



High throughput phenotyping of interactions between plants and microorganisms, associated devices. Phenotyping Platform for Plant and Plant Micro organisms Interactions (4PMI, INRA Dijon)

Christophe Salon

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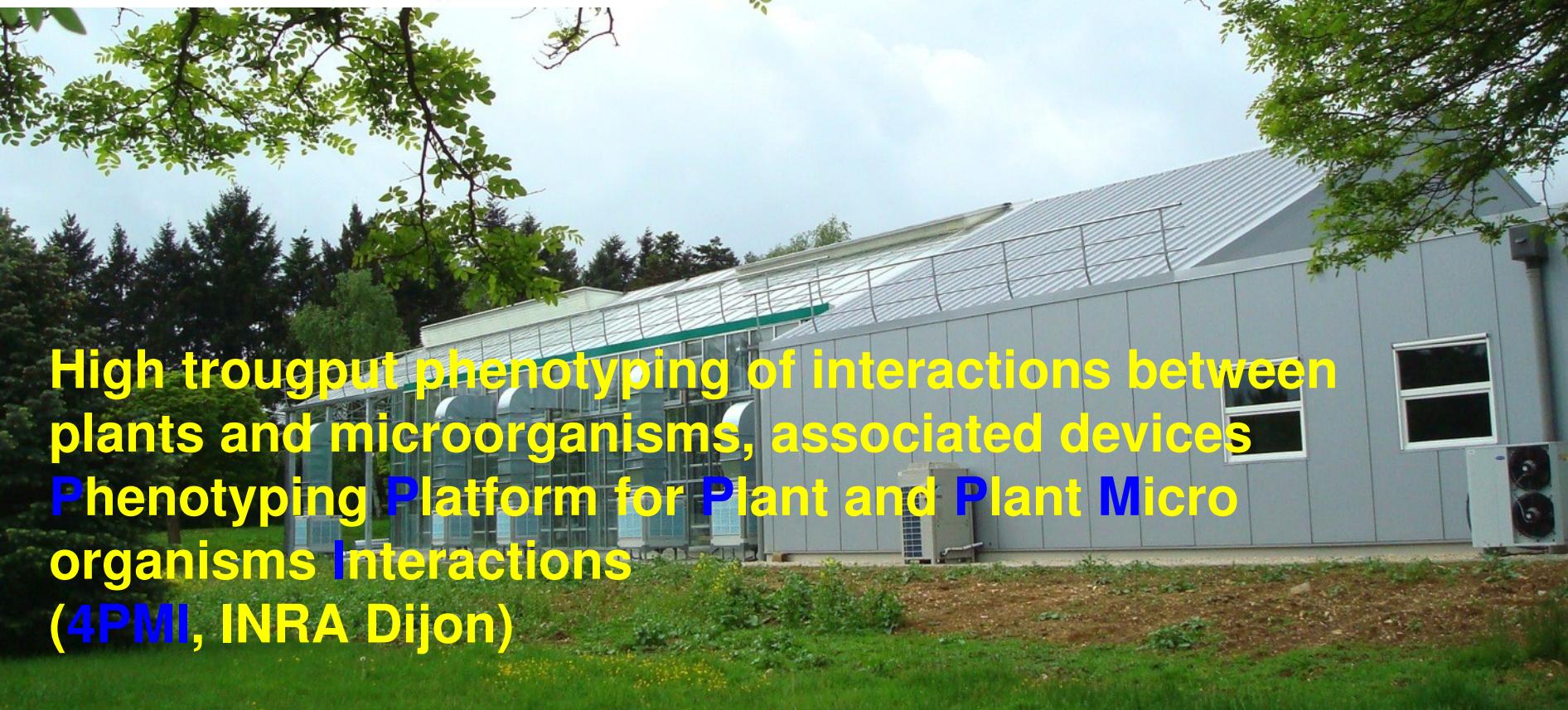
Submitted on 2 Jun 2020

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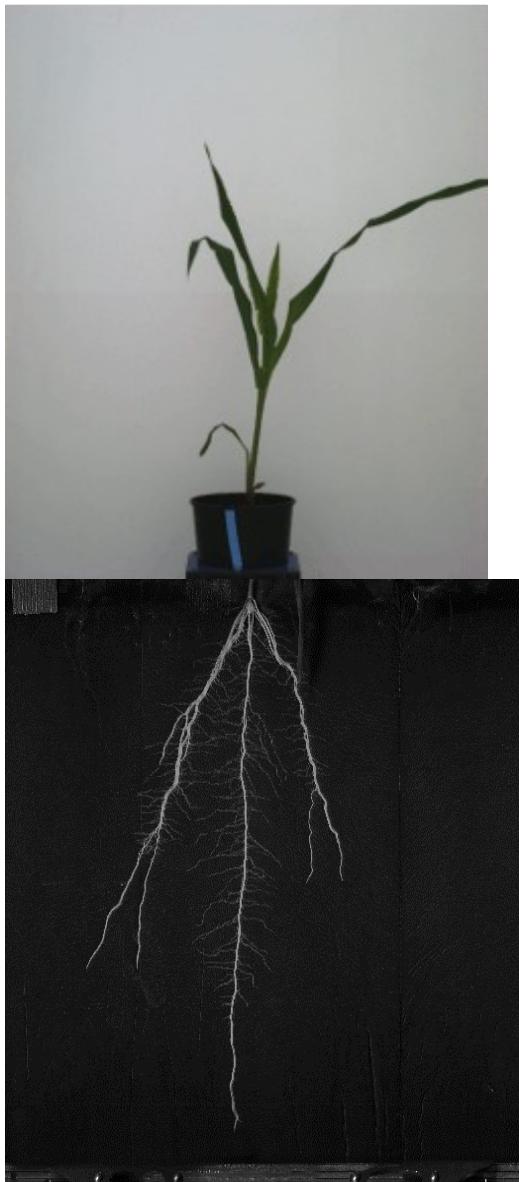
**High throughput phenotyping of interactions between plants and microorganisms, associated devices
Phenotyping Platform for Plant and Plant Micro organisms Interactions
(4PMI, INRA Dijon)**



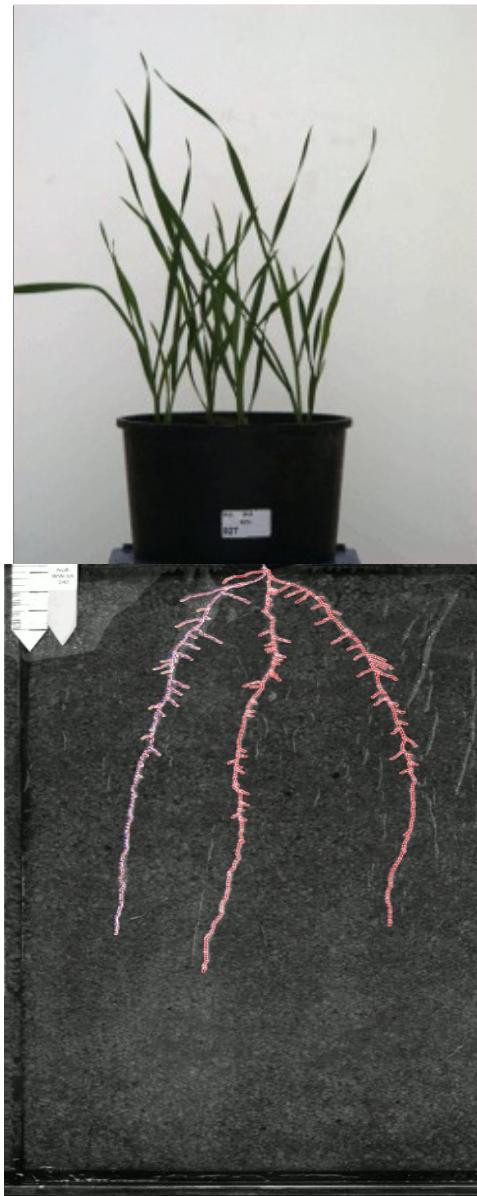
Christophe Salon

UMR 1347-AgroSup/INRA/uB, 17 rue Sully - BP 86510 - 21065 Dijon - France

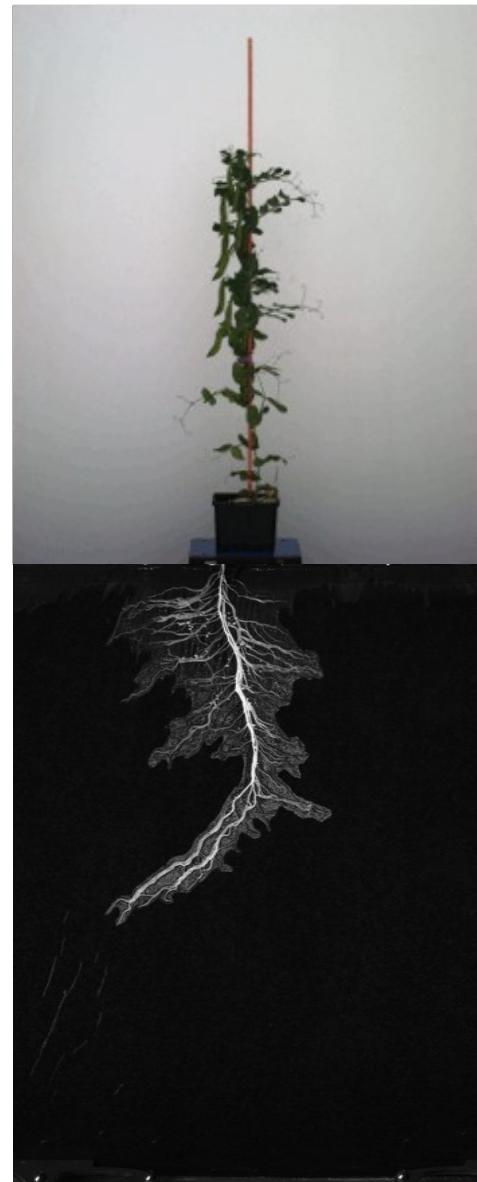
Achievements: Shoot phenotyping



Maize

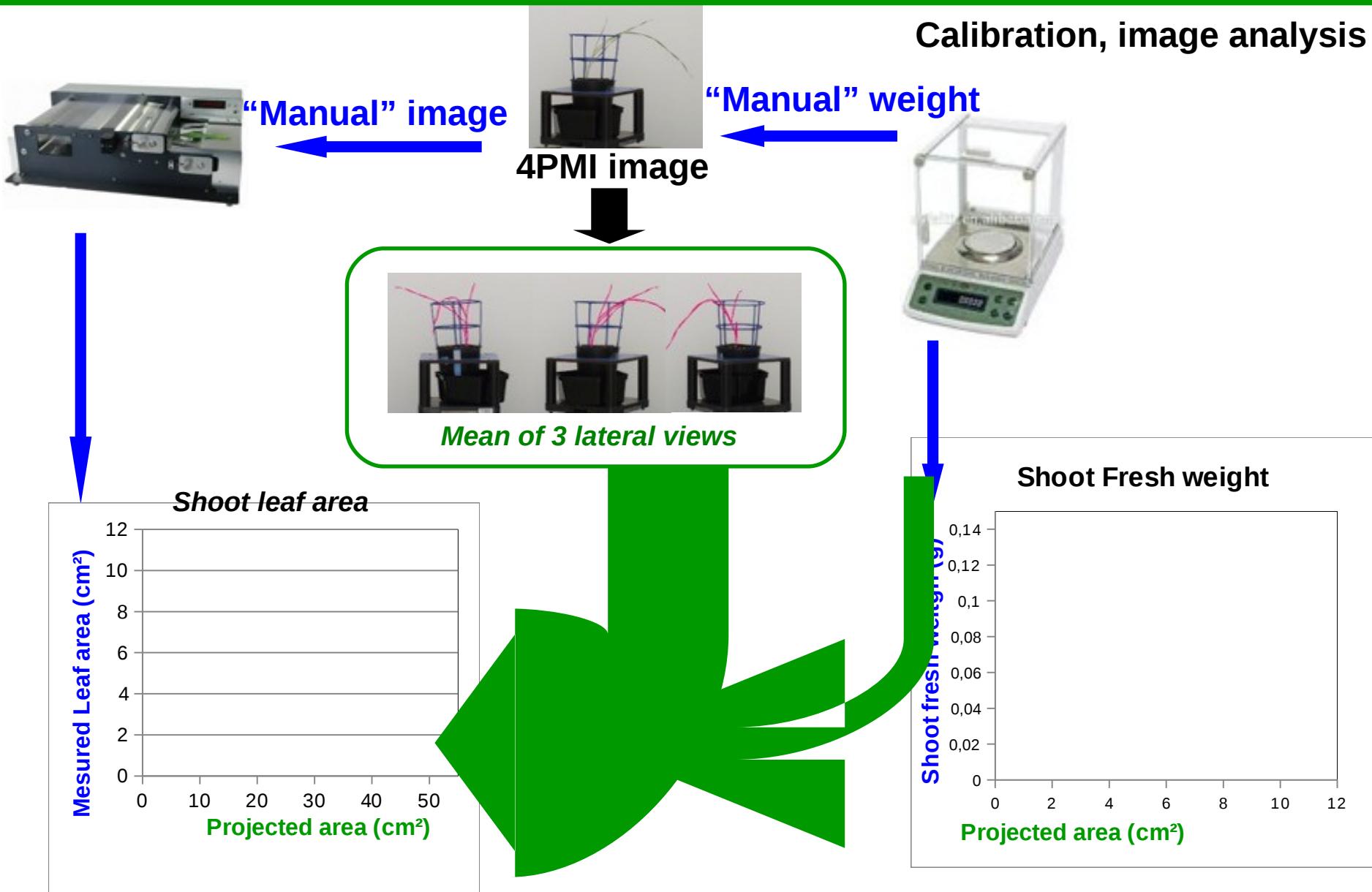


Wheat



Pea

Achievements: Shoot phenotyping



Choice of best image acquisition model !

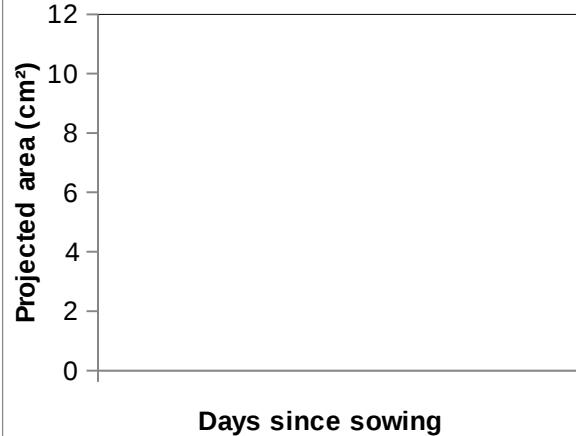


Wheat



4PMI image

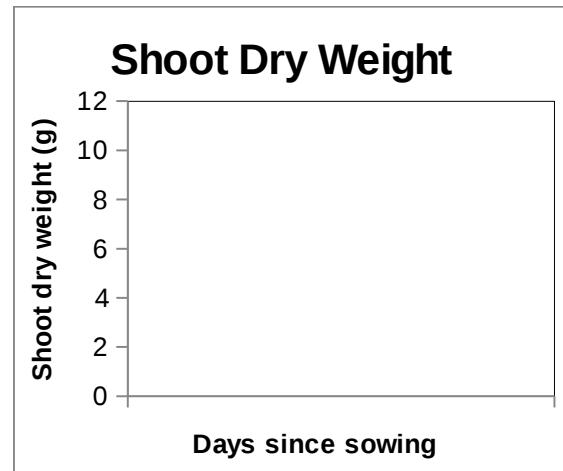
Projected area from images



Plant Height from image

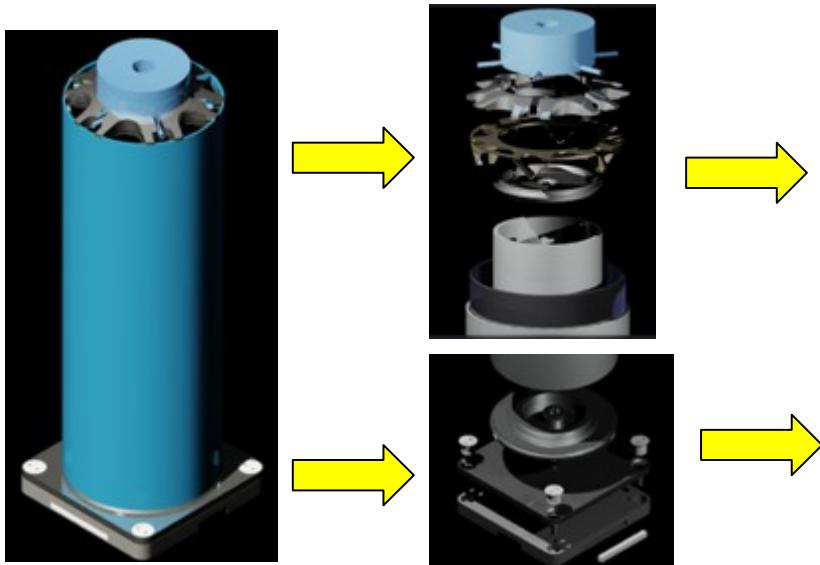


Shoot Dry Weight

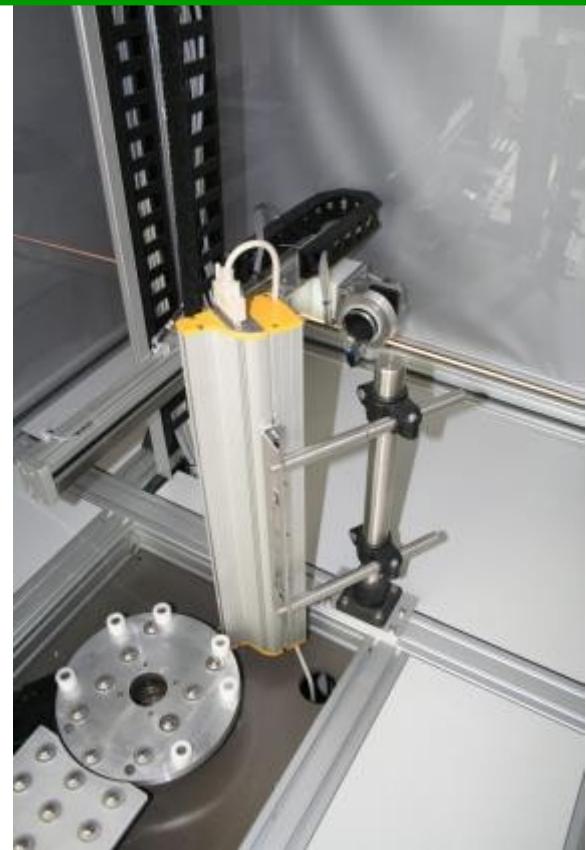


Prototyping approach: Partnership with SMEs (Inoviaflow and Shakti):

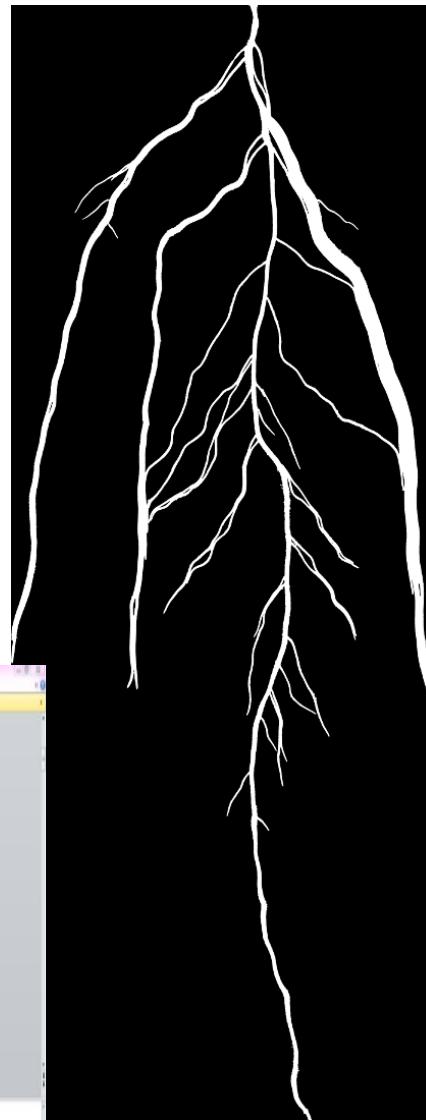
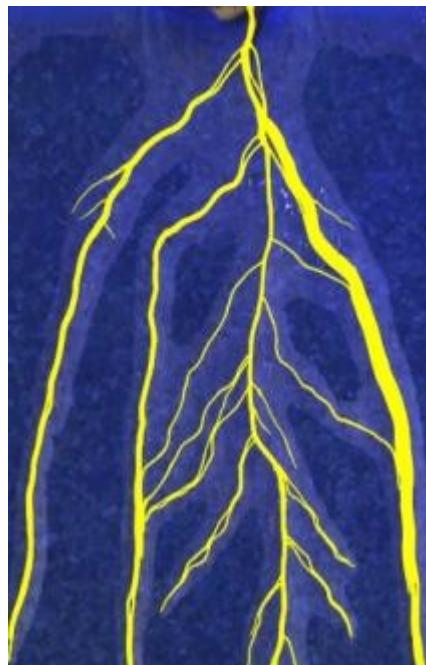
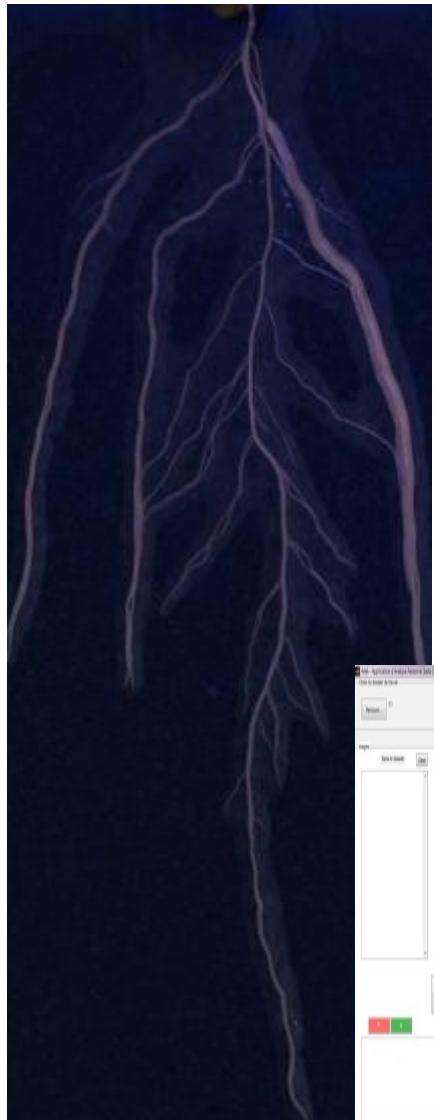
- very innovative rhizotrons (European patent) called RhizotubeHD,
- associated imaging cabins (Rhizocab and Rhizocab-HT) and software,
- irrigating, potting depotting tools.



**EU Patent INRA InoviaFlow,
World licence distributions
ongoing (INRA-Inoviaflow)**

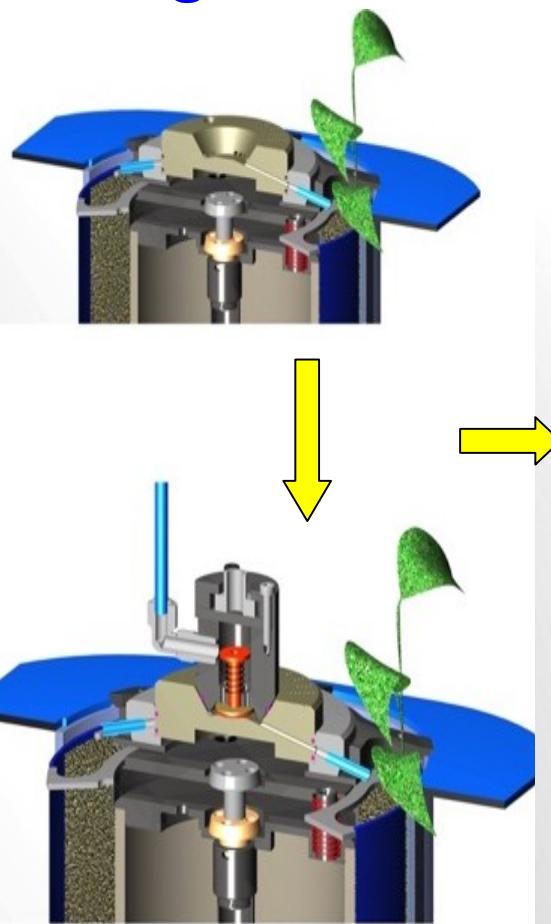
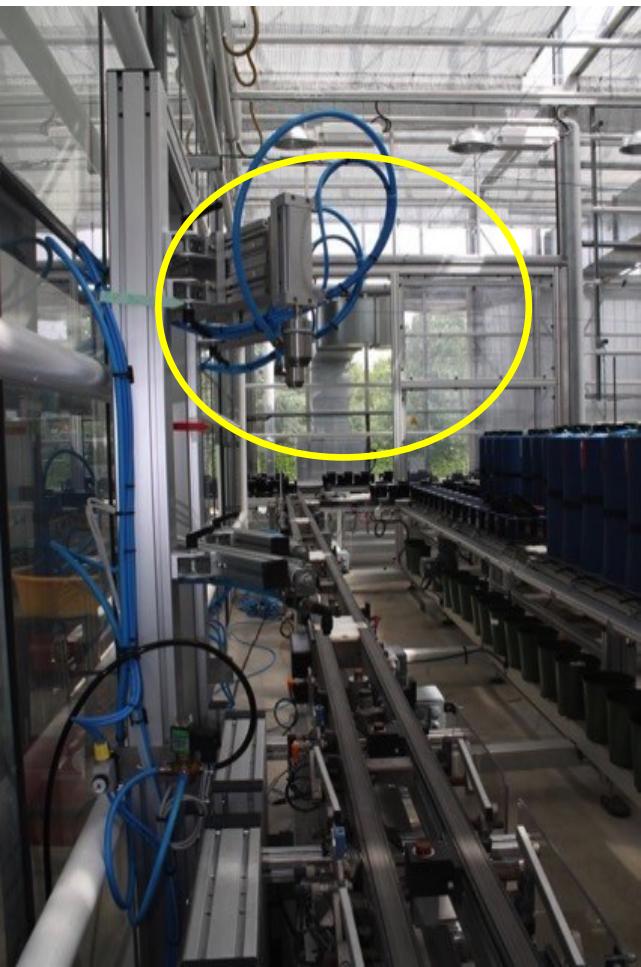


Segmentation software



A screenshot of a software application titled "INRA Application d'analyse d'images". The interface includes several panels: a main image viewer showing a root system with a yellow circle highlighting a specific area; a control panel with sliders and buttons for "Sélection de la couleur" and "Filtre"; a "Liste des racines" panel showing a list of detected roots; and a "Racines transparentes - Valeur" panel showing a grayscale image of the root system with white lines overlaid. The software is developed by INRA and includes a help section and various configuration options.

Irrigation arm



Shell

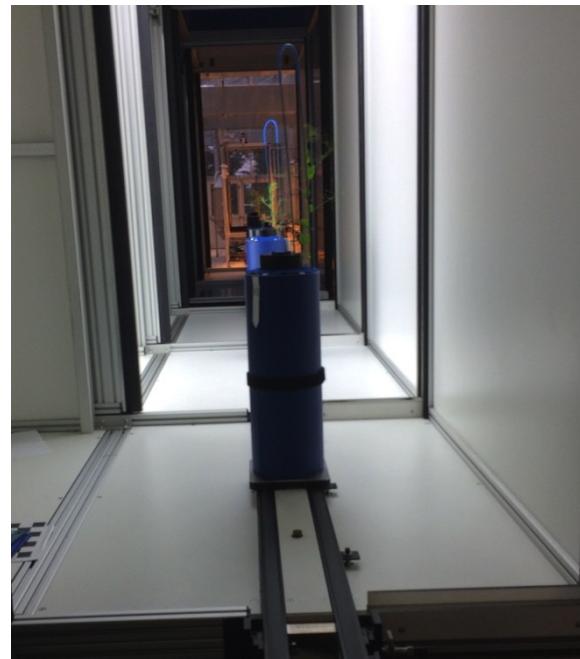
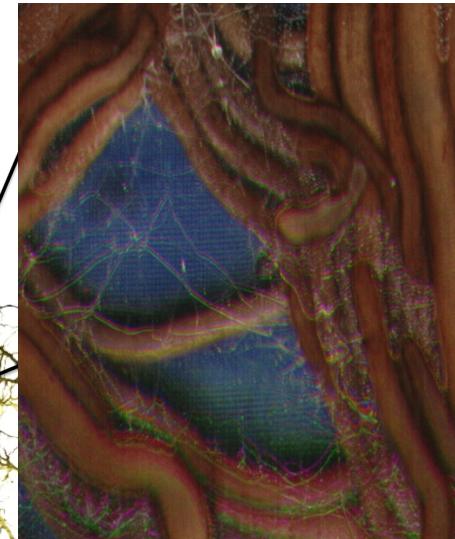
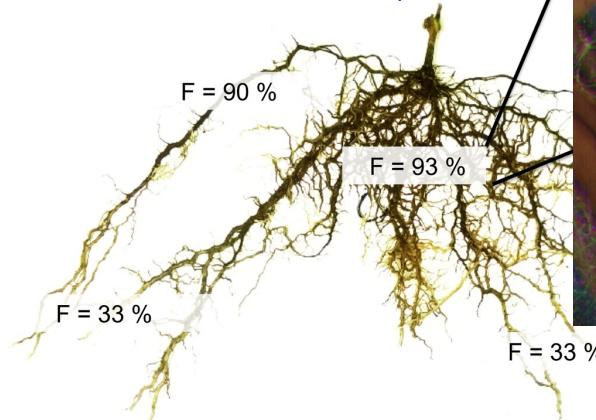


Ok for small amount of nutritive solutions
Drainage hole

RhizoCab HT development



Low throughput:
50 RT/day, 45s/RT
Very high resolution (7 μm)



High throughput:
100ds/day
15s/RT
Medium resolution (42 μm)



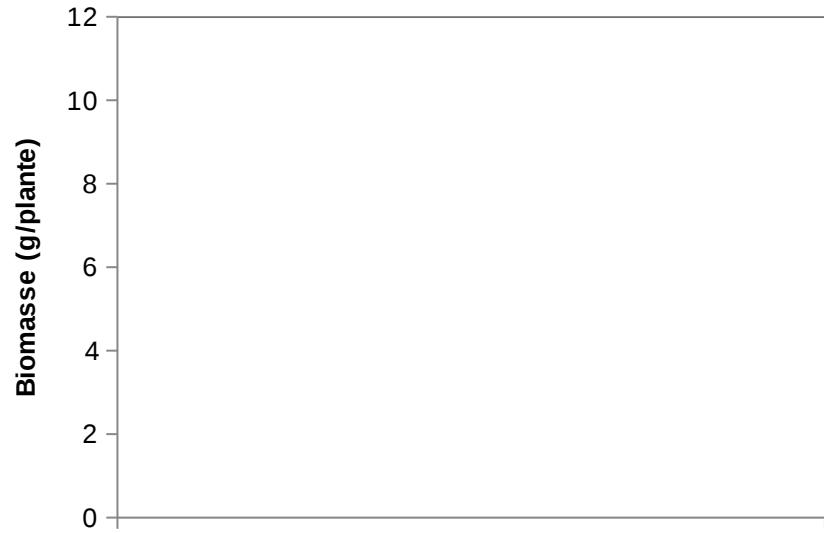


BOM: RhizoTubes vs Pots ?

Shoots over root biomass ratio



Mean Nodule weight



*Similar plant compartments and
nodule traits*



BOM: RhizoTubes vs Pots ?

1st order lateral roots



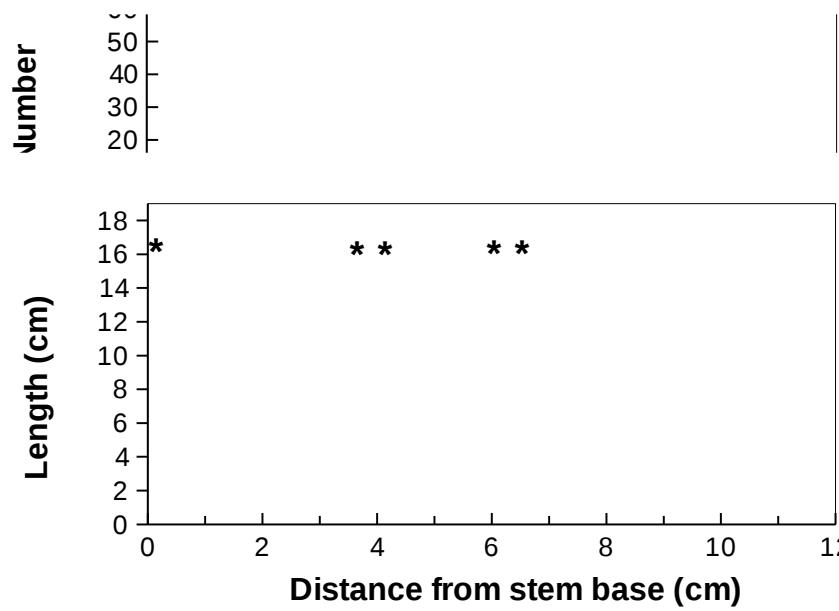
○ *Pot*

● *RhizoTube*

Same length upper

... but pot vs RhizoTube depth !

2nd order lateral roots

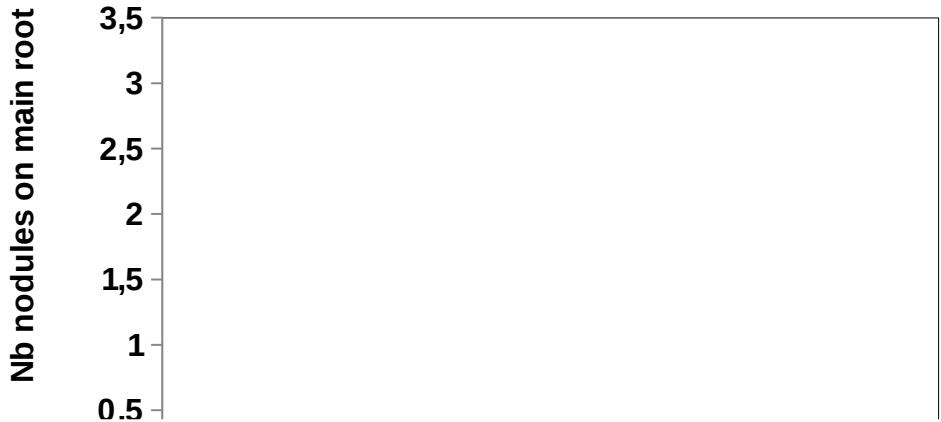


Same number and distribution of roots on 2nd order laterals

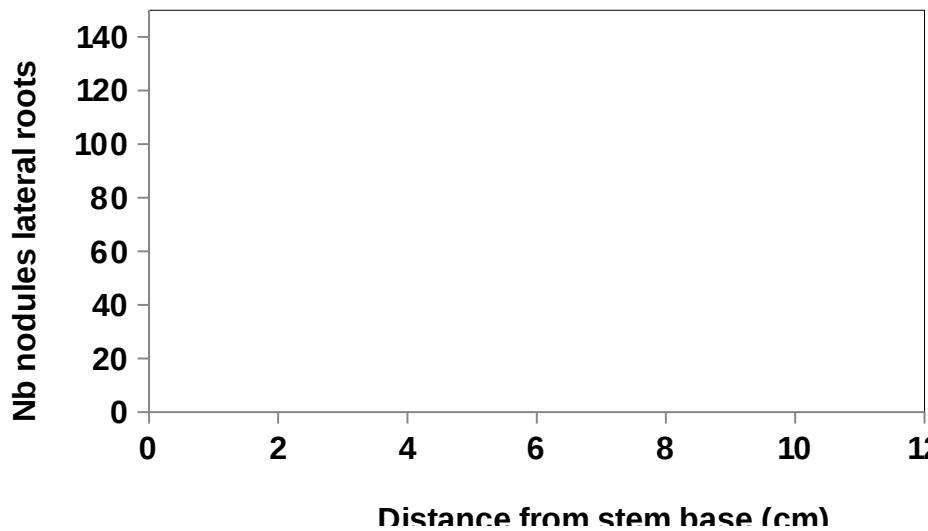


BOM: RhizoTubes vs Pots ?

○ *Pot*
● *RhizoTube*



Same nodule profile distribution, shifted



Length main root

Length (cm)

0

Date

Number of nodule

Number

0

Date

Number of laterals

Number

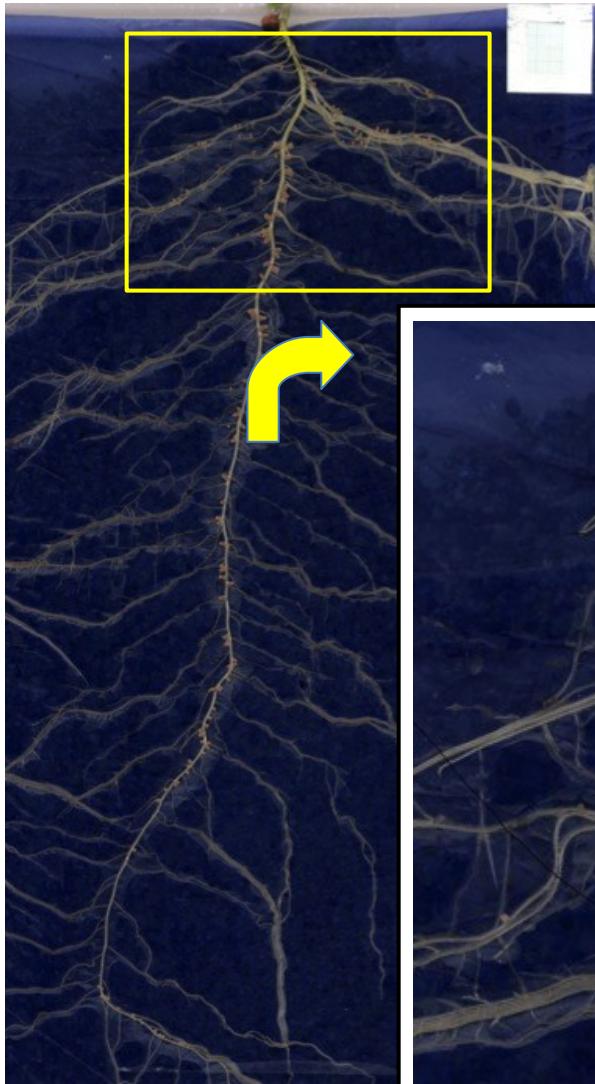
0

Date

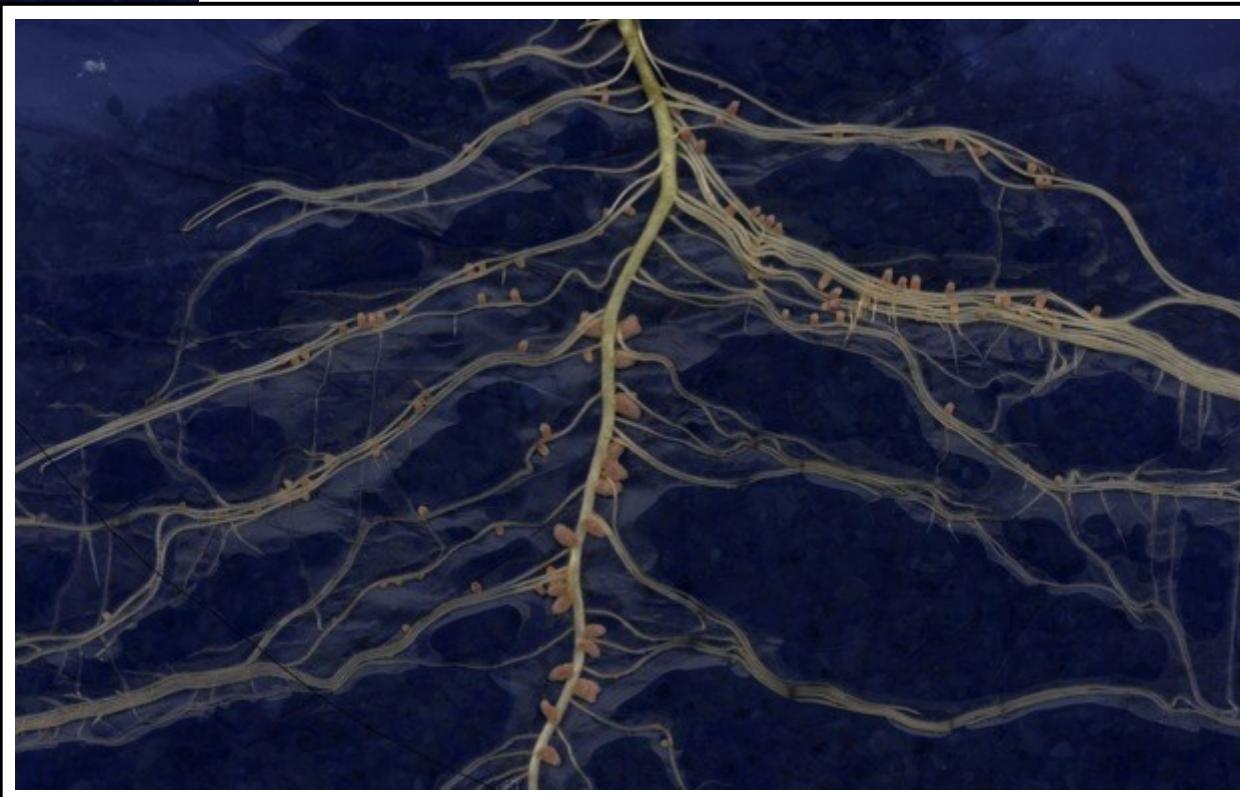


Phenotypic traits: examples

Nodules: Number, projected surface, position, color

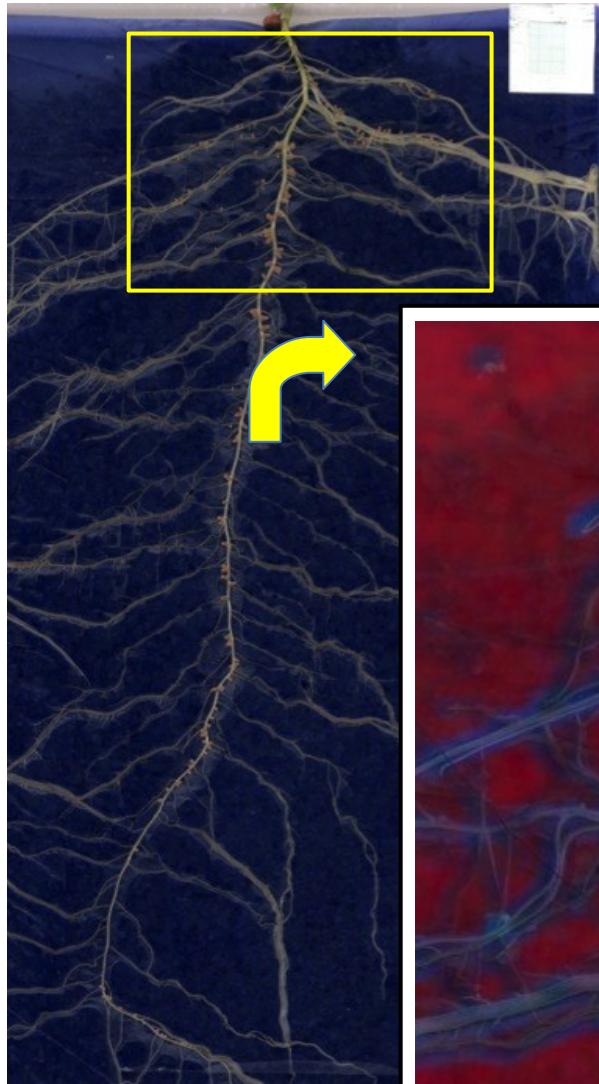


Focus on image

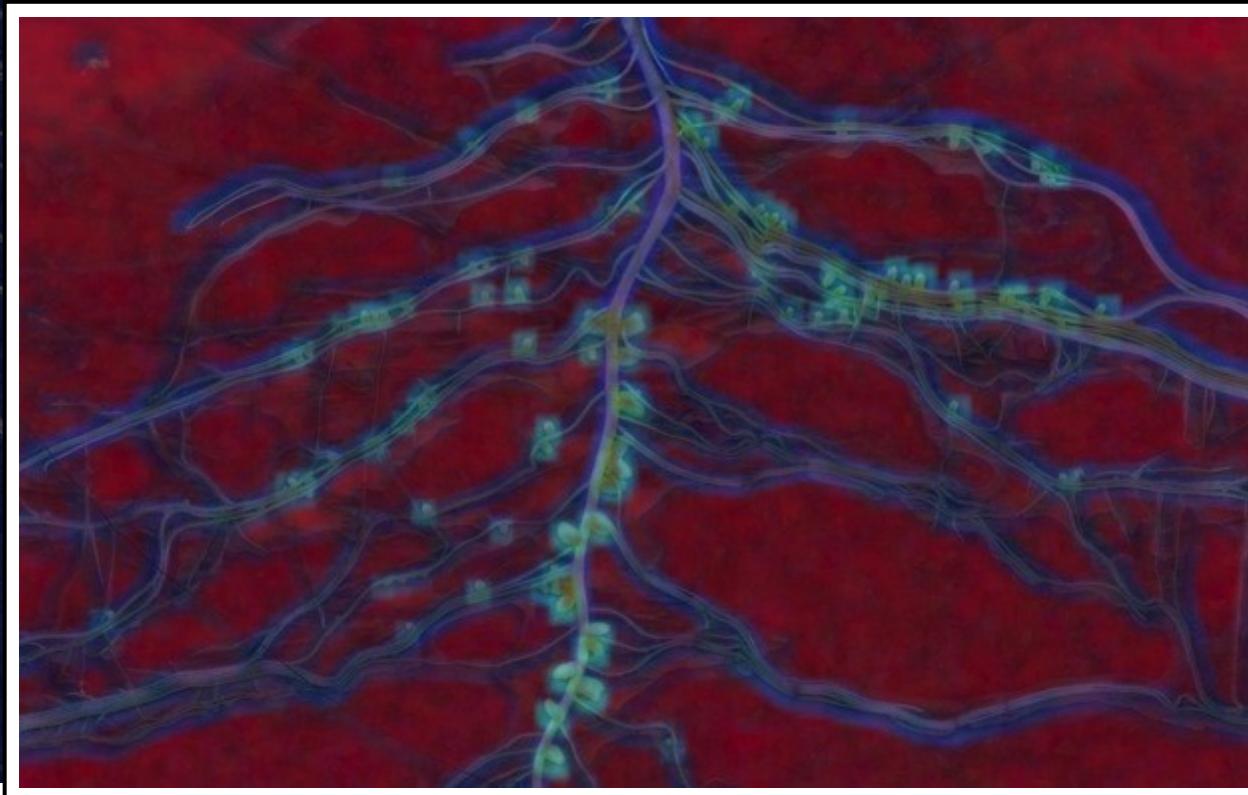


Phenotypic traits: examples

Nodules: Number, projected surface, position, color



Hybrid spaces (color + texture)
(Cointault et al, 2008)



Phenotypic traits: examples

Nodules: Number, projected surface, position, color

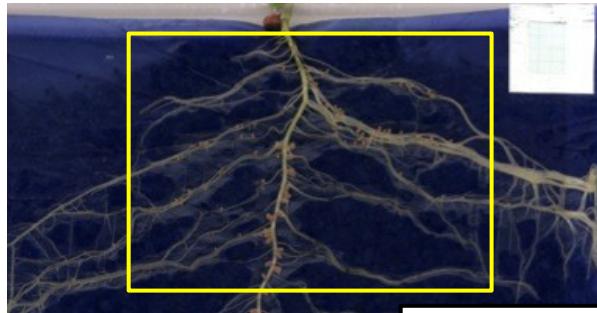
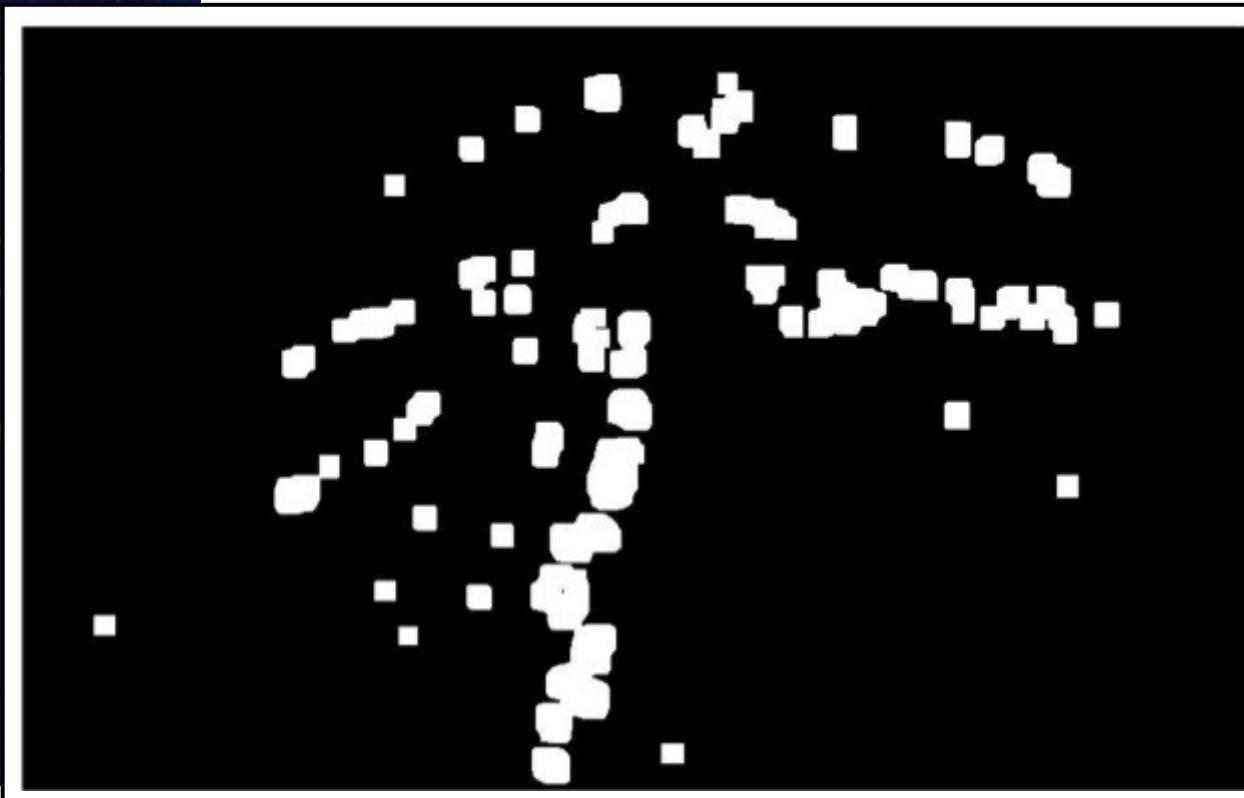
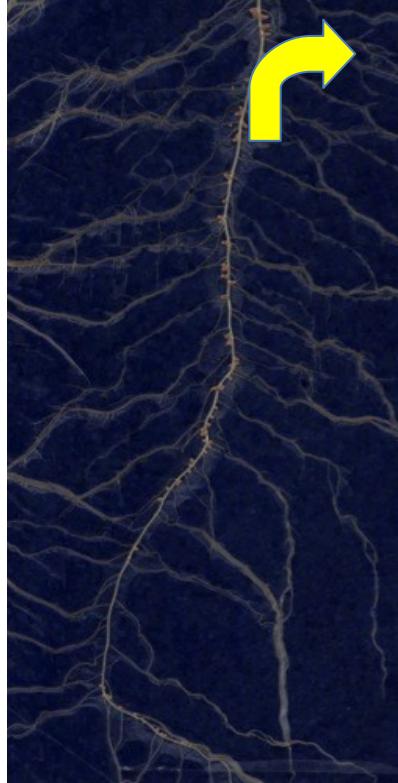
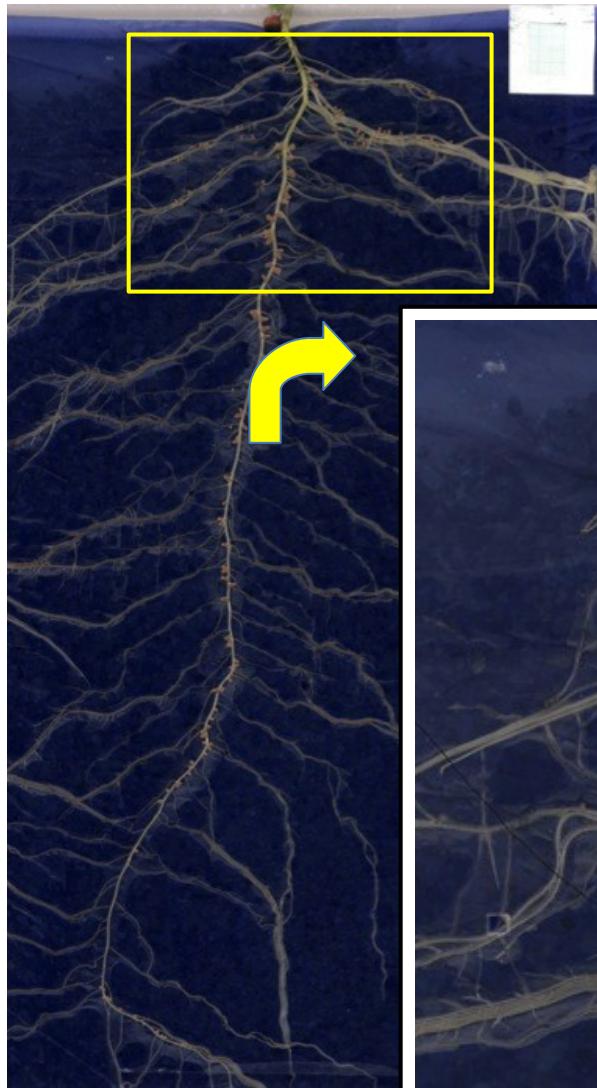


Image with nodules

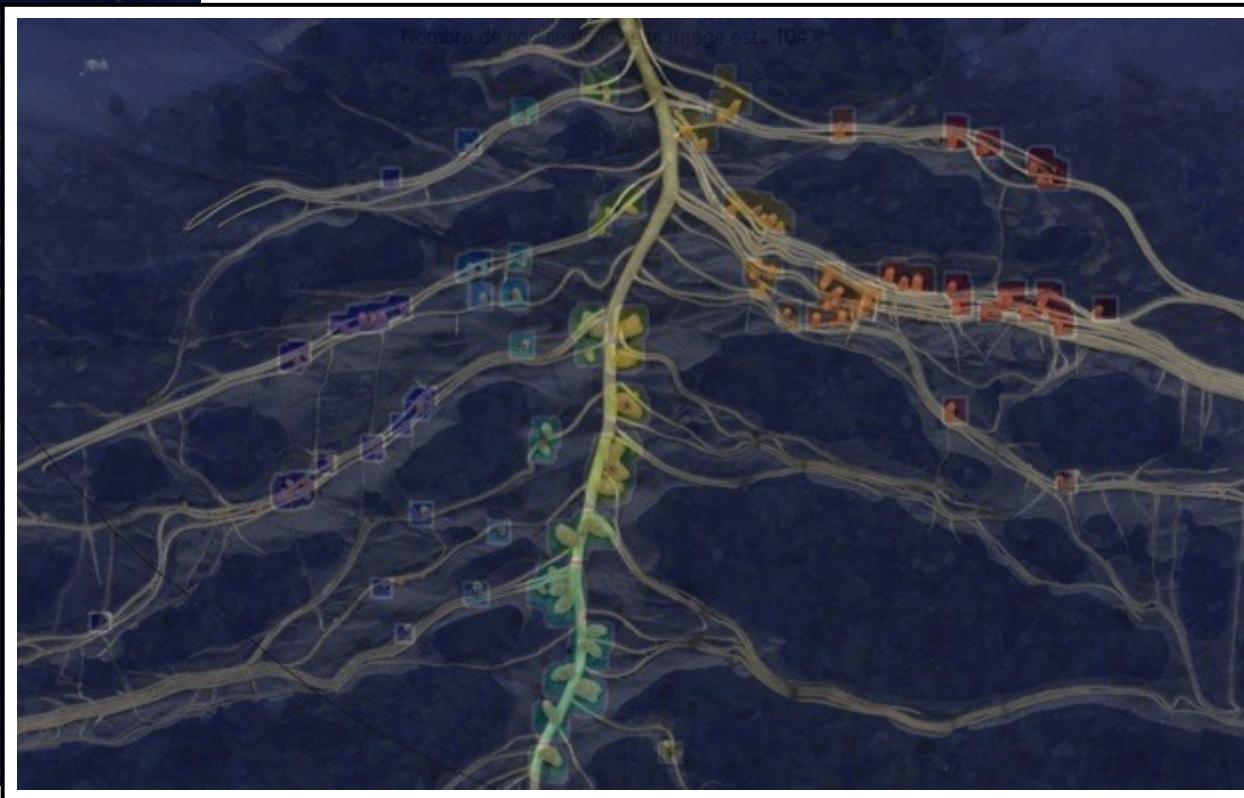


Phenotypic traits: examples

Nodules: Number, projected surface, position, color

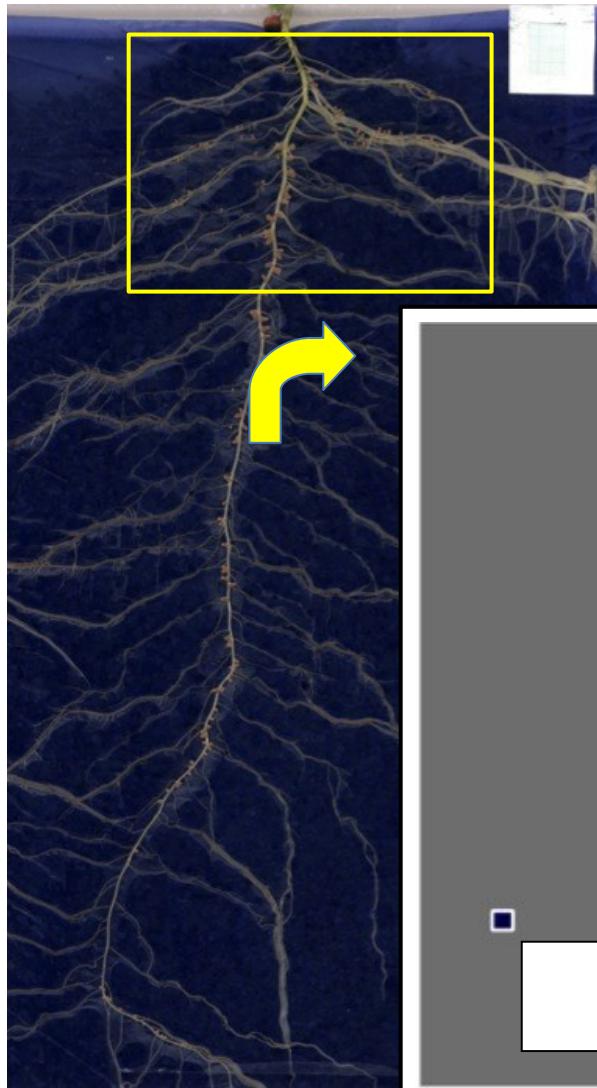


Original image + superimposed nodules



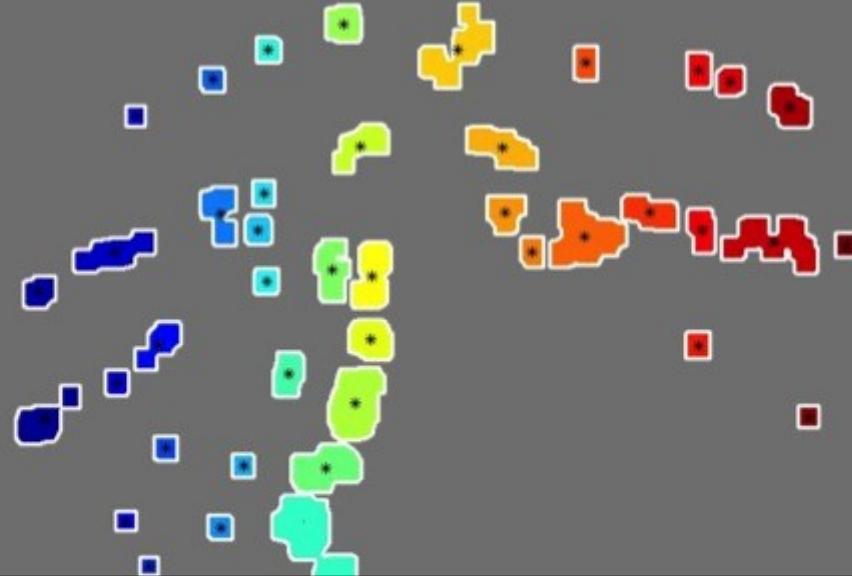
Phenotypic traits: examples

Nodules: Number, projected surface, position, color



Nodules automatically detected

Nombre de nodule dans cette image est : 104

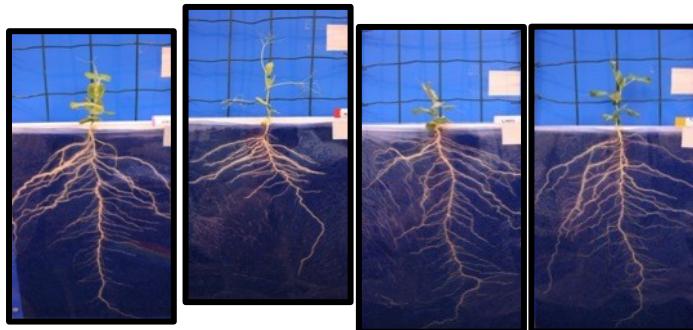


95% detection efficiency

Phenotypic traits: examples

Nodules: Number, projected surface, position, color

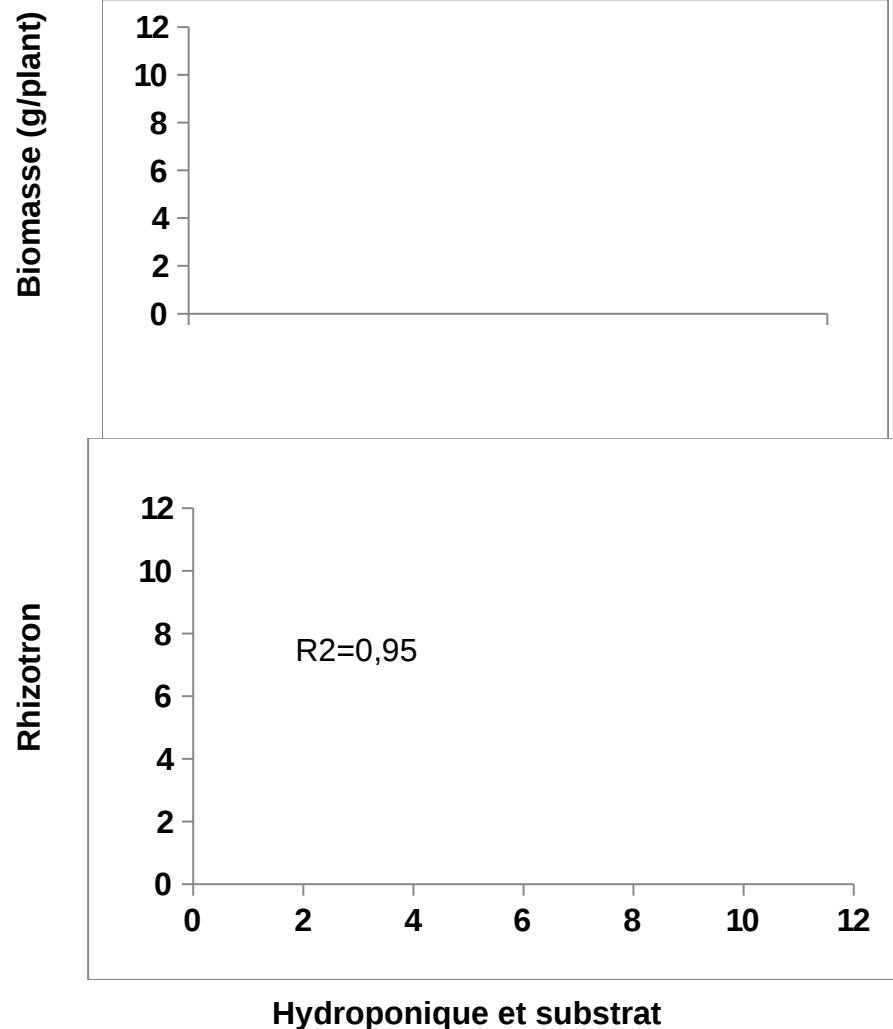
Pea core collection



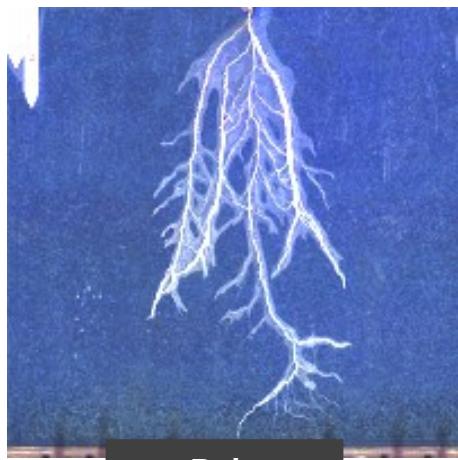
AMINO KAYANNE L1073 CAMEOR



ISARD CUZCO LIVIOLETTA PI186093



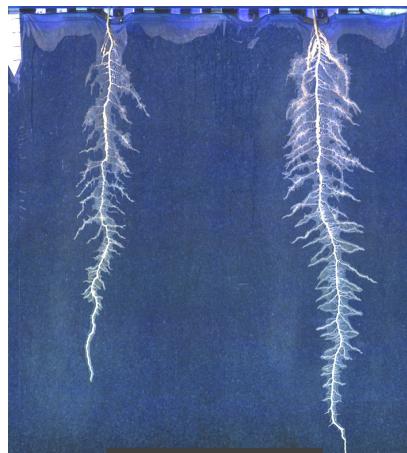
Some root example



Pois



Féverolle



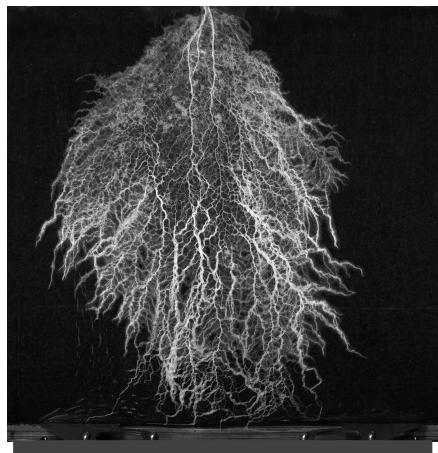
Lupin



Haricot



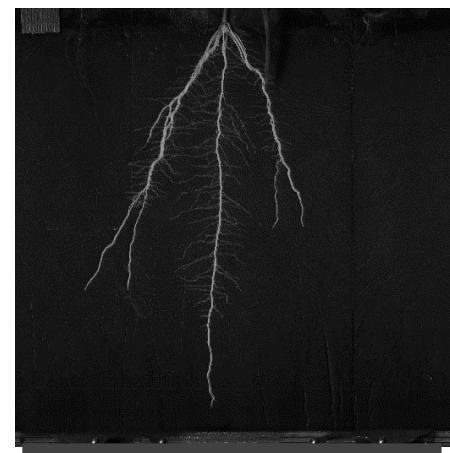
Vesce Commune



Colza

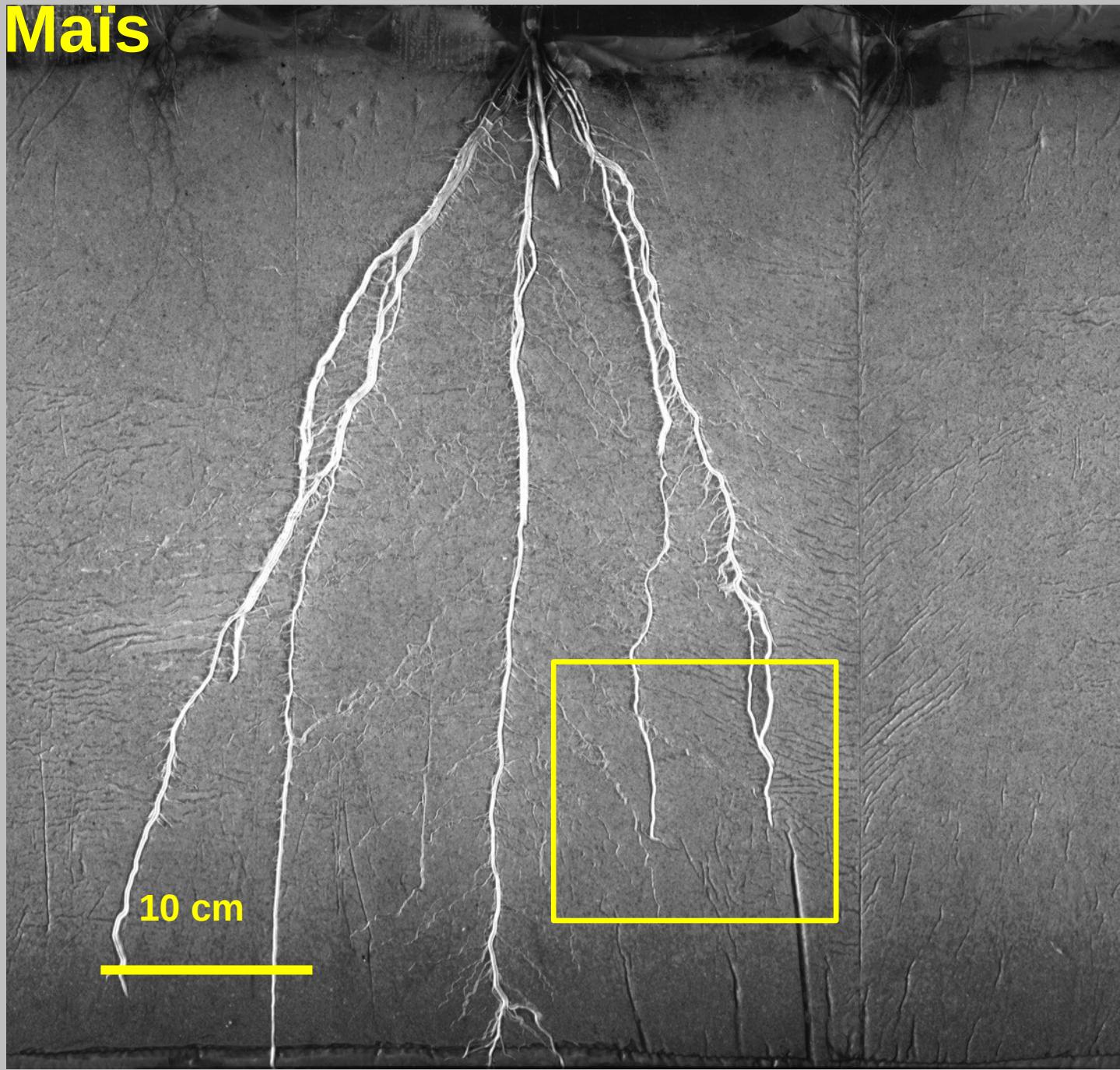


Vulpie

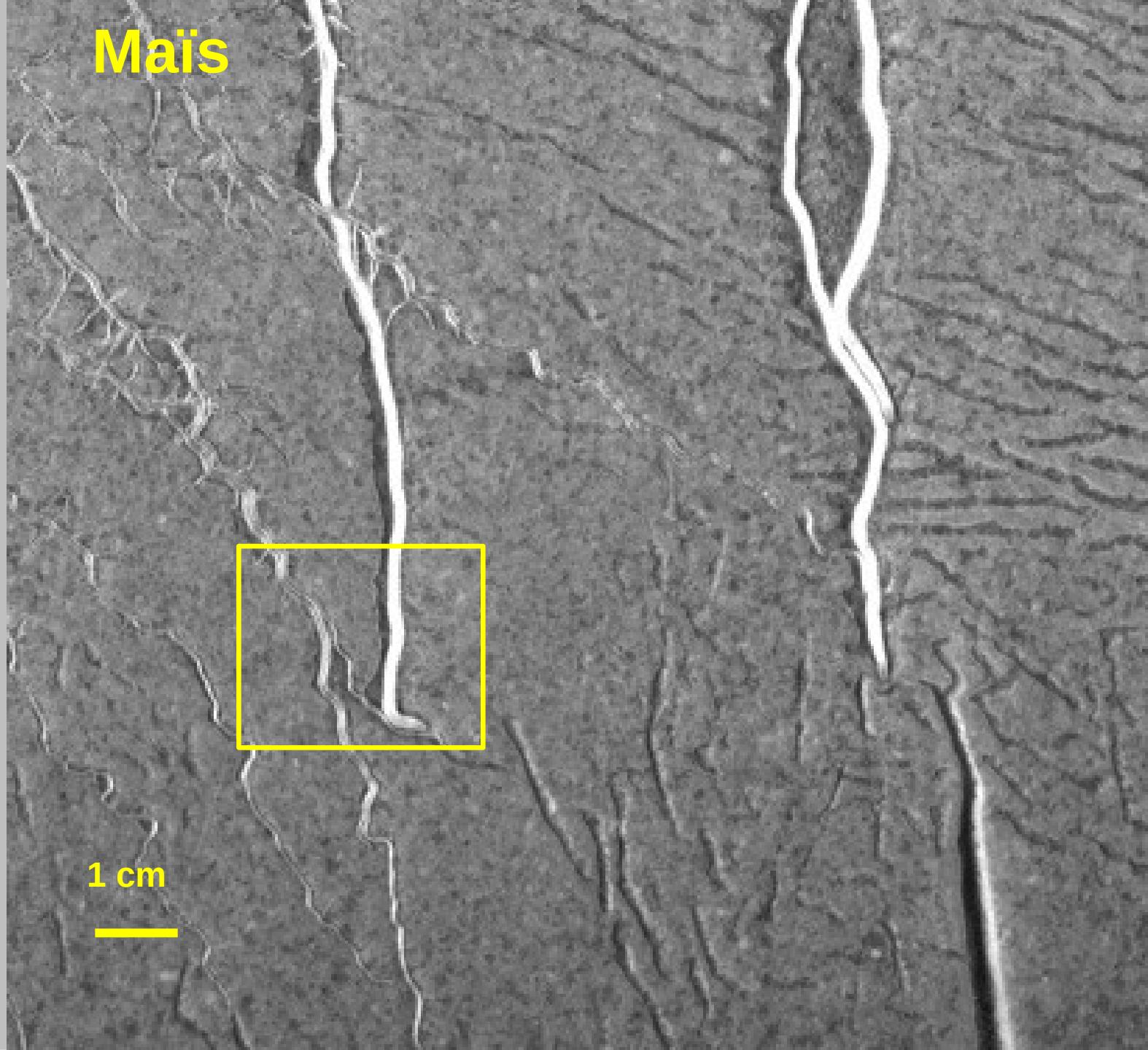


Maïs

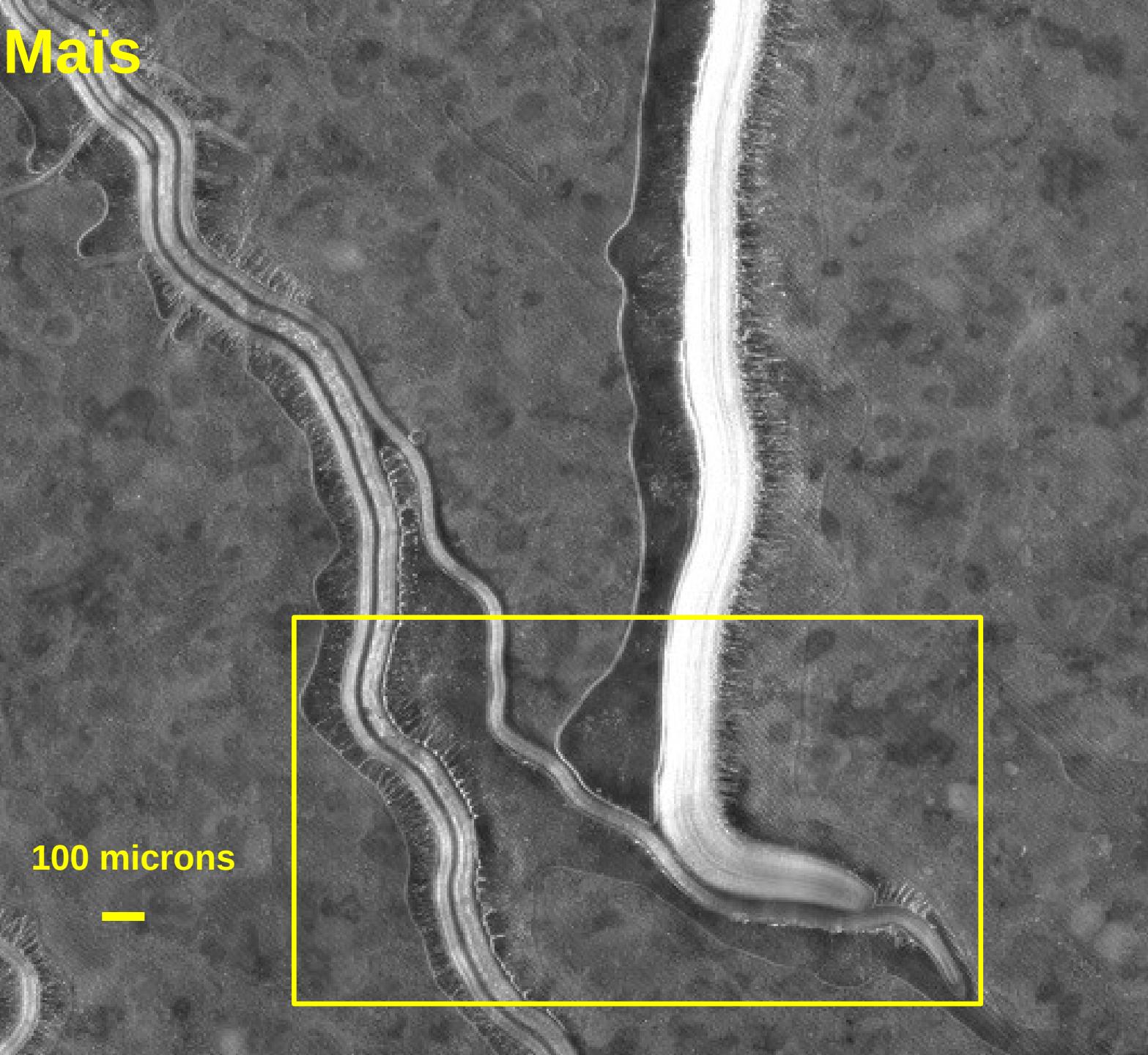
Mais



Mais



Maïs

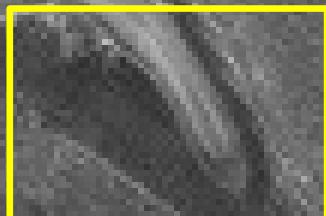


100 microns



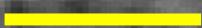
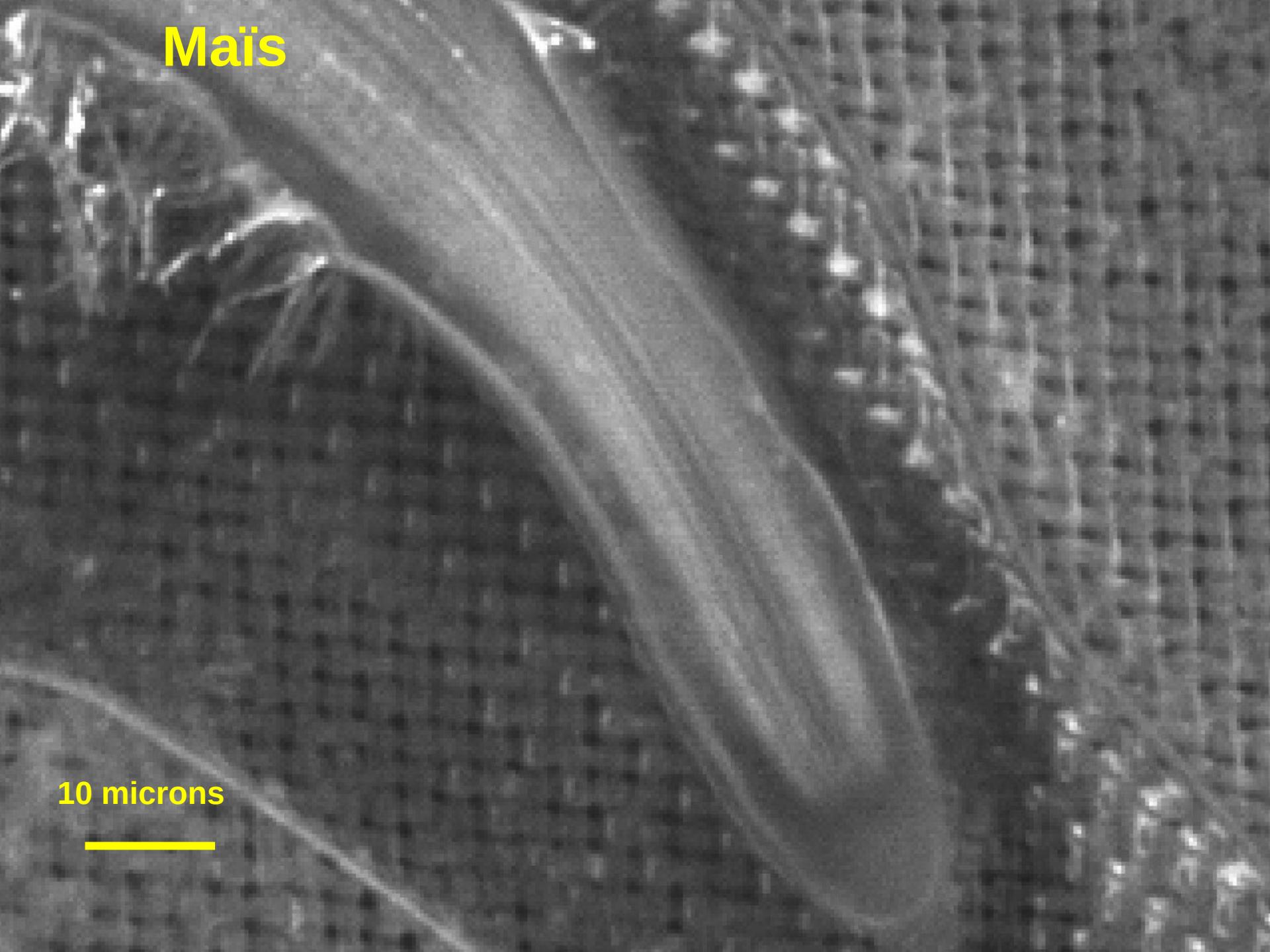
Maïs

50 microns

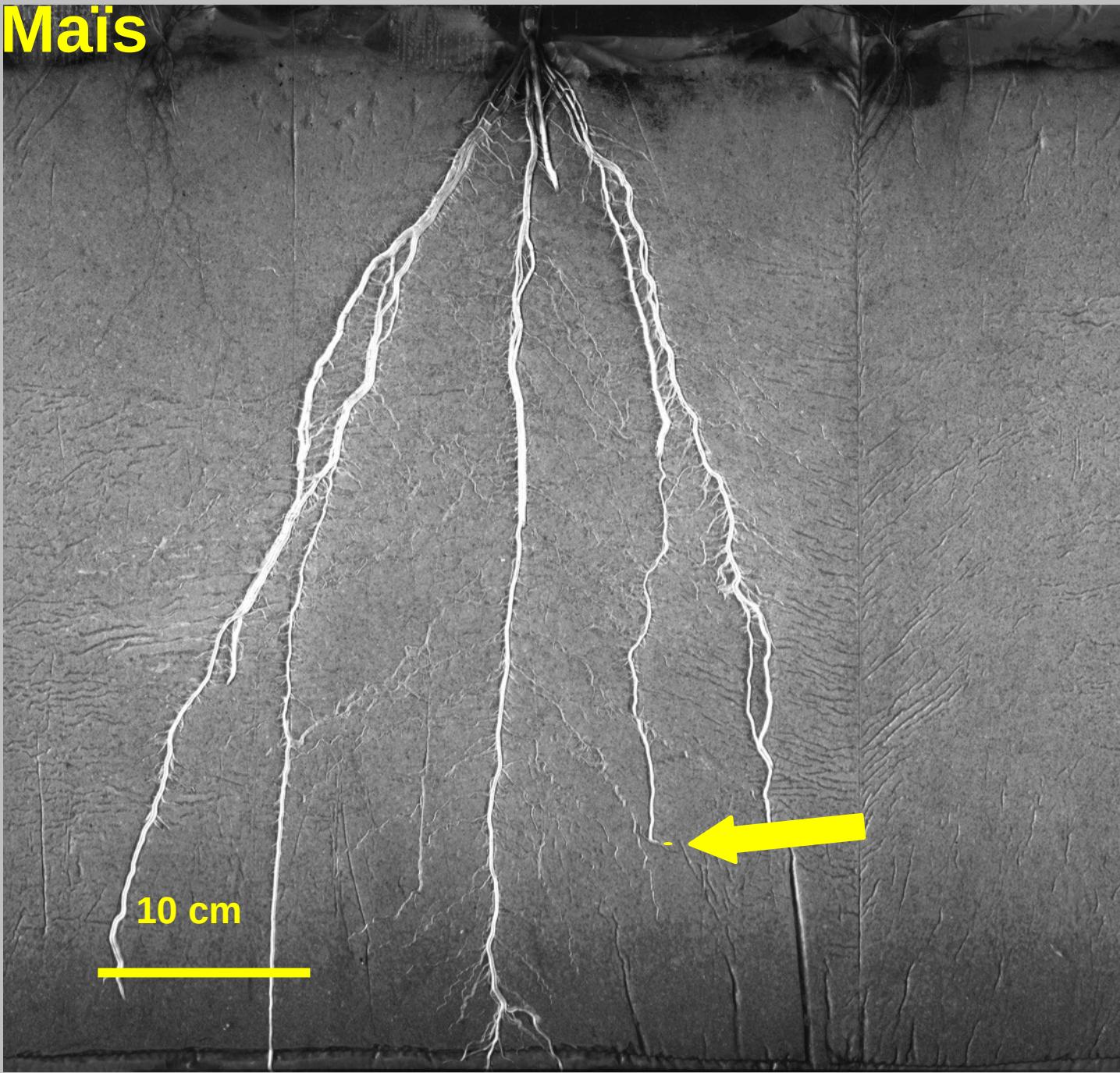


Maïs

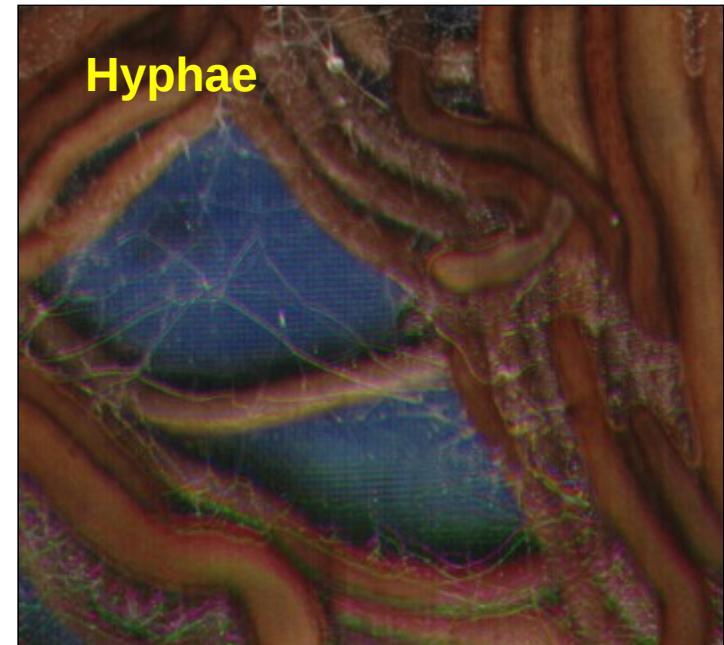
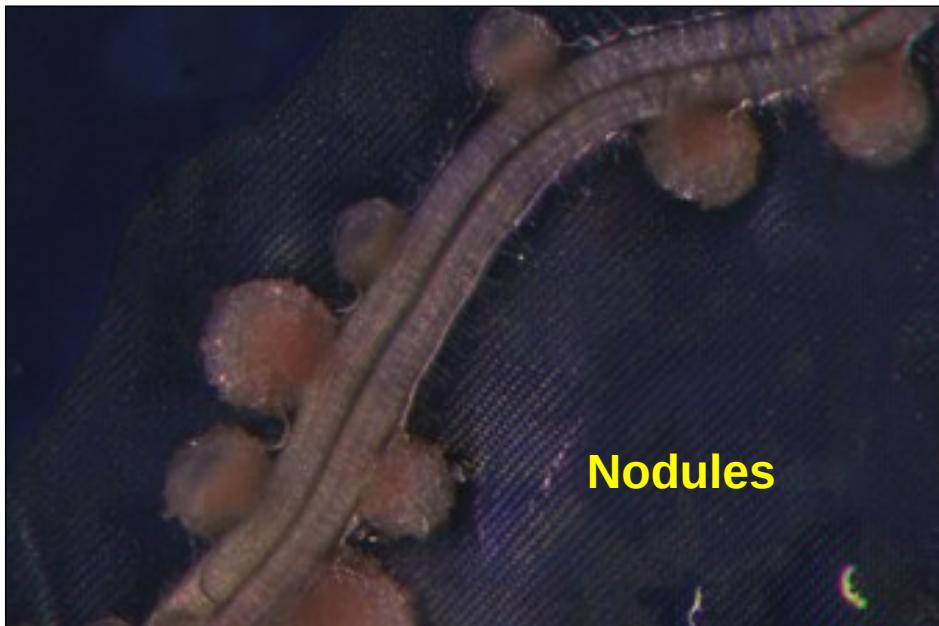
10 microns



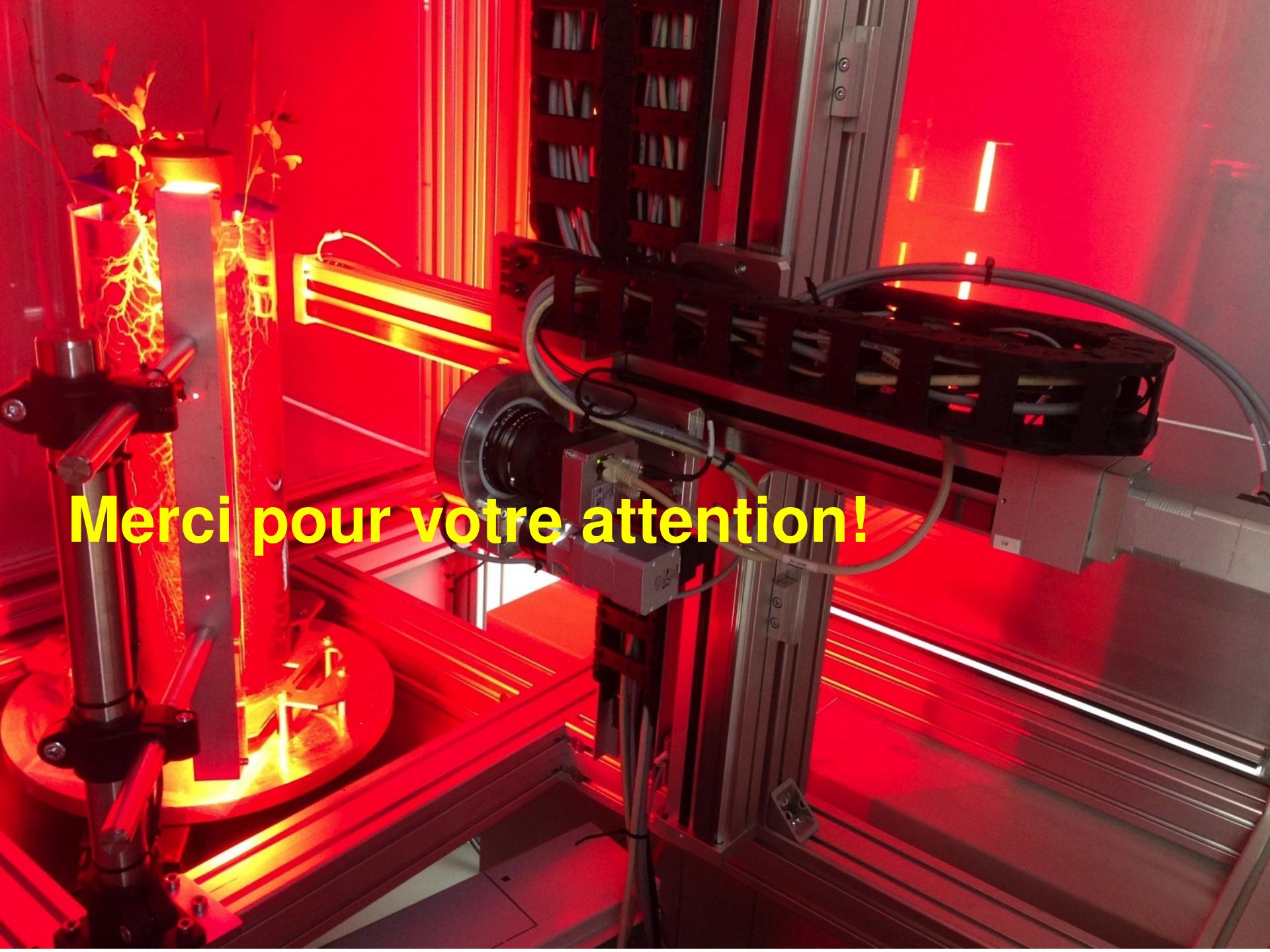
Mais



Root phenotyping: High resolution



Down to 7 microns

A photograph of a sophisticated scientific apparatus, possibly a confocal microscope or a similar imaging system. The machine features a complex array of mirrors, lenses, and optical components mounted on a sturdy metal frame. A bright red light source is positioned on the left, casting a strong glow across the entire setup. In the background, a bookshelf filled with books is visible, suggesting a research laboratory environment. A small potted plant sits on the left side of the machine, adding a touch of life to the otherwise technical scene.

Merci pour votre attention!