

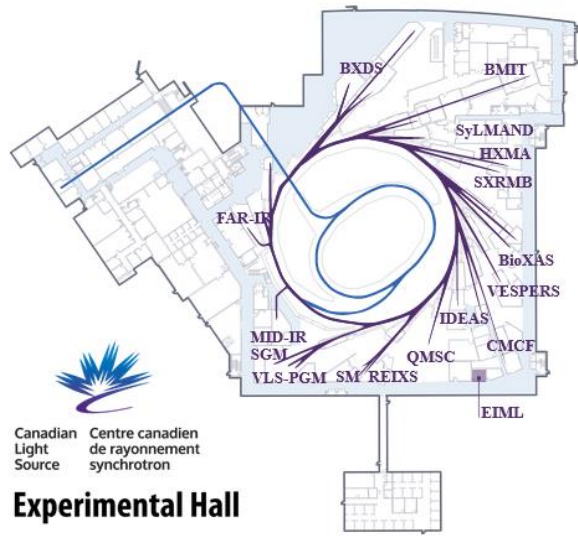
# Canadian Light Source contribution to Agriculture

Lucia Zuin, Senior Scientist, PALSA LOC Chair

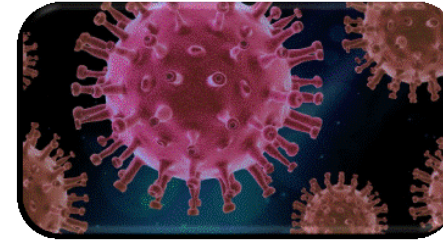
Nov 21st 2024



# The Canadian Light Source



## Strategic Areas



Health



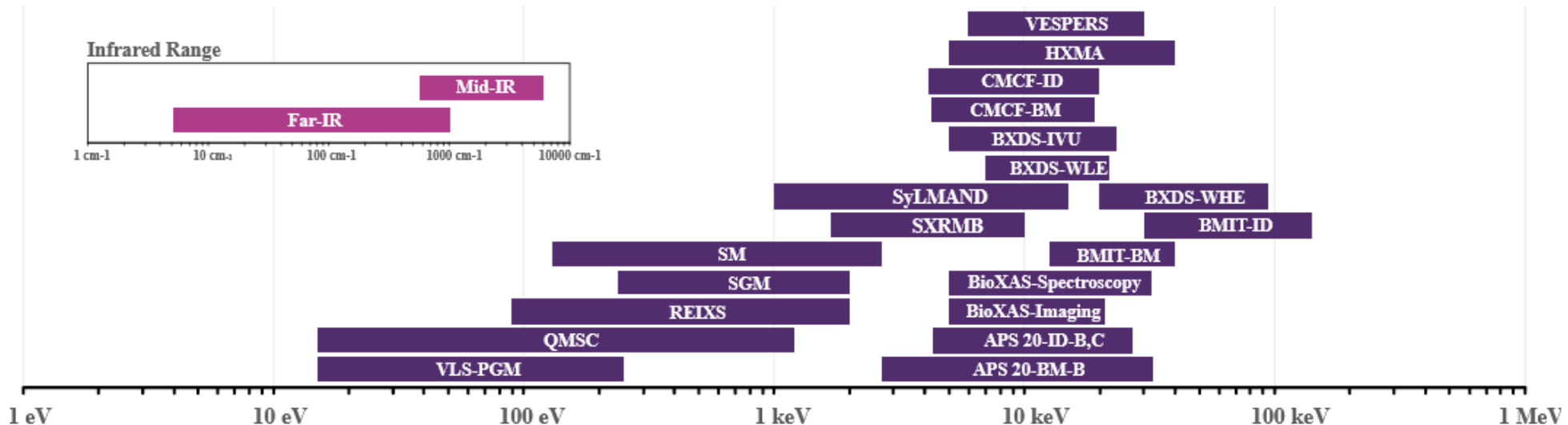
Agriculture



Environment



Energy/Materials



## Techniques

- Imagine and Microscopy
- Spectroscopy
- Diffraction and Scattering
- Microfabrication



# Agriculture as strategically important discipline @ CLS

- ✿ Canada: 4.3 acres per capita of arable land
- ✿ Saskatchewan: more than 40% of Canada's arable land; 55 acres per capita of arable land



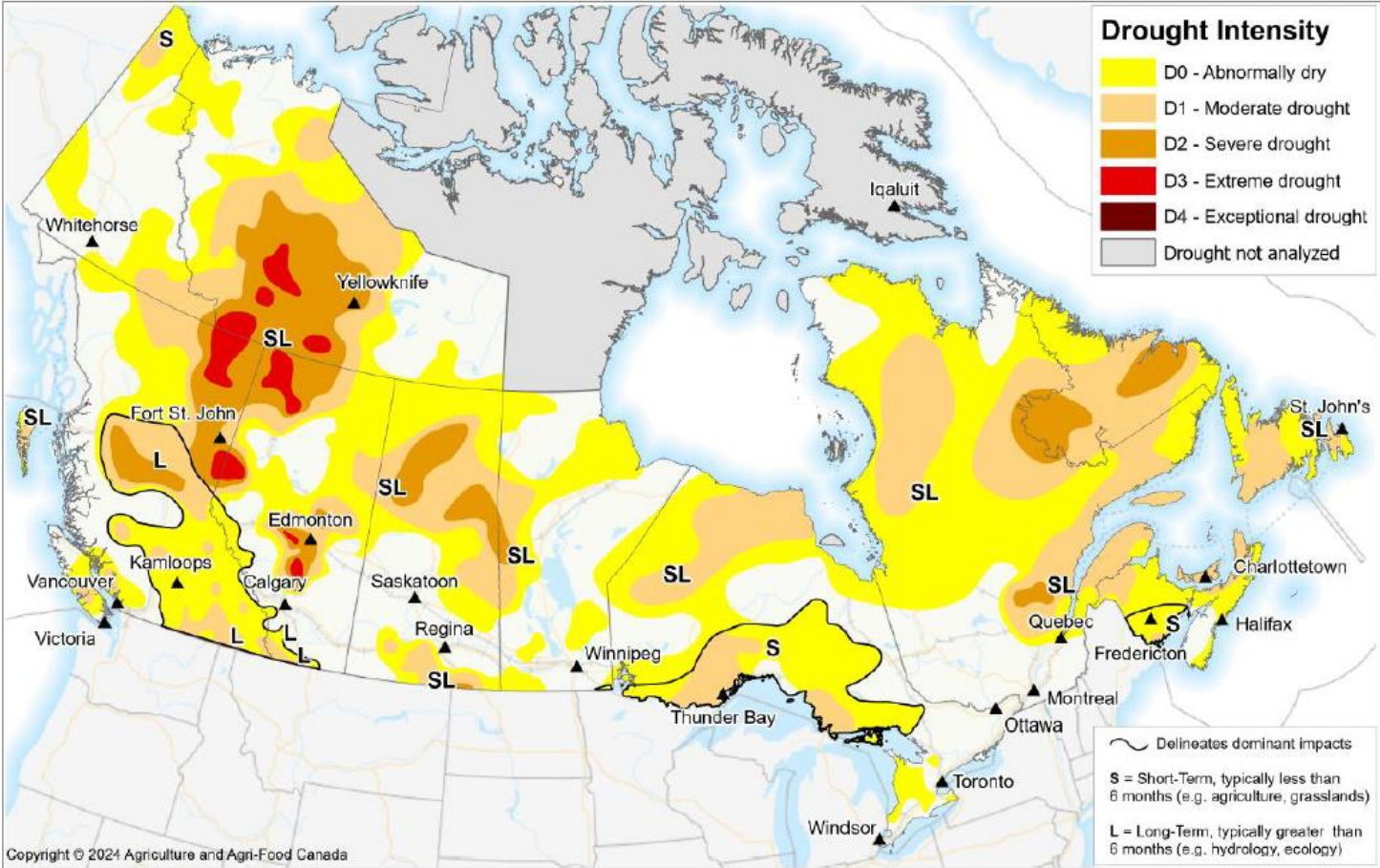


# Food production to feed a growing world population needs to nearly double by 2050



# Canadian Drought Monitor

Conditions as of September 30, 2024





# Pan-American Light Sources for Agriculture: PALSA



2019



2021



2023



# PALSA

PAN AMERICAN LIGHT SOURCES FOR  
AGRICULTURE



# 2025

AUGUST 20-22  
SASKATOON, CANADA

ADVANCING SUSTAINABLE AGRICULTURE AND FOOD RESEARCH

This hybrid event will showcase state-of-the-art research aimed at furthering agriculture and food research through the use of synchrotron techniques.

Watch the website for more details or email [palsaloc@lightsource.ca](mailto:palsaloc@lightsource.ca)!



Canadian  
Light  
Source

Centre canadien  
de rayonnement  
synchrotron



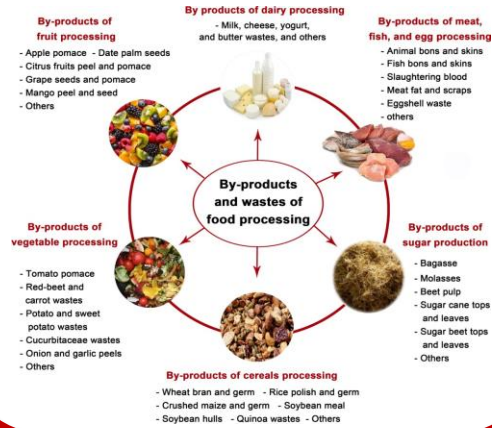
Brazilian Synchrotron  
Light Laboratory

CHES  
CORNELL HIGH ENERGY  
SYNCHROTRON SOURCE



[event.fourwaves.com/palsa-2025](http://event.fourwaves.com/palsa-2025)

## Animal, Industry, and Value Added Products



## Soil Health and Environment



## Big Data in Agriculture



## Plant Science Crop Development Seed & Breeding



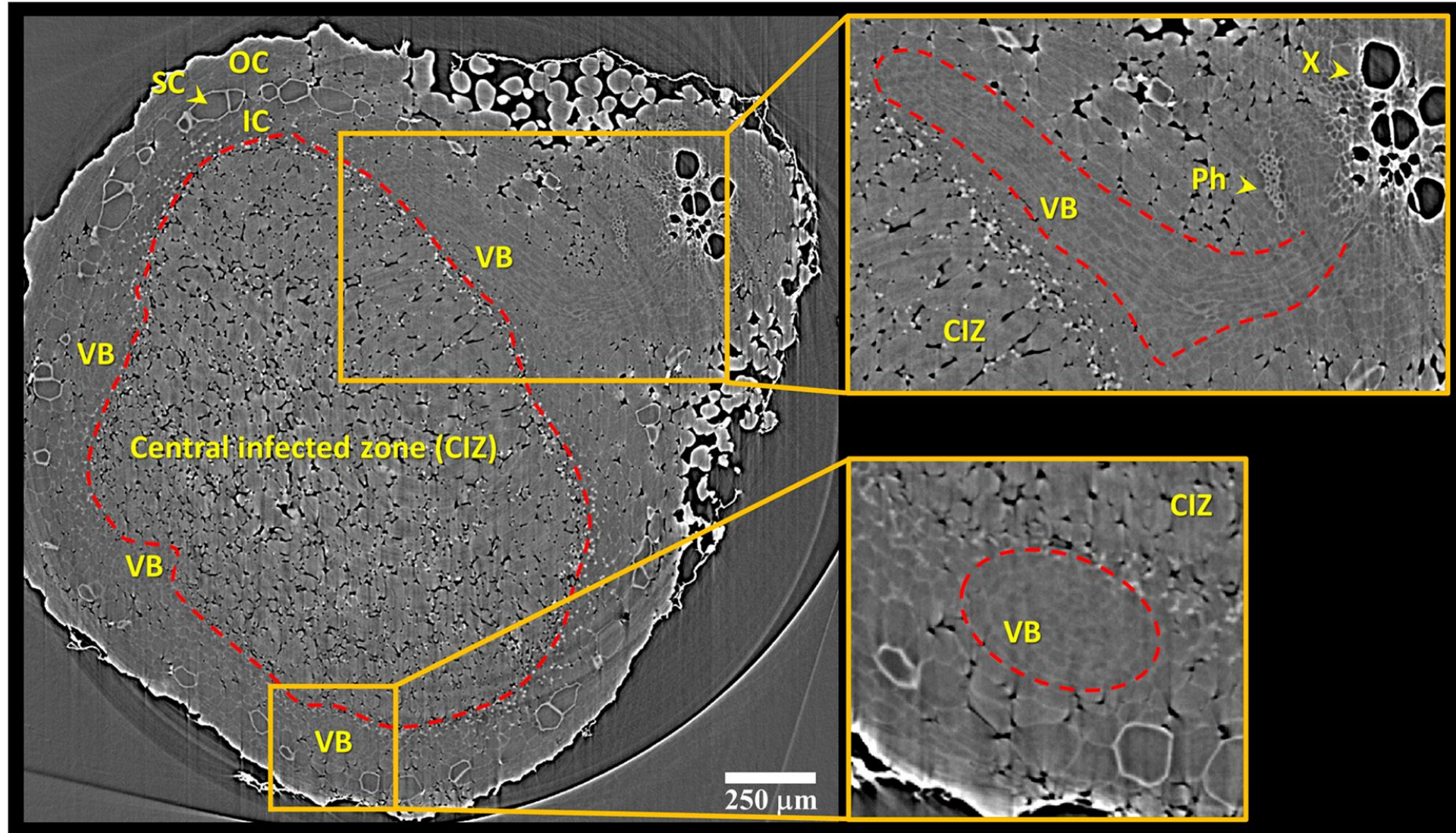
## Sustainable & Nutritional Food Development





# Visualization and Quantitative Evaluation of Functional Structures of Soybean Root Nodules via Synchrotron X-ray Imaging

The efficiency of N<sub>2</sub>-fixation in legume–rhizobia symbiosis is a function of root nodule activity. A quantitative evaluation of these tissues is essential to unravel their functional importance in N<sub>2</sub>-fixation.



Synchrotron X-ray microtomogram of a fresh root nodule.

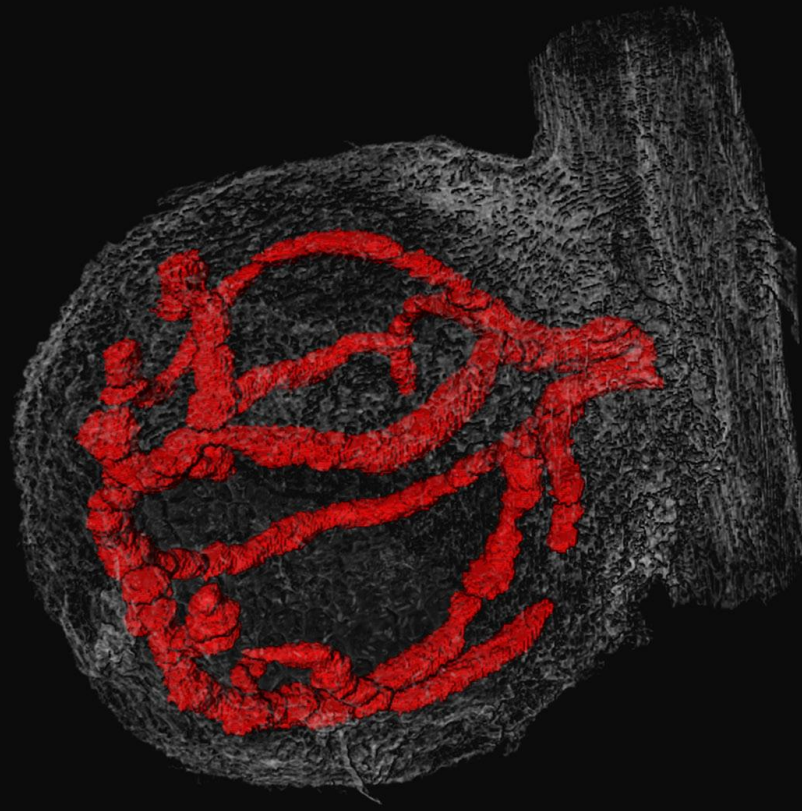
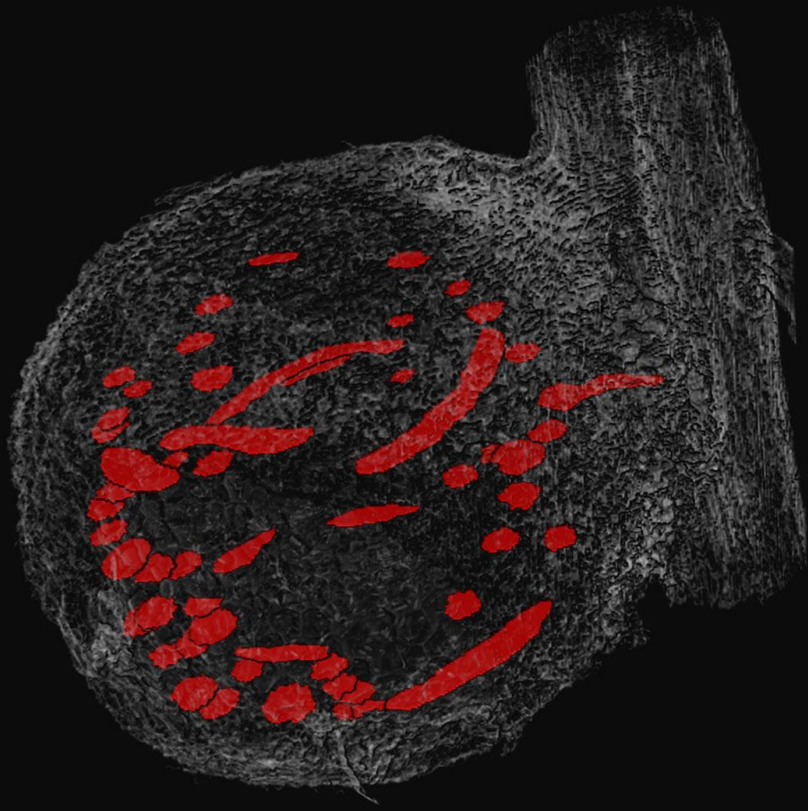
The central infected zone (CIZ) is identified by the packed non-infected cells of the boundary layer that surrounds it.

The vascular bundle (VB) outlines in red.

The scleroid layer (SC), separating the inner (IC) and outer (OC) cortices, is labeled.



The tomographic nodule volume obtained through the reconstruction of synchrotron X-ray  $\mu$ -CT images acquired from a fresh root nodule at BMIT



500  $\mu$ m

3D model of soybean nodule vasculature obtained through a (semi)automated segmentation approach using the smart interpolation algorithm **Biomedisa**.

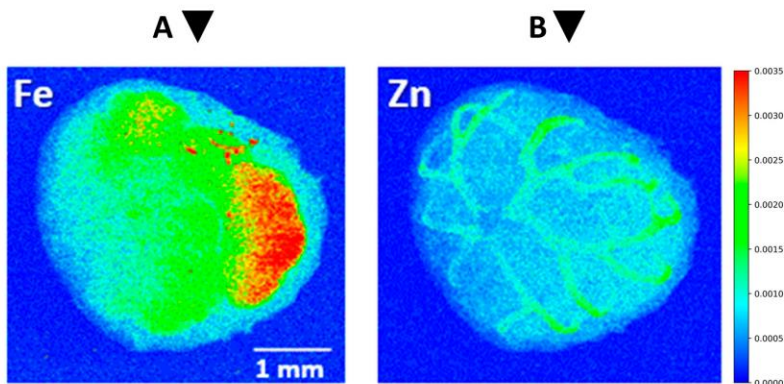
Left panel: manual segmentation of the VBs was performed on every 40th slice within the tomographic volume of the nodule.

Right panel: Biomedisa's Interpolation resulting in the reconstruction of a 3D model of nodule vasculature.

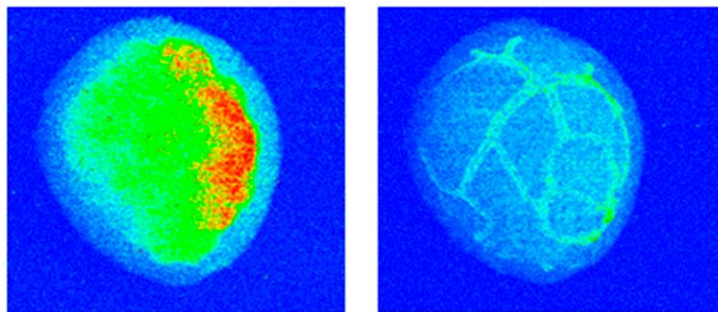
DOI: [10.34133/plantphenomics.0203](https://doi.org/10.34133/plantphenomics.0203)



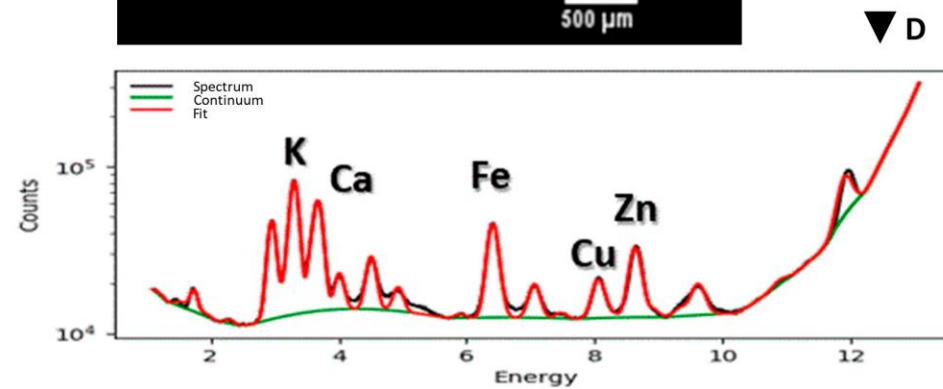
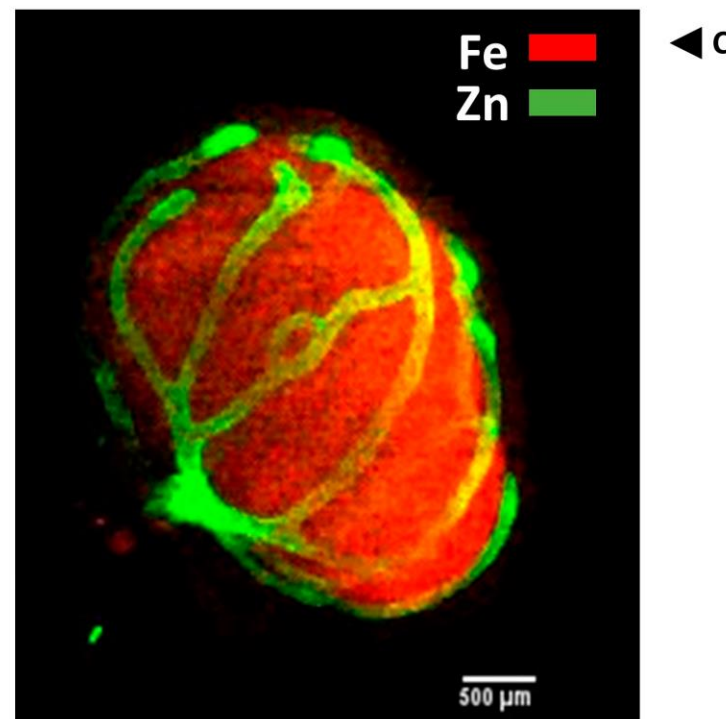
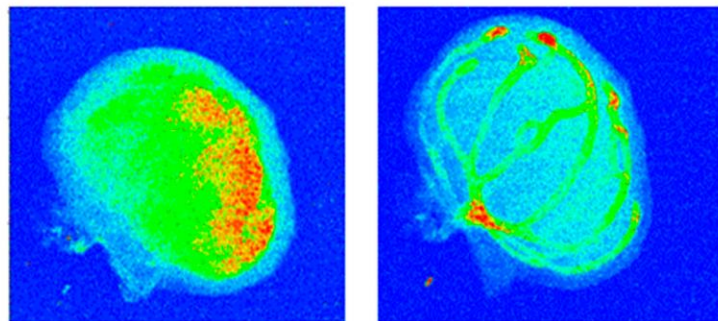
Dundas



Woodstock



Gaillard



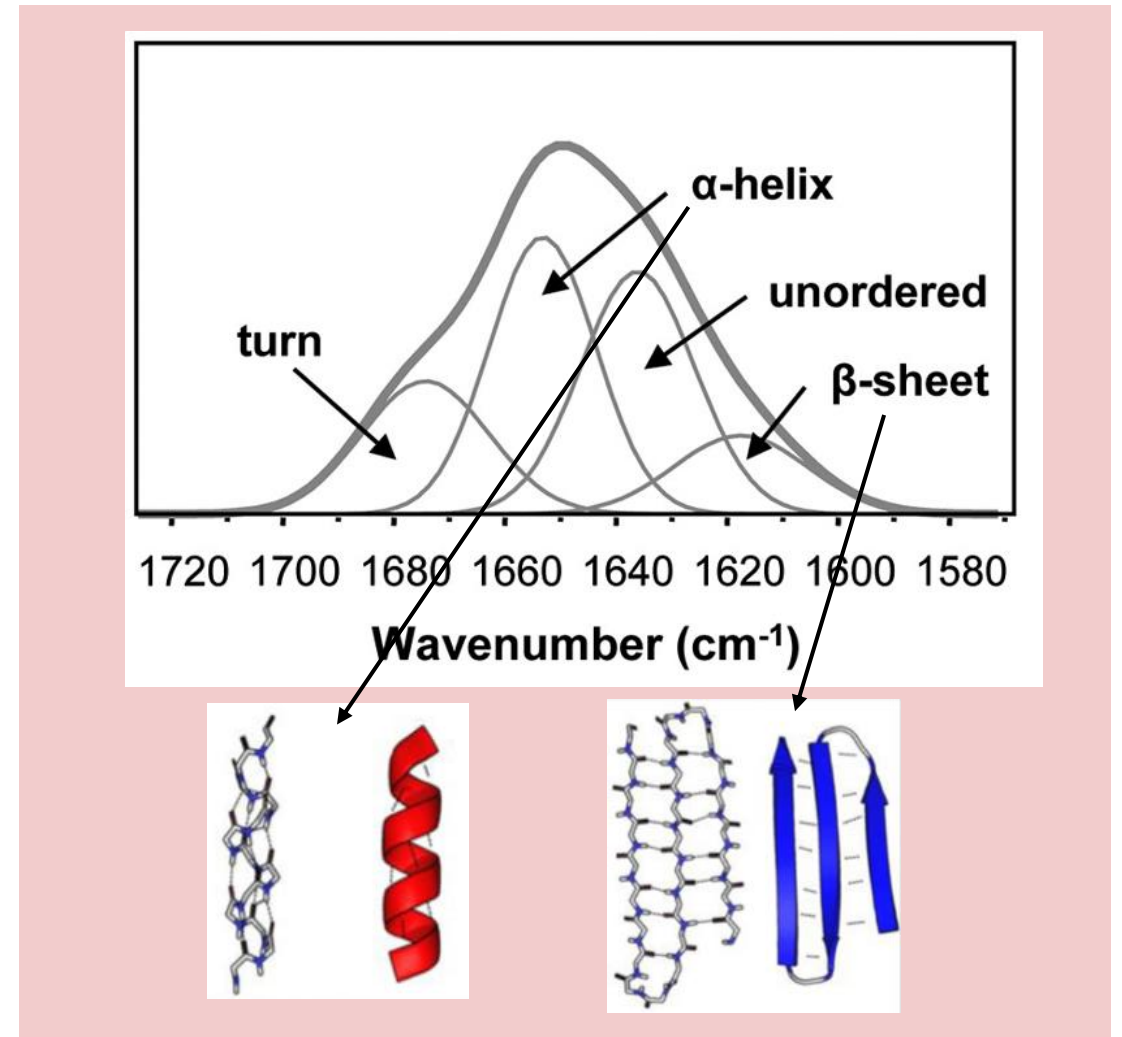
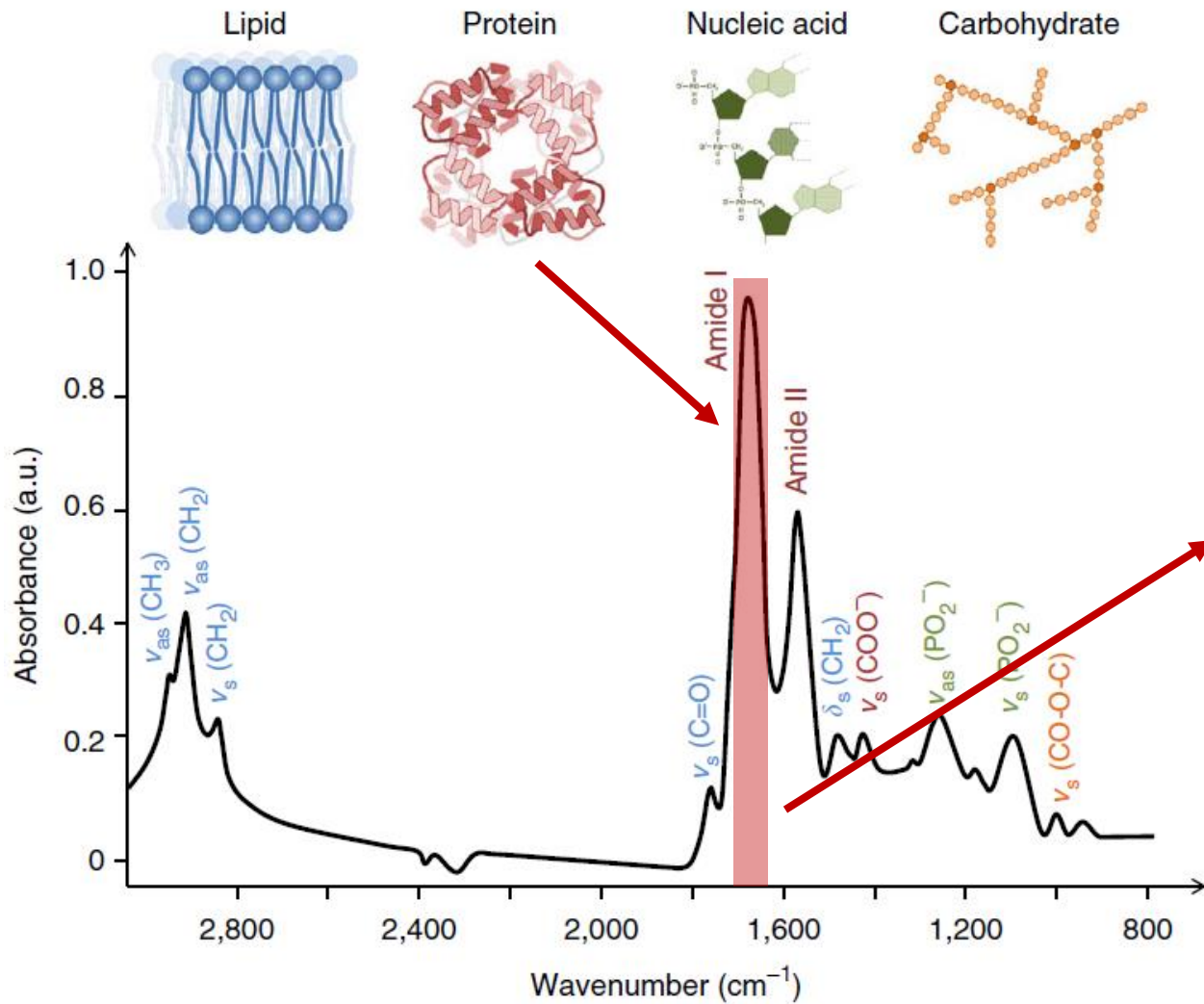
Synchrotron X-ray fluorescence imaging (SR-XRF) revealed a distinctive localization of Fe (A) and Zn (B), allowing for their visualization in 2 dimensions.

(C) reveals the localization of Fe within the bacteroid containing cells of the central infected zone tissue (CIZ), and Zn within the nodule vasculature (VB) in a soybean nodule.

(D) representative X-ray fluorescence emission spectrum of a nodule.



# 'Typical' Bio/Life/Plant/Food IR Spectrum





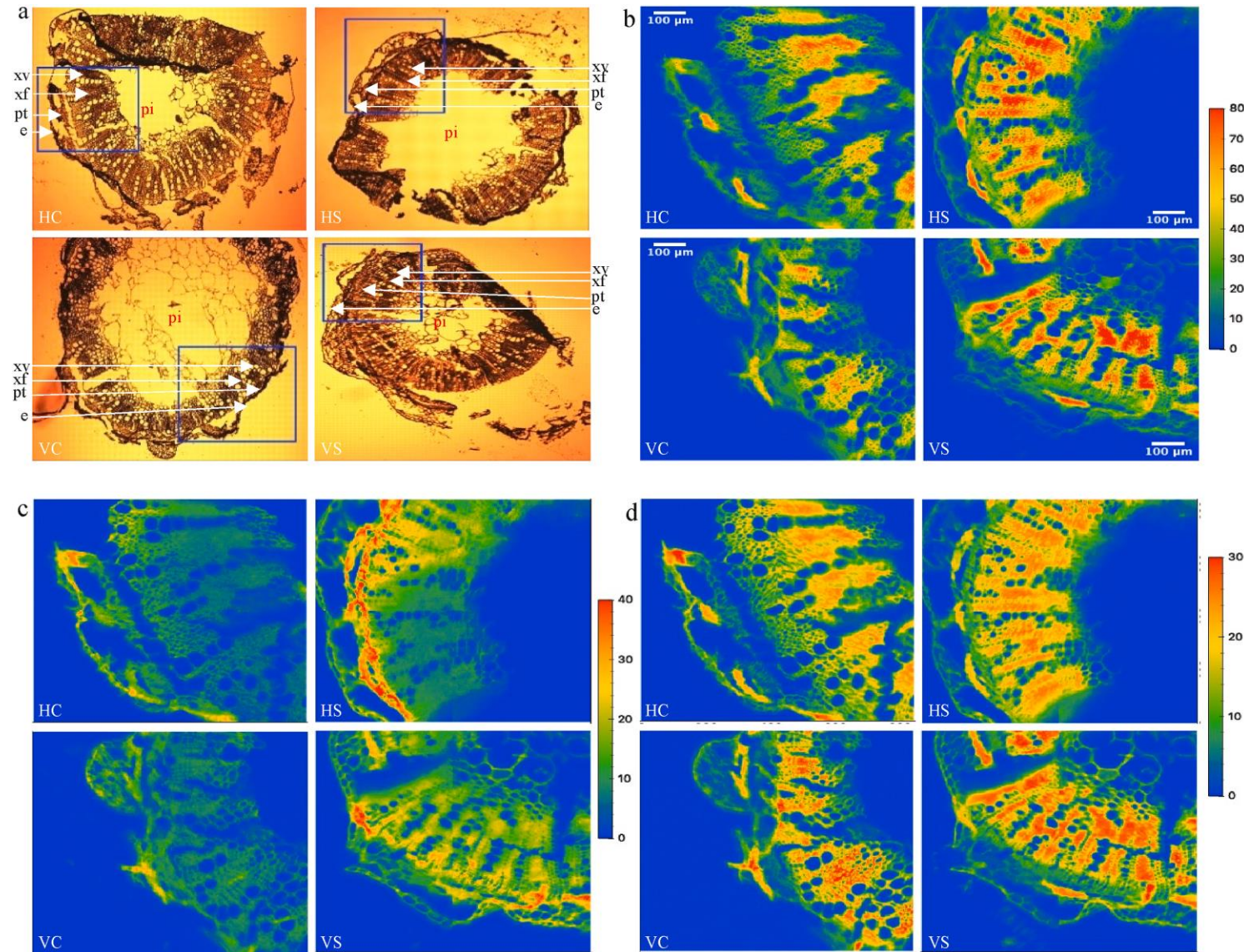
# Tissue specific changes in elements and organic compounds of alfalfa (*Medicago sativa* L.) cultivars differing in salt tolerance under salt stress

Soil salinity is a global concern and the primary factor contributing to land degradation which limits crop growth and production.

Alfalfa is a low input high value forage legume with a wide adaptation.

The responses of two alfalfa cultivars (salt tolerant 'Halo', salt intolerant 'Vernal') were studied for 12 weeks in five gradients of salt stress.

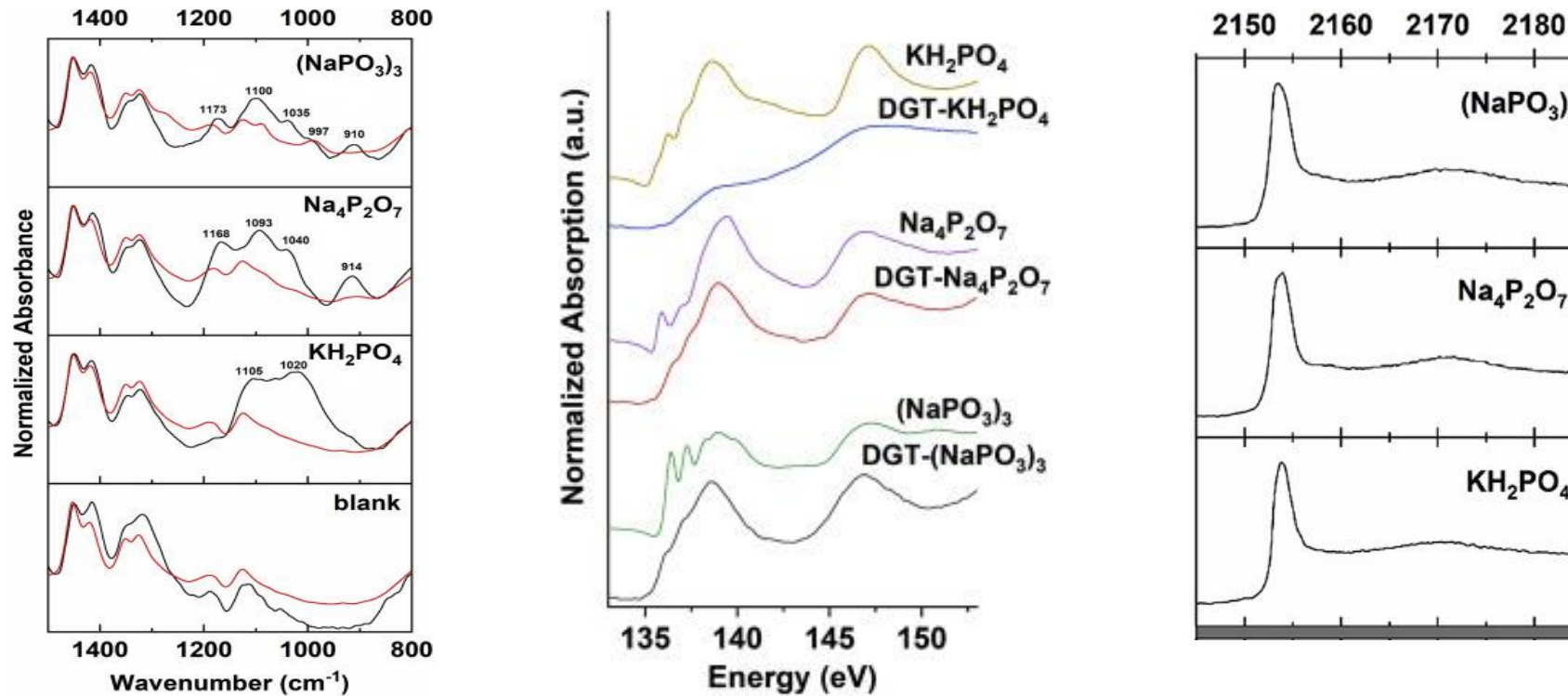
The accumulation and localization of elements and organic compounds in different tissues of alfalfa: a) stem cross-section samples for FTIR spectromicroscopy study; b) distribution of carbohydrate structures; c) amide I/II; d) lipid



mid-IR @ CLS



# Phosphorus speciation in soils



Infrared and XANES (P L<sub>2,3</sub>-edge & K) spectra of different phosphates in comparison to applied phosphates

- ✦ Diffusing Gradient Thin film technique (DGT) in combination with spectroscopy technique determines plant-available phosphorus species in soils.
- ✦ All three spectroscopic methods were able to distinguish between different kinds of phosphates, with infrared been more sensitive to distinguish between inorganic and organic phosphates; K-edge have lower detection limits, species identification and quantification; L<sub>2,3</sub>-edge provide more information especially for organic and polyphosphates.

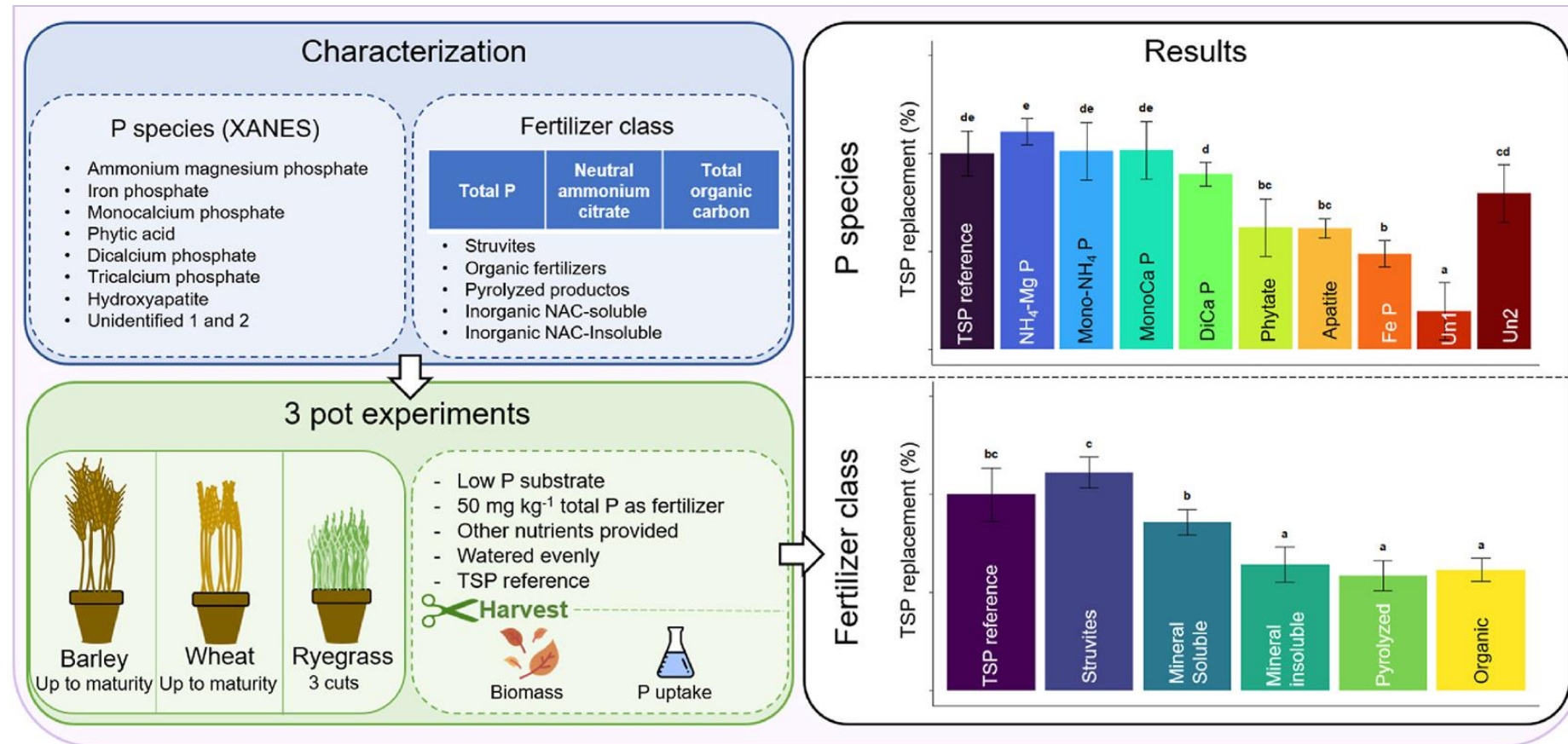


# Fertilization efficiency of thirty marketed and experimental recycled phosphorus fertilizers

Tested fertilizers are either on the market or in an advanced development stage.

Refined products containing soluble P salts performed similar to mineral fertilizer applied as triple superphosphate (TSP).

Raw products with hydroxyapatite, tricalcium phosphate, phytic acid or iron phosphates as their main P species had lower fertilization efficiencies.



Positive trend towards high-efficiency, refined inorganic recycled P fertilizers. Lower-performing, mostly unrefined fertilizers must be assessed in light of their long-term P supply potential.

# CLS and LAAAMP

CLS is partner in the *LAAAMP* (Lightsources for Africa, the Americas, Asia, Middle East and Pacific) project.

Thank you to the FAST TEAMS 2023 Award, Prof Keyla Soto Hidalgo, from the Universidad de Puerto Rico, spent two months at our facility using 5 BLs, with a project about *Mangroves for decontamination process*.





*see you at PALSAs 2025*

*Thank you: Jarvis Stobbs, Scott Rosendahl, and LO Committee*