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Does crop diversification impact plant-soil interactions?

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DOES CROP DIVERSIFICATION IMPACT PLANT-SOIL INTERACTIONS ?

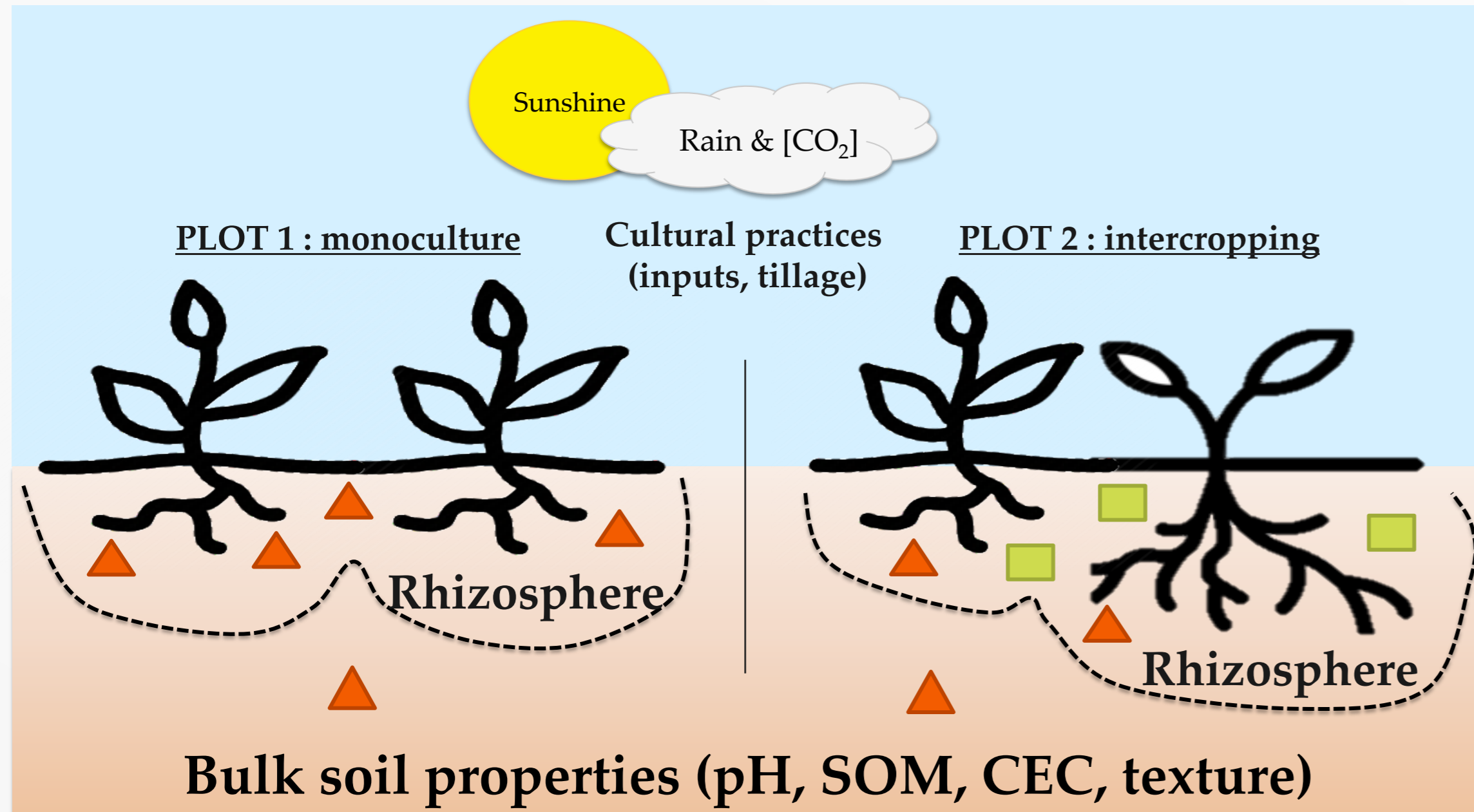
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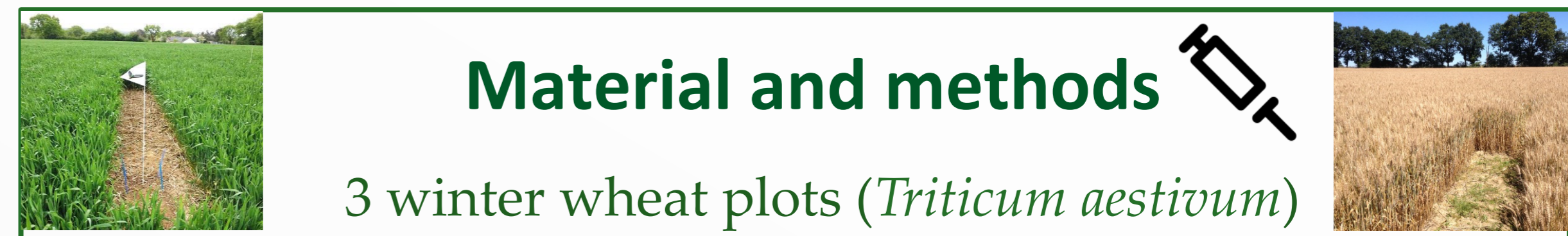
Context and objectives

Plants modify physical and chemical properties around their roots¹
The rhizosphere is a hot spot of biological activity²
Rhizosphere functioning may explain plant performances³



Hypothesis (1) : Bulk soil ≠ Rhizosphere along a cultural cycle
Hypothesis (2) : Rhizosphere effect is maintained along a gradient of diversification

Material and methods

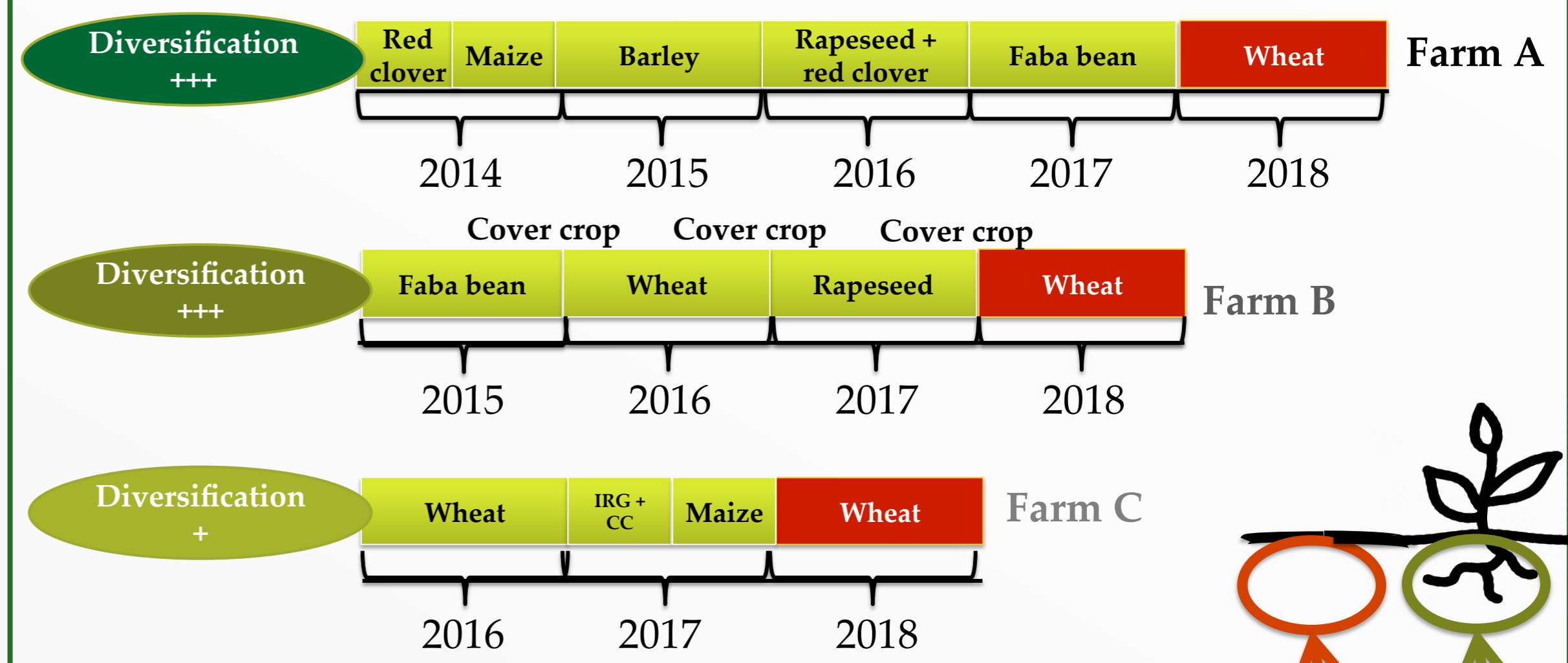


3 winter wheat plots (*Triticum aestivum*)

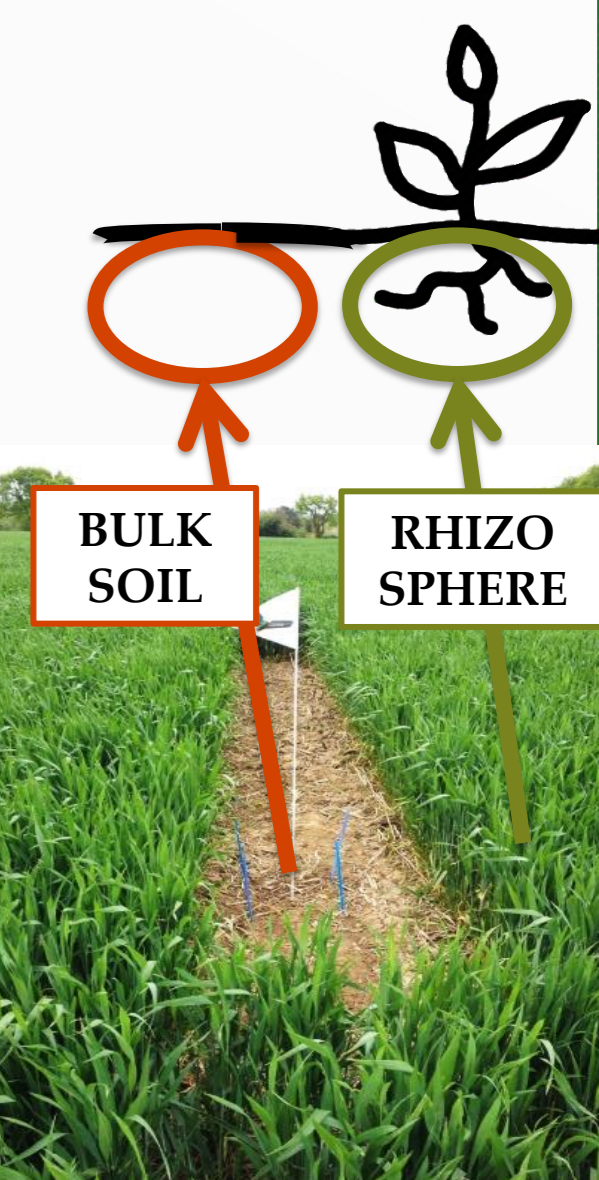
Dynamic sampling : 6 dates of sampling per farm



3 farms - 3 degrees of diversification



Soil samples (4 replicates)
Rhizosphere Soil (RS) & Bulk Soil (BS)
-Phosphate & Nitrate fluxes estimated using Anion Exchange Membranes (ANV Selemion)
-Enzymatic activities
Indicator used : BS – RS / BS + RS



Results and discussion

Hypothesis (1)

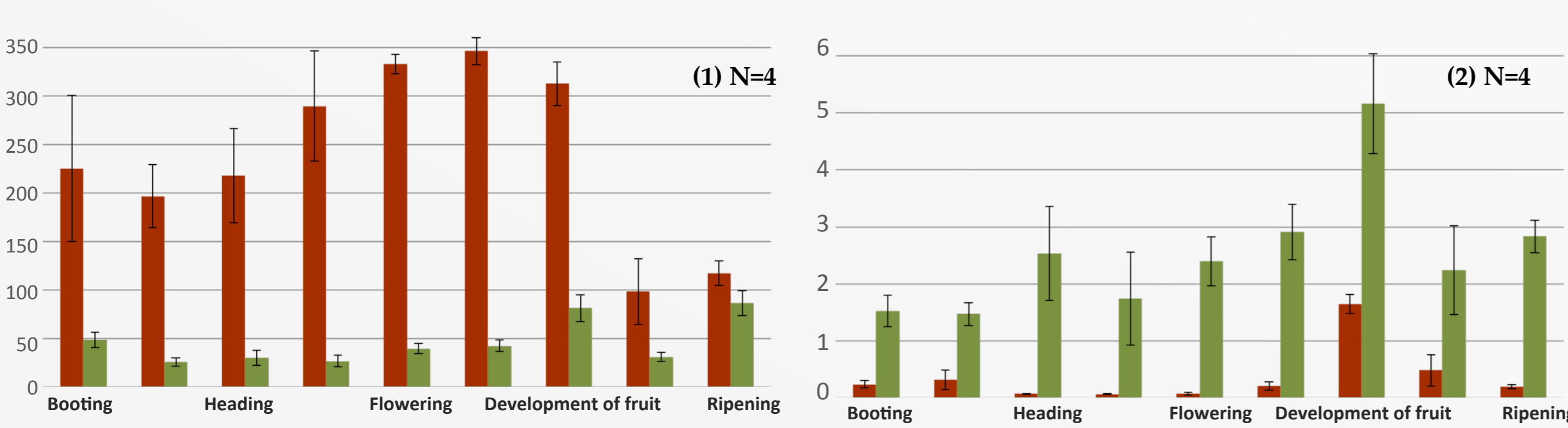


Figure 1 : Nitrate (1) and phosphate (2) fluxes (ng/day) in rhizosphere (green) and bulk soil (red) measured with a method using Anion Exchange Membranes (AEM). Bars indicate standard errors. Differences are significant ($p < 0,05$) between soil samples for each date of sampling.

- ❖ NO_3^- fluxes in BS > NO_3^- fluxes in RS → NO_3^- uptake by the plant
- ❖ PO_4^{3-} fluxes in BS < PO_4^{3-} in RS → plant effect on P availability
- ❖ Enzymatic activities RS > Enzymatic activities in BS
→ higher microbial activity in RS

Bulk soil ≠ Rhizosphere ✓

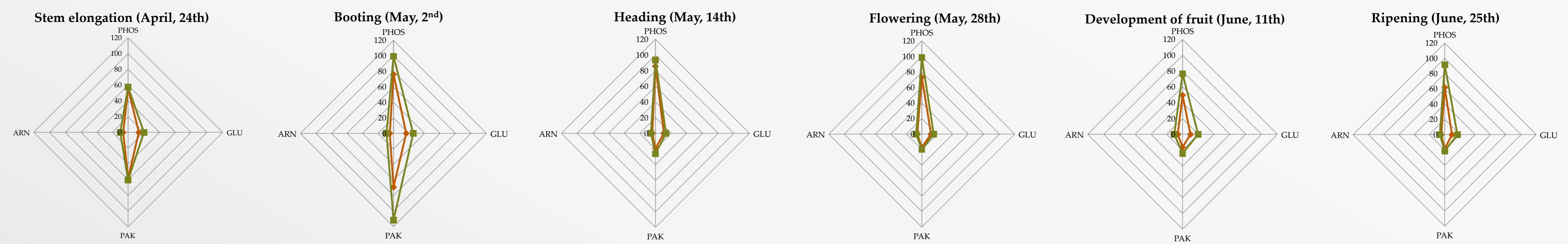


Figure 2 : Enzymatic activities (PHOS = acid phosphatase, PAK = alkaline phosphatase involved in P cycle, ARN = Arylamidase involved in N cycle, GLU = Glucosidase involved in C cycle) in mU/g of soil in rhizosphere (green) and bulk soil (red). Differences are significant ($p < 0,05$) between soil samples for each date of sampling.

Hypothesis (2)

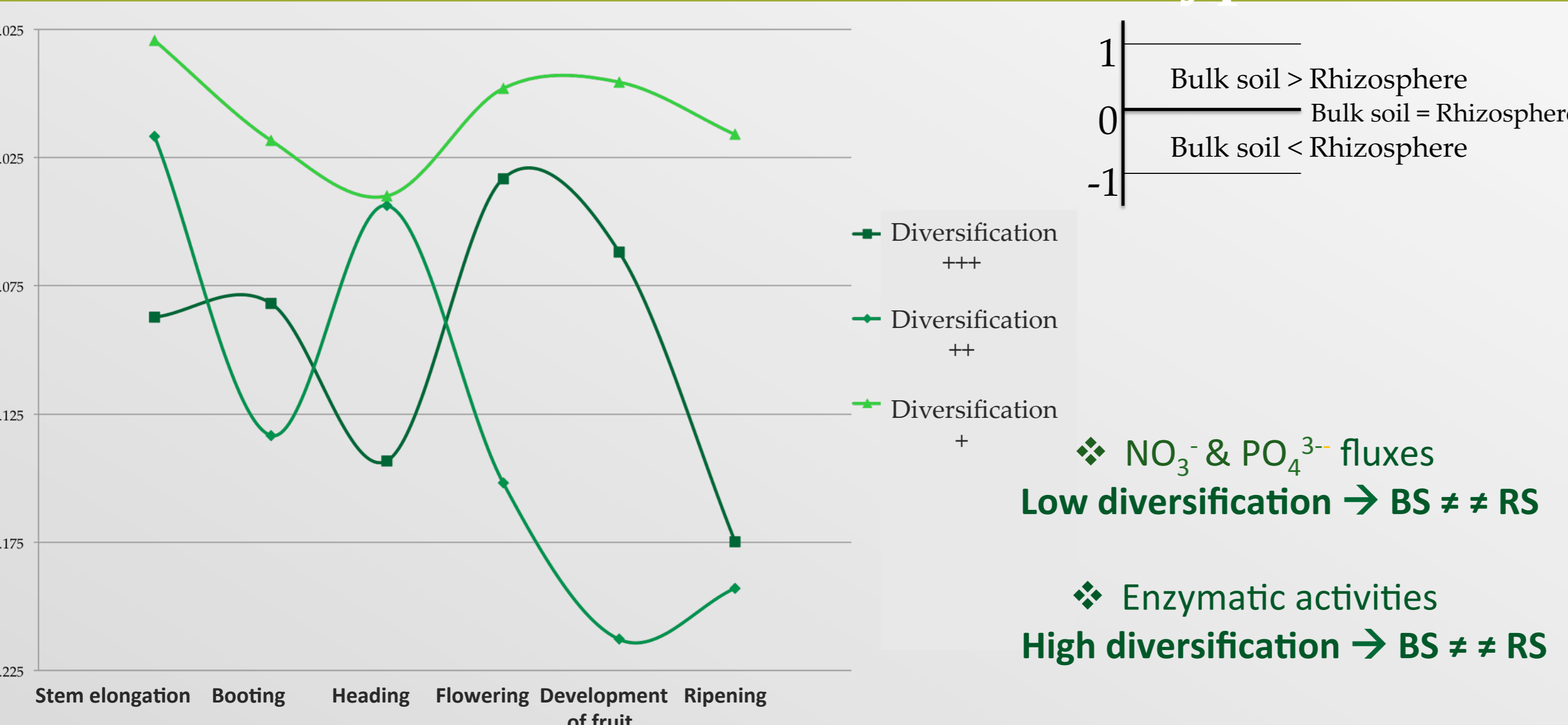


Figure 4 : Differences in enzymatic activity of alkaline phosphatase between bulk soil and rhizosphere in function of diversification degree and plant growth stage. Differences are significant ($p < 0,05$) between soil samples for each date of sampling.

Diversification impact rhizosphere processes ✓

Figure 4 : Differences in nitrate (green variations) and phosphate fluxes (red variations) between bulk soil and rhizosphere in function of diversification degree and plant growth stage. Differences are significant ($p < 0,05$) between soil samples for each date of sampling.

Take home messages

- ❖ Soil analysis should collect rhizosphere soil (and not only bulk soil) to explain plant performances
- ❖ Rhizosphere is a dynamic compartment as variables are greatly influenced by plant growth stage and species
- ❖ Intensity of crop diversification (duration of the crop rotation and number of cultivated species) impact rhizosphere functioning

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References

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