



HAL
open science

Kinetics of growth responses of a root encountering an obstacle

Marie-Béatrice Bogeat-Triboulot, Evelyne Kolb

► **To cite this version:**

Marie-Béatrice Bogeat-Triboulot, Evelyne Kolb. Kinetics of growth responses of a root encountering an obstacle. ALERT Geomaterials Workshop. The mechanics of root-soil systems: from microscopic to macroscopic approaches., ALERT, Oct 2019, Aussois, France. pp.1-10. hal-03139548

HAL Id: hal-03139548

<https://hal.inrae.fr/hal-03139548>

Submitted on 12 Feb 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Kinetics of growth responses of a root encountering an obstacle

Marie-Béatrice BOGEAT-TRIBOULOT, UMR Silva, INRA - Nancy

Evelyne KOLB, UMR PMMH

Root responses to axial mechanical resistance

Soil is heterogeneous ➤ interfaces, obstacles

Macroscopic responses

- growth reduction or stop
- or root bending and growth axis reorientation

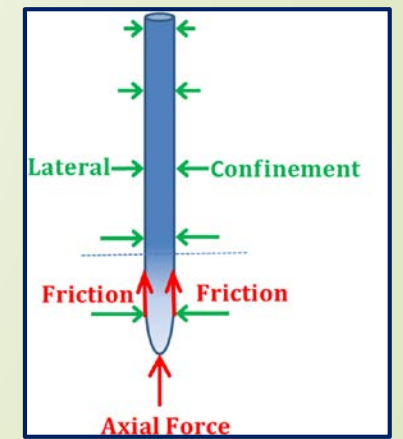
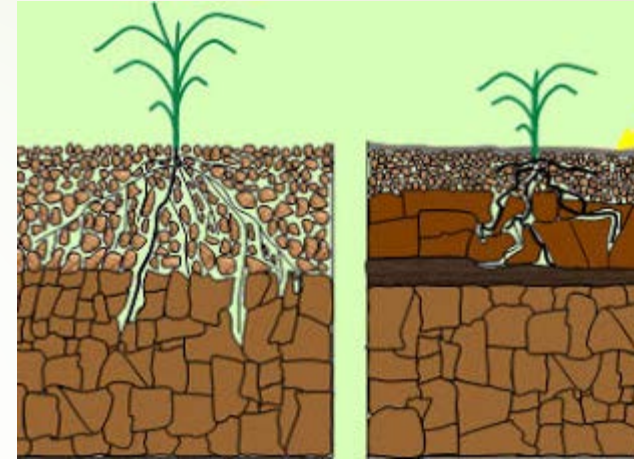


Cellular responses:

- ↗ osmotic pressure ➤ ↗ Turgor pressure ➤ counteracts soil pressure
- ↗ mucilage exudation ➤ reduces soil-root frictions ➤ favours penetration
- ↗ growth in diameter ➤ resistance to bucking ➤ favours penetration
- Cell wall properties , ...



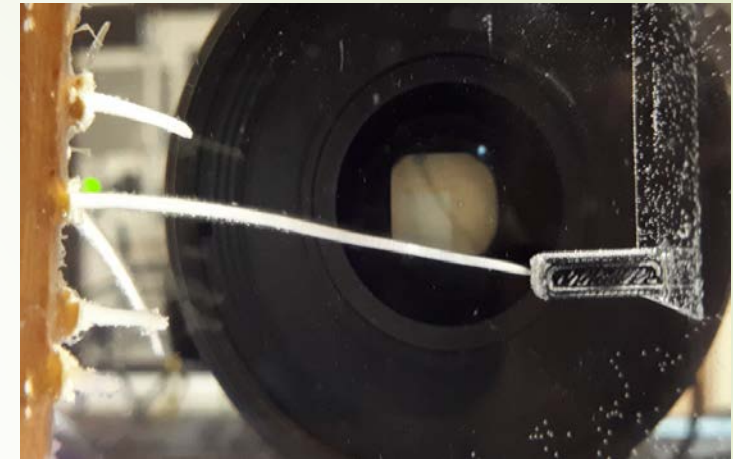
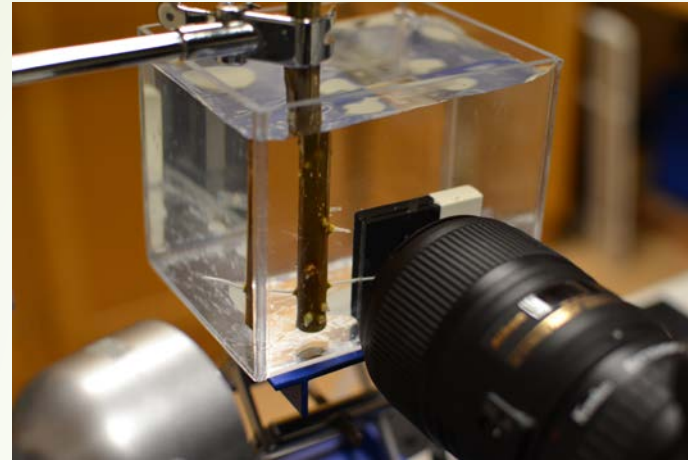
Sensing, signaling and molecular responses



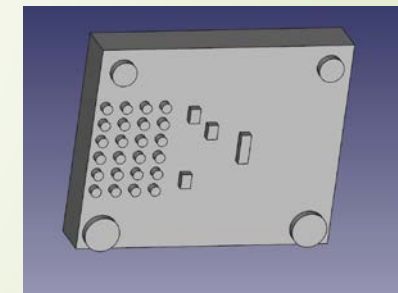
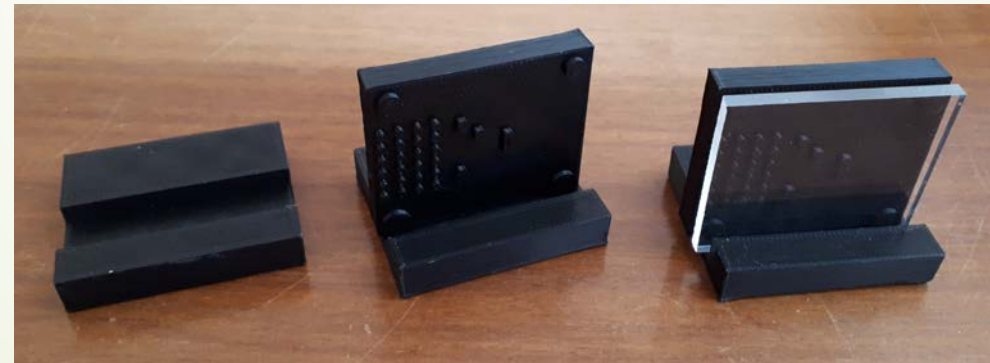
Questions

- ▶ How sensitive is root growth to an axial contact / pressure ?
 - ▶ What is the minimum force that reduces root growth rate?
 - ▶ How fast is axial growth rate reduced?

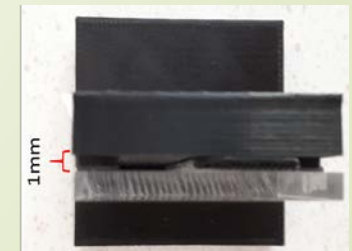
Adventitious root of poplar cutting as a model



- Hydroponics
- Plagiotropic
- Fast growing



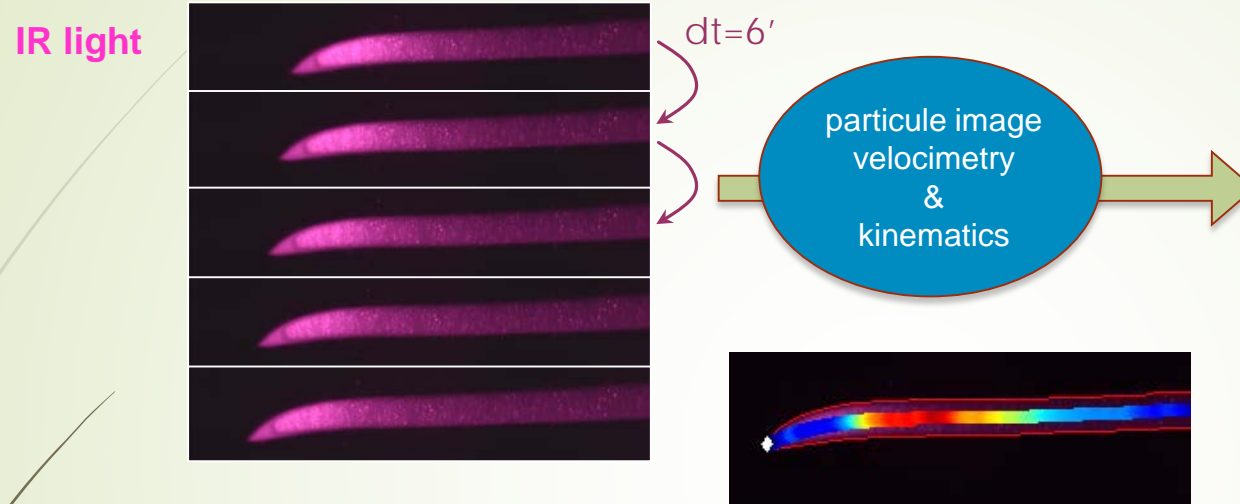
- Sandwich system to keep the root in the focal plan
- Back and obstacles from 3D printing
- Channels to brace the root



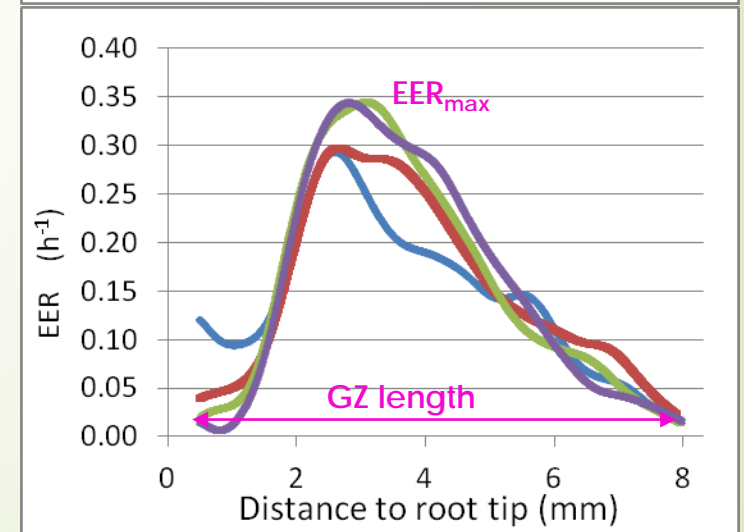
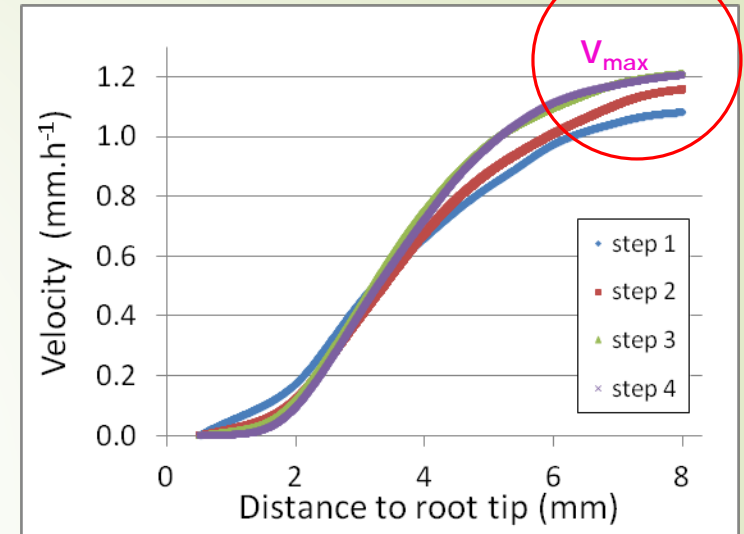
Spatial characterisation of growth with kinematics

5

- time-lapse photography : $dt=6'$
- high resolution : $2\mu\text{m} / \text{pixel}$



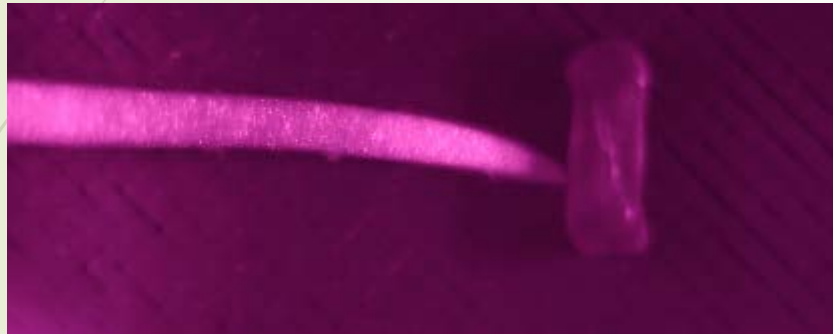
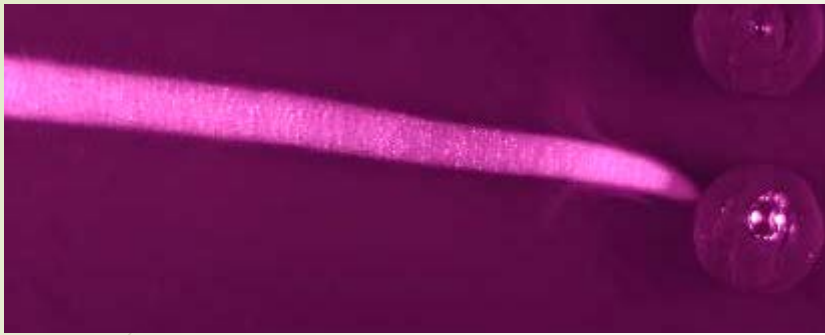
Kymorod, Bastien et al, 2016



GROWTH COMPONENTS

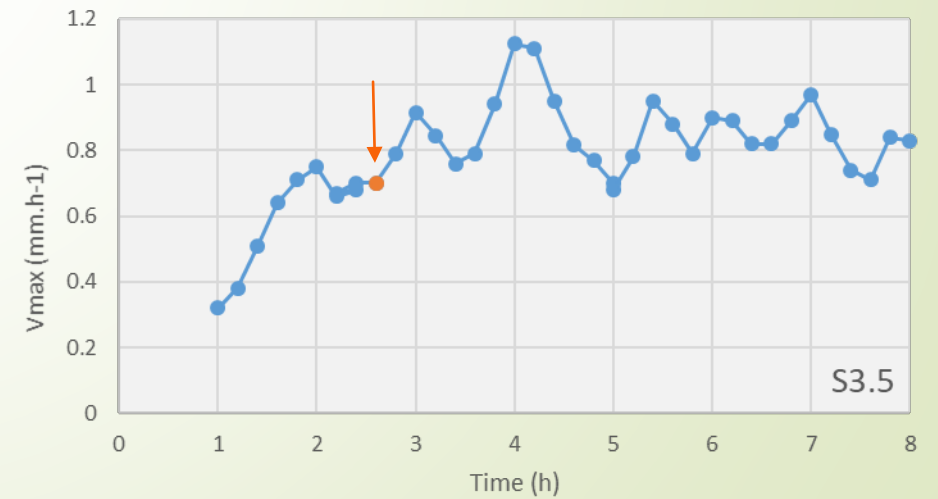
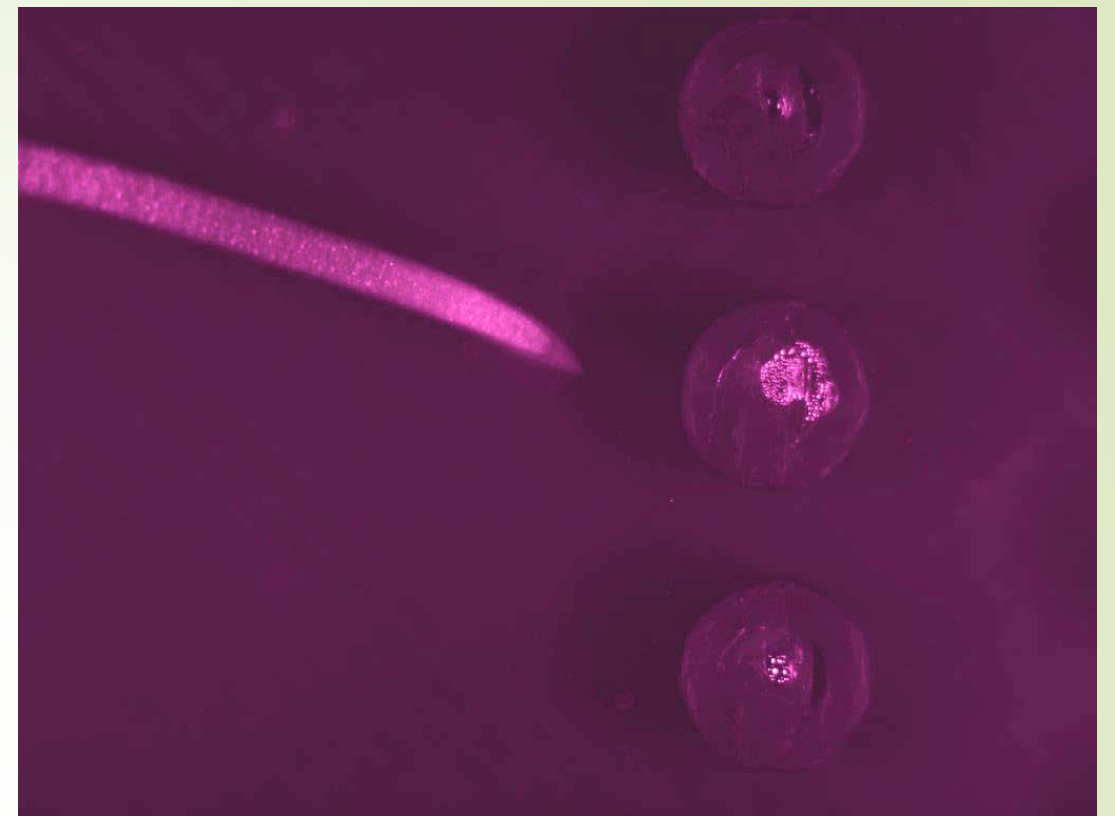
- Root growth rate = maximal Velocity (V_{max})
- Maximal Elemental Elongation Rate (EER_{max})
- Growth Zone length (GZ)

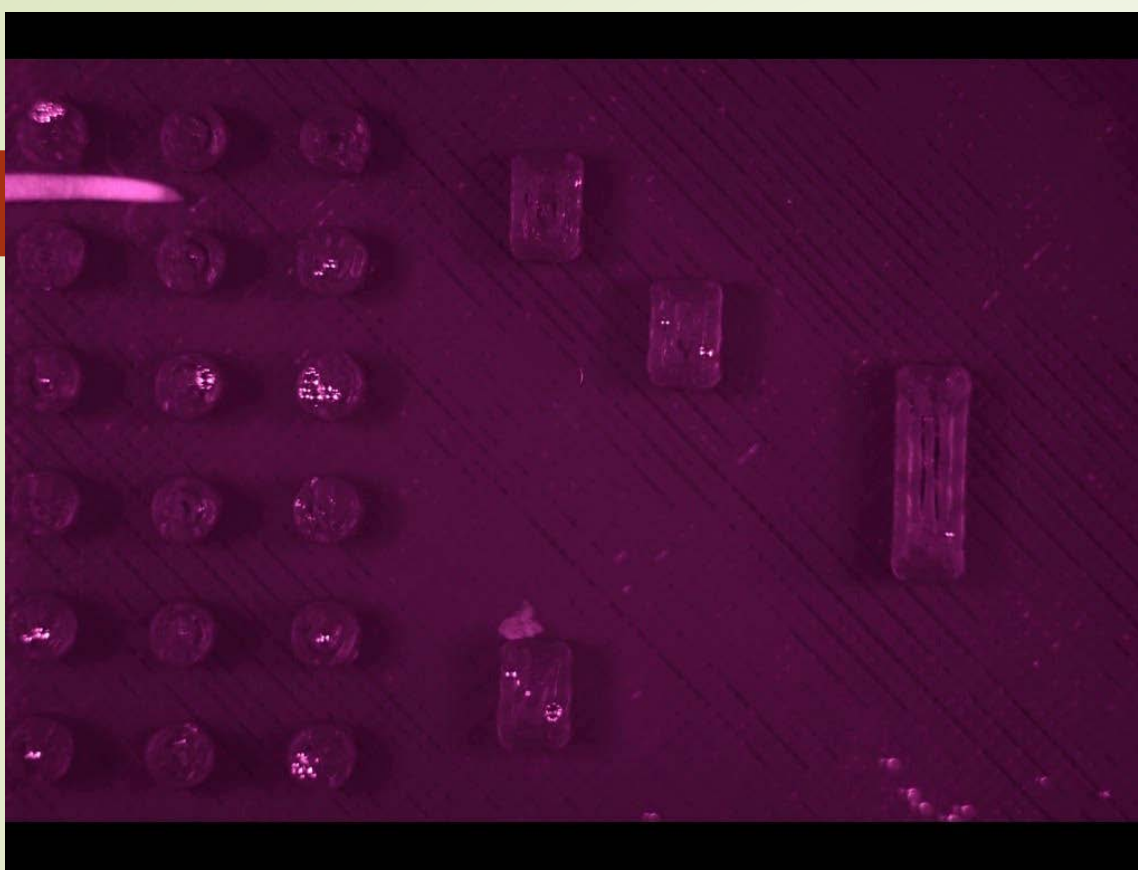
6



- The sandwich system keeps the root in the focal plan but root is free (not braced)
- Obstacle = 2mm diameter circle or 3 mm long flat

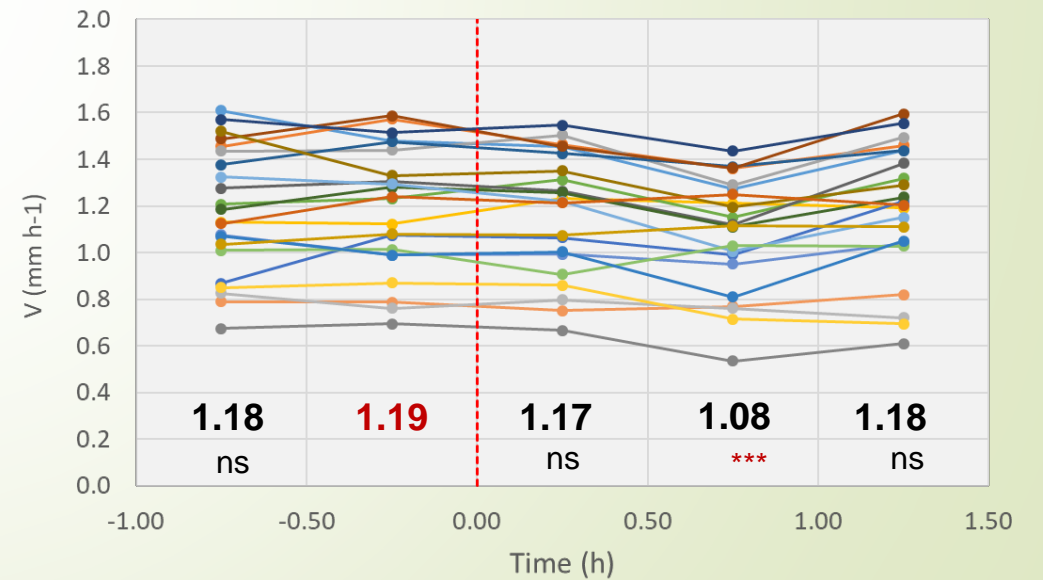
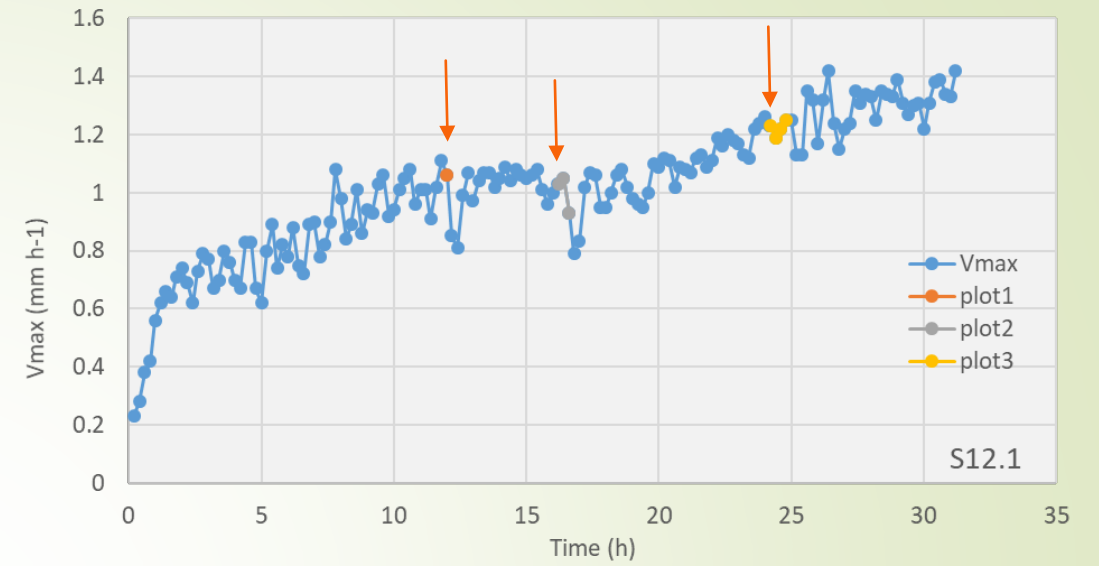
If the root is free, a short apical touch does not affect growth rate

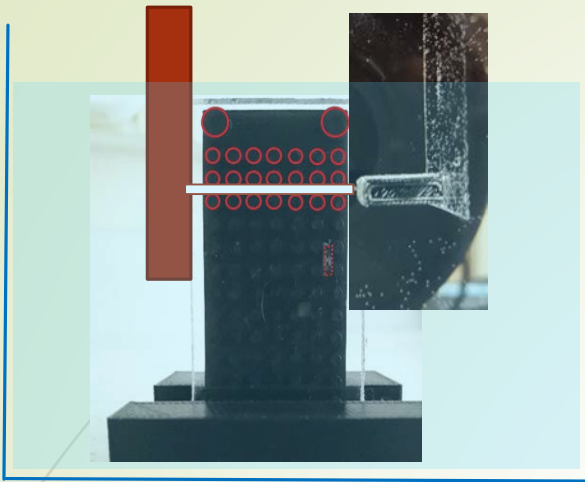




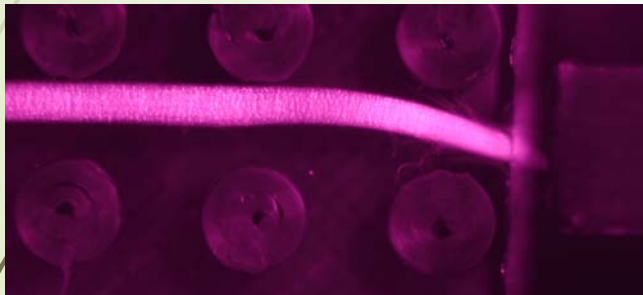
- The root is lightly braced in a channel
- Longer contact time

If the contact root-obstacle is a bit longer/stronger,
light and delayed reduction of root growth rate



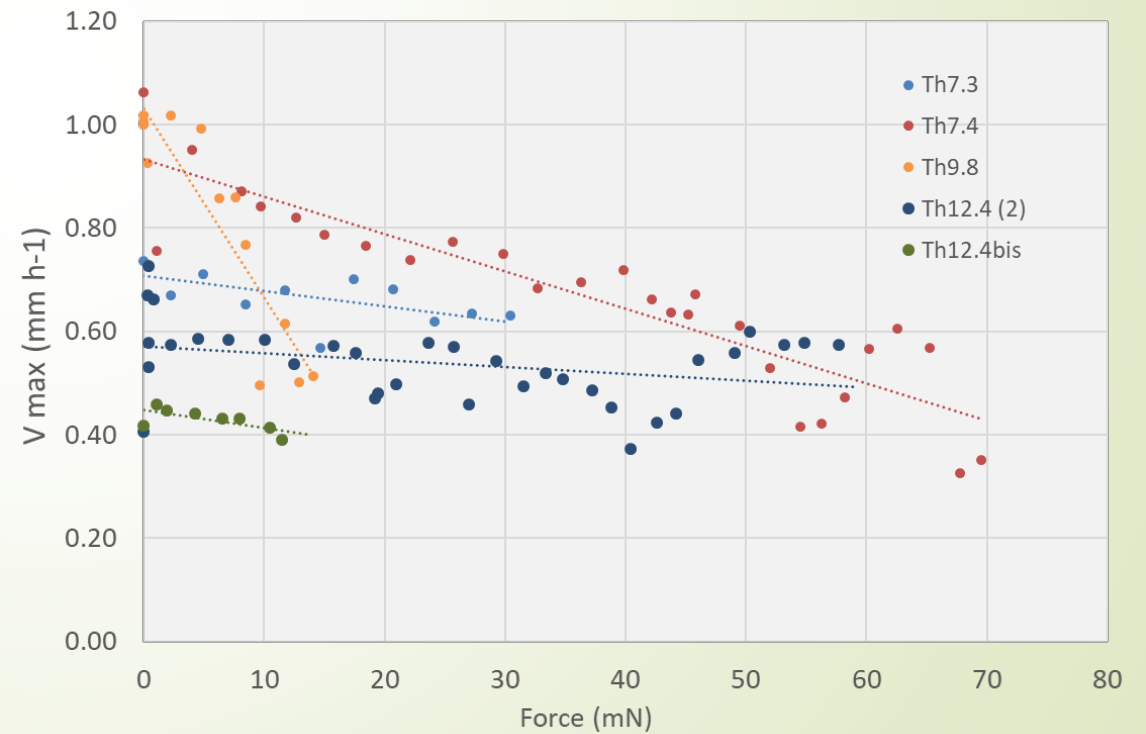
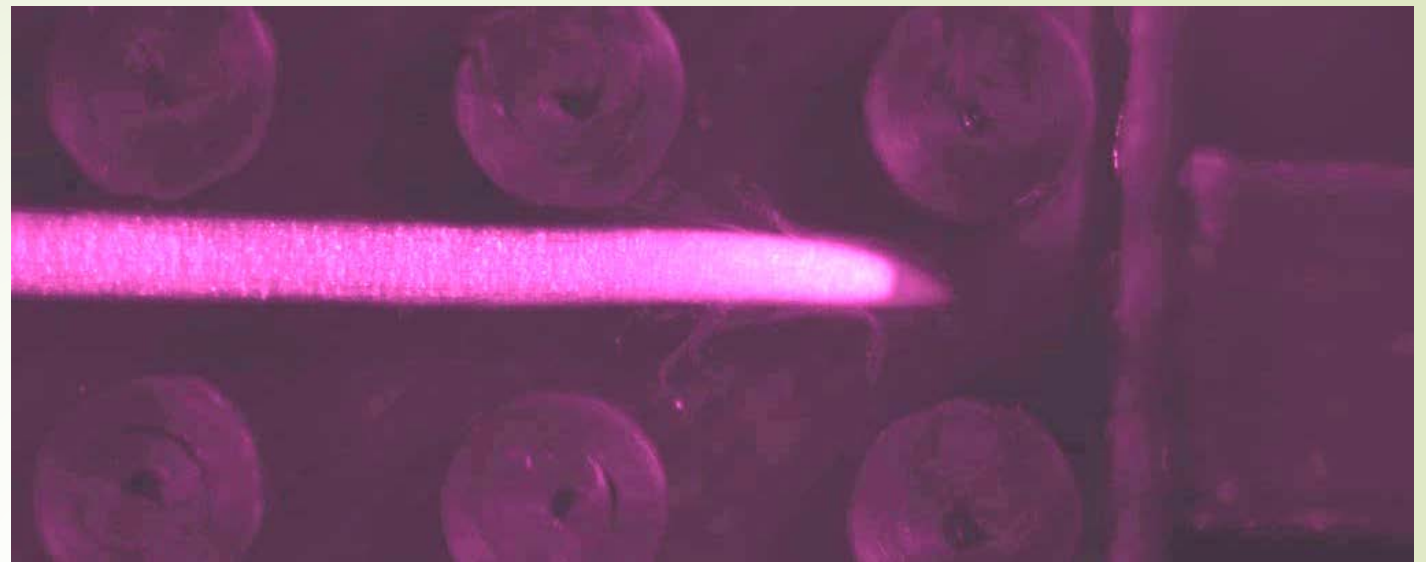


- The root is braced in a channel
- glass blade = obstacle + force sensor



Variability among roots (diameter?)


Root with high growth rate more sensitive than roots with low growth rate?





Future

- Brace root more tightly
 - Consider incidence angle
 - Consider root diameter
 - Use sensors with different stiffness : disentangle time and force

 - Other growth parameters : EERmax, turgor
- 

- Simon Berrar (Master 2)
- Antoine Cambien (Master 1)
- Thibaut Gaillot (CPP)

Thank you for your attention

