hoagland (3,75mM NO<sub>3</sub>) solution. P was measured by X-Ray Fluorescence (XRF)

- 166 strains have shown a positive solubilization index
- Positive strains have been tested on (for?) auxin (IAA) production

<u>Table 1 :</u> Isolated strains presenting positive solubilization index and potential other growth promoting properties as IAA or siderophore production.

PVK = Pikovskaya medium, NBRIP = NBRIP medium. Solubilization index = solubilization halo size / colony size

Crop	Strain	PVK solubilization index	NBRIP solubilization index	IAA production (ng/µL)	siderophore production
Pisum sativum	P21	1,176	1,297	208,400	+
	Pc12	1,000	1,698	97,200	+
Vicia faba	F46	3,674	1,600	76,300	+
	Fc30	1,368	1,314	99,700	-
	Fc48	1,210	1,000	147,600	-
Brassica napus	C17	1,000	1,401	297,126	NA
	C32	1,824	2,540	211,600	NA
	Cc15	1,468	1,885	122,900	NA
	Cc21	1,358	2,711	113,700	NA

**Objective 3: Effect of PSM inoculum on rapeseed growth and N/P cycles** 

- Morphometric and physiological traits
   Biomass production, root architecture, seed yield
   P and N efficiencies, changes in P and N fluxes
   Biological soil properties
   Real-time PCR analysis :
   Bacterial and fungal biomass
   N-cycling genes :
  - Ammonia monooxygenase : amoA
  - Nitrite reductase : napA, narG, nirK, nirS





- P-cycling genes :
  - phosphatases : phoD, phoN
  - Phytase : appA
  - Organic acid production : gcd
  - Bacterial P transporters : *pitA*, *pstS*

Abiotic soil properties Soil pH, C N P contents

# **Perspectives :**

- Quantitative P solubilization and organic acids production assays will be carried out in order to better discriminate PSM under each crop
- Other analyses will be done to test other growth promotion properties of the isolated strains : HCN production, ACC deaminase activity, germination test
- Interesting microorganisms will be then identified by DNA sequencing

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[3] Avice, J.-C. et al. (2014). Journal of Experimental Botany. 65. ; [4] Colza d'hiver - Éditions CETIOM - mai 2002