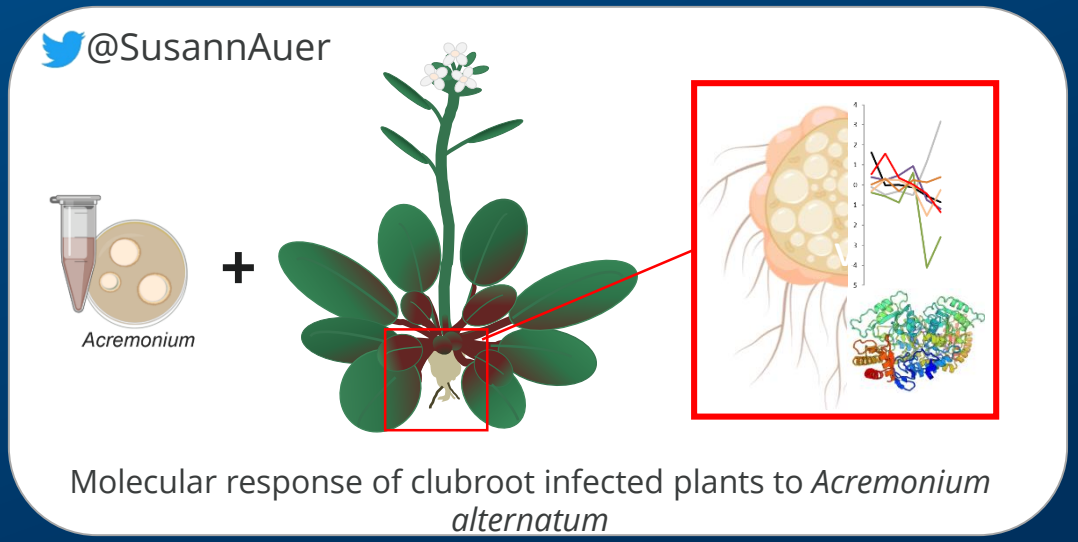
TECHNISCHE UNIVERSITÄT DRESDEN

DRESDEN concept

Dr. Susann Auer

Molecular reponse of clubroot infected plants to the endophytic fungus *Acremonium alternatum*



Molecular response of clubroot infected plants to *Acremonium alternatum*

Clubroot is distributed worldwide now

https://www.cabi.org/isc/datasheet/41865

Hard facts about clubroot disease

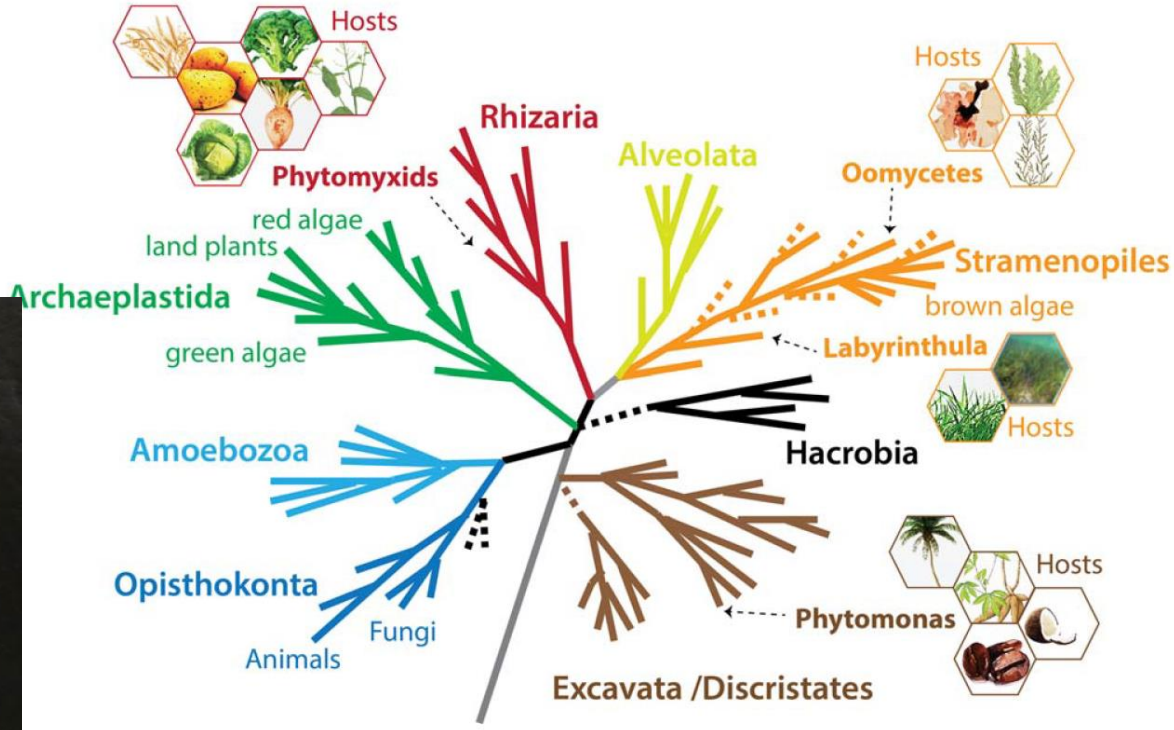
- one of the most damaging diseases in crucifer crops worldwide:
  - oilseed rape, broccoli, cauliflower, Chinese cabbage, turnip, …

- first described in 19th century - still poorly understood
- estimated annual yield loss in EU: 700 kha oilseed rape = 630 mio €
- new fields get infested every year, causalities are rising
  - Canada: from 12 infected fields to 3000 in 15 years!

The top 3 things to know about clubroot

1. Clubroot is caused by a biotrophic protist: *Plasmodiophora brassicae*

- eukaryotic protist
- Phytomyxid, Rhizaria
- closer relative: *Spongospora subterranea*

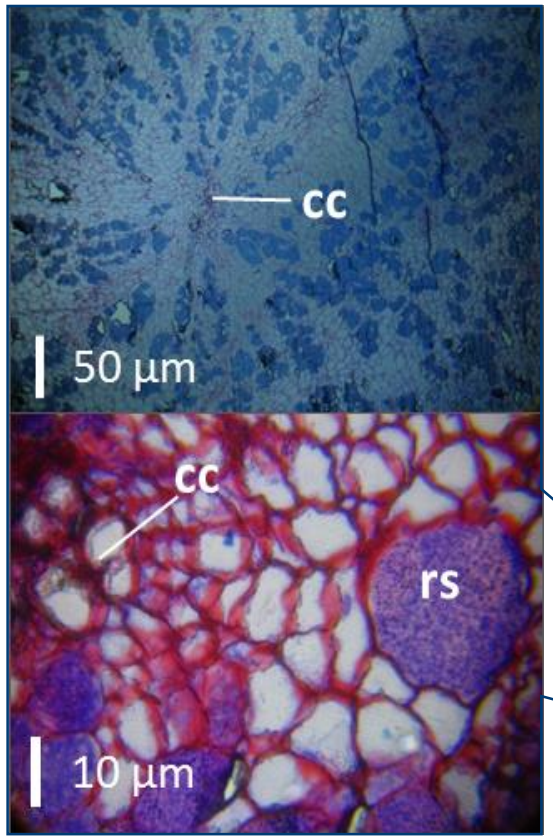


S. Baldauf / Schwelm et al. 2017 (Mol Plant Path)

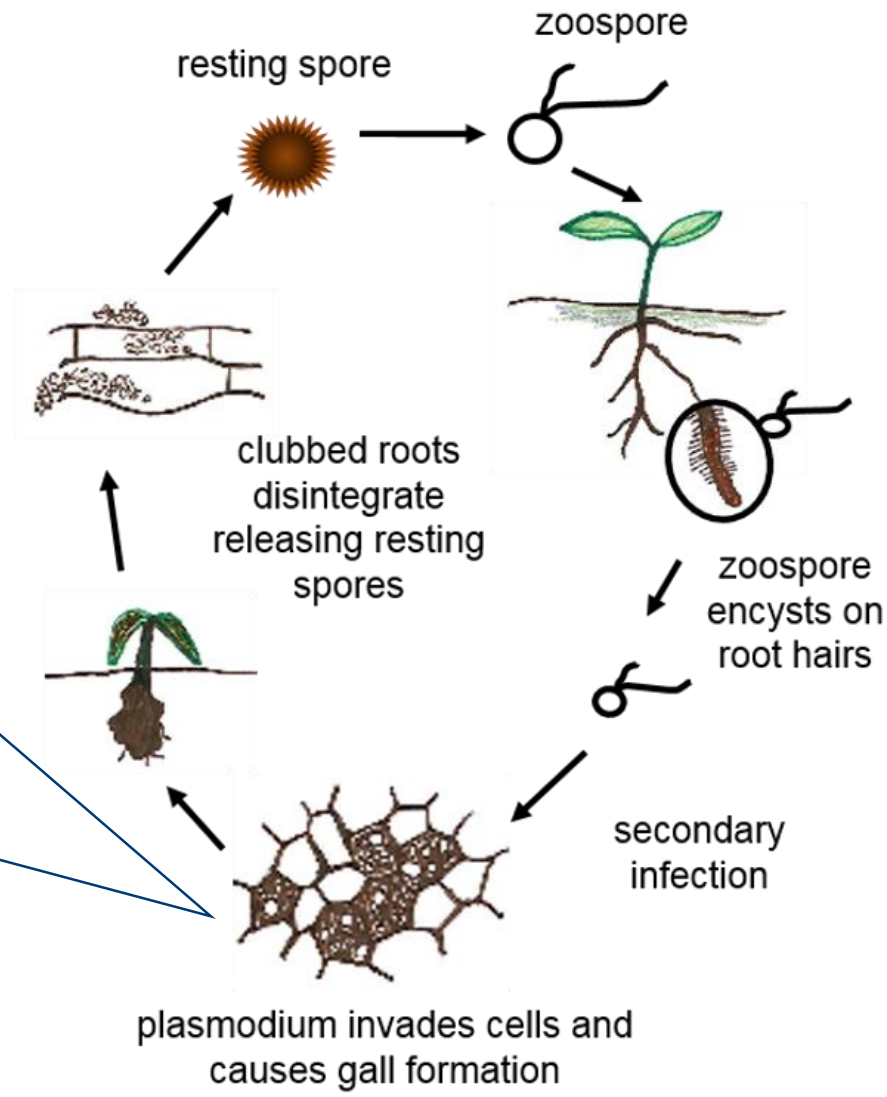
2. Complex biphasic life cycle

- durable resting spores stay infective in soils for up to 20 years

- contaminated soil is not suitable for crucifer crops for consecutive years



Rapeseed roots with clubroot; cc: central cyclinder, rs: resting spore



Auer and Ludwig-Müller (2015): J. Endocyt. Cell Res.

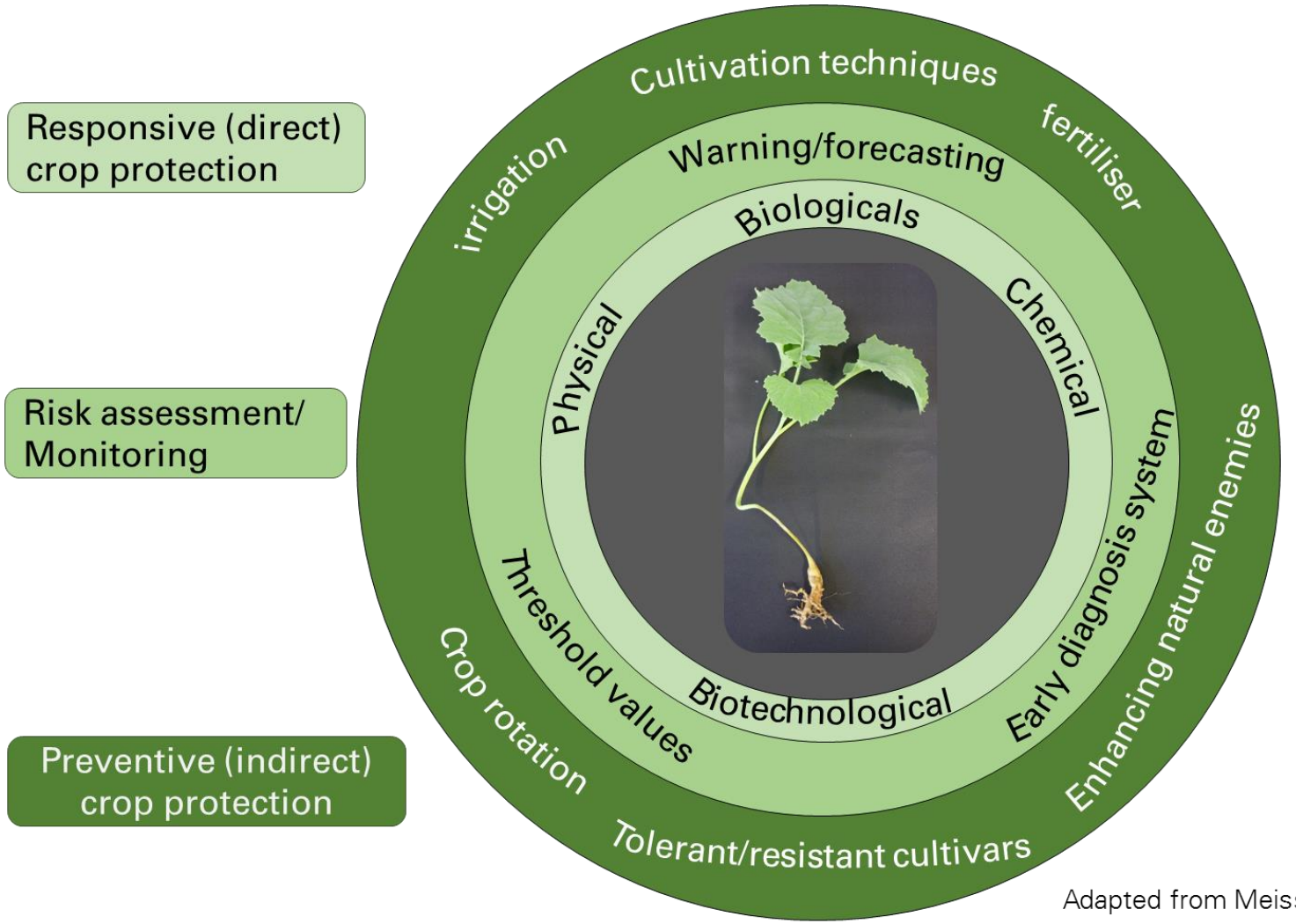
3. The clubroot pathogen is soilborne

- infested soil moves from field to field with machinery, soil on boots, wind drift, water….
  - machines like field tractors can have 150 kg infested soil stuck on them… but cleaning is tedious and costly
- control measures:
  - liming, fumigation of soils, fungicides, crop rotation

  → not practical to use/not sustainable
- inconsistent chemical control

→ integrated pest management practises most promising strategy right now

Integrated pest management (IPM) tools



Adapted from Meissle et al. 2011

@the Lab: working with the protist *Plasmodiophora brassicae*

- cannot be cultivated outside host plant
- full developmental cycle 4 – 12 weeks
- Arabidopsis: 4 weeks, *Brassica*: 8 - 12

Acremonium species are simple build fungi

- simply structured filamentous anamorphic fungi that are ubiquitous
- very diverse, inhabiting very different habitats
- colonizers of diverse organisms: animals (insects, mammals), plants, fungi
- producers of specialized compounds such as Acremines, Acremolactones
- *Acremonium alternatum*: Hypocreales, Ascomycetes

available online at www.studiesinmycology.org
doi:10.3114/sim.2011.68.06

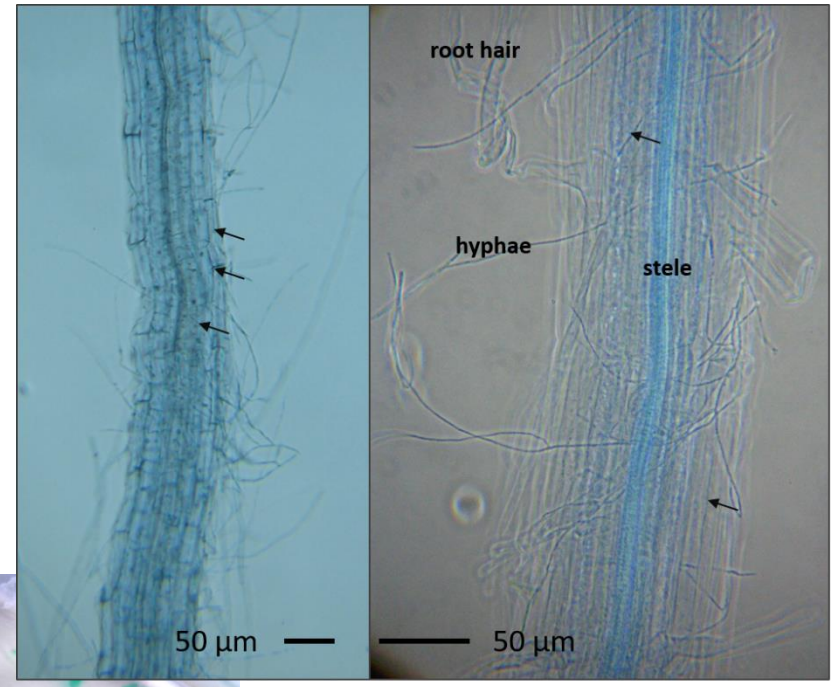
STUDIES IN MYCOLOGY 68: 139–162. 2011.

Acremonium* phylogenetic overview and revision of *Gliomastix*, *Sarocladium*, and *Trichothecium

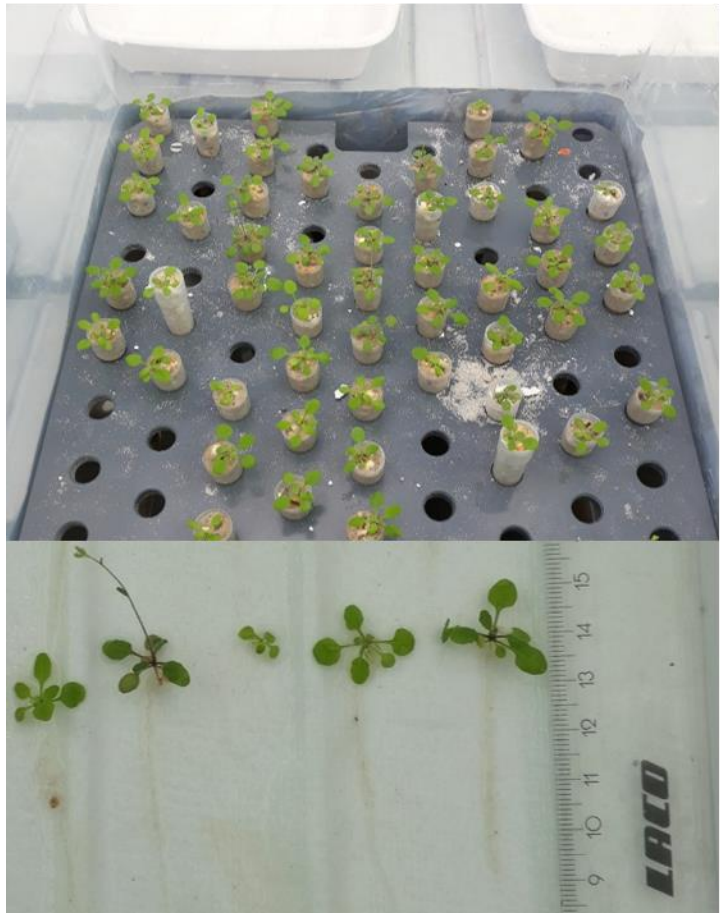
R.C. Summerbell[1,2*], C. Gueidan[3,4], H-J. Schroers[3,5], G.S. de Hoog[3], M. Starink[3], Y. Arocha Rosete[1], J. Guarro[6] and J.A. Scott[1,2]

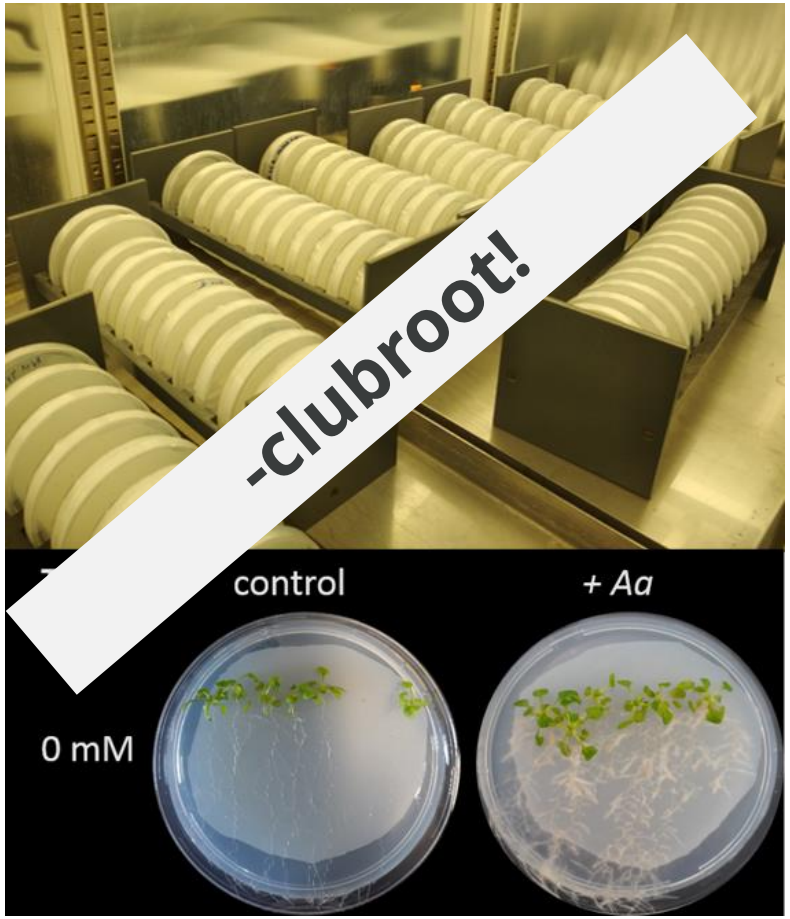
Acremonium alternatum has been used as BCA successfully

- applied as biological control agent (BCA) in Brazil
- reduced infection of powdery mildew in tomatoes (*L. taurica*) and melons (*S. fusca)*
- reduced feeding of diamondback moth larvae in cabbage and increased phytosterol content
- colonizes rapidly: rapeseed, Chinese cabbage, maize, wheat, tomato, Arabidopsis, …



Experimental setup: soil, hydroponic and petri dish cultivation

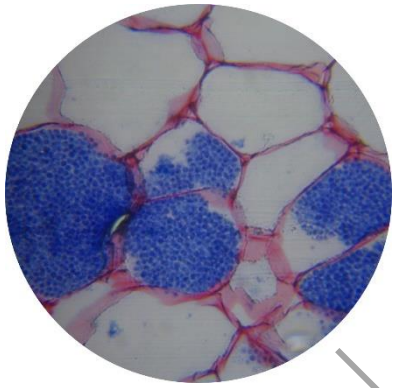


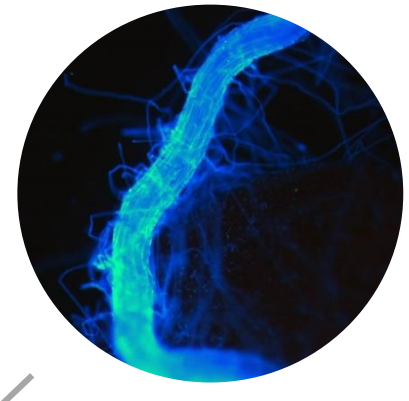


Pathosystem with Arabidopsis

Plasmodiophora brassicae (Pb) *Acremonium alternatum (Aa)*

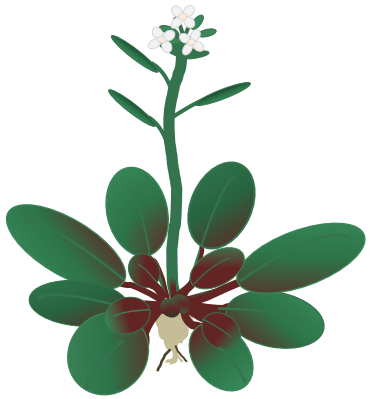
resting spores in roots

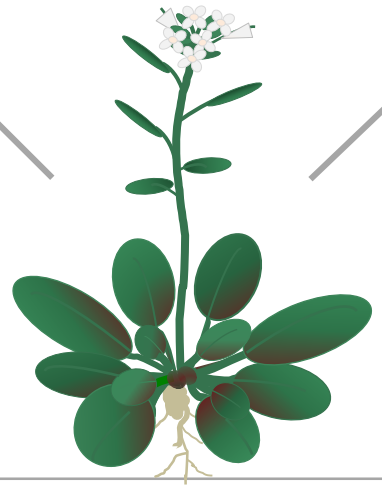




roots with hyphae

P. brassicae
- is a protist (Rhizaria kingdom)
- is persistent in the soil up to 20 years!





A. alternatum
- is a fungus (Ascomycete)
- reduces *Pb* disease severity by 20 - 30%

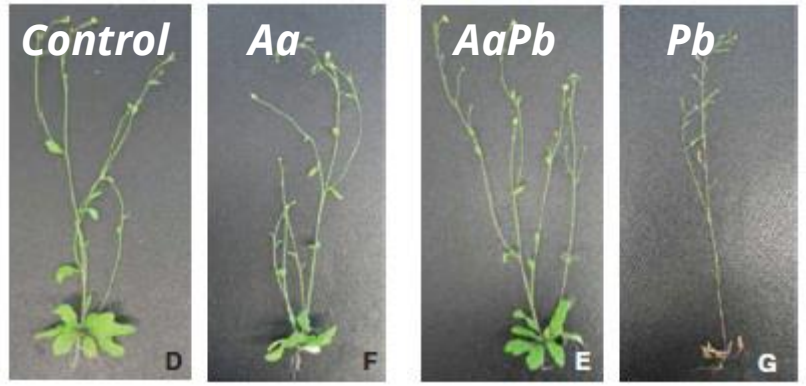
A. alternatum suppresses clubroot disease

Plant Pathology (2010) 59, 100–111 Doi: 10.1111/j.1365-3059.2009.02199.x

Suppression of clubroot (*Plasmodiophora brassicae*) development in *Arabidopsis thaliana* by the endophytic fungus *Acremonium alternatum*

D. Jäschke[a], D. Dugassa-Gobena[b], P. Karlovsky[b], S. Vidal[b] and J. Ludwig-Müller[a]*

[a]*Department of Biology, Technische Universität Dresden, Zellescher Weg 20b, 01062 Dresden; and* [b]*Georg-August-Universität Göttingen, Department of Crop Sciences, Grisebachstrasse 6, 37077 Göttingen, Germany*



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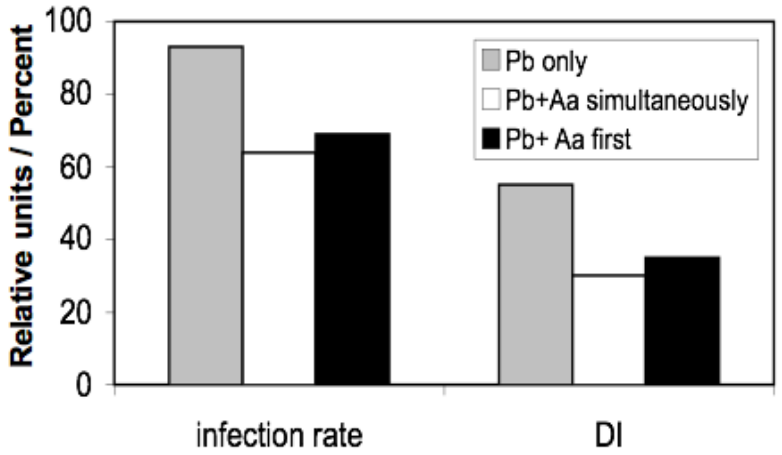
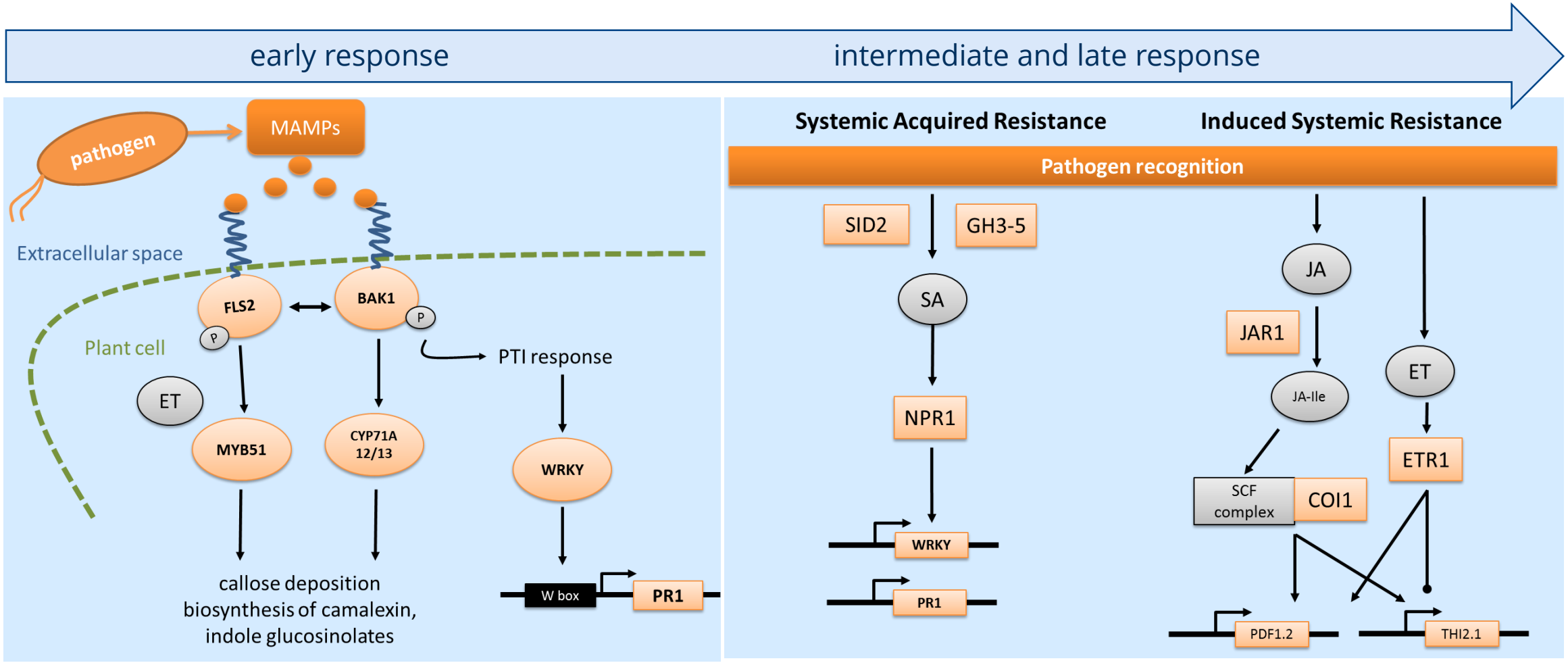
AN ENDOPHYTIC FUNGUS INDUCES TOLERANCE AGAINST THE CLUBROOT PATHOGEN *PLASMODIOPHORA BRASSICAE* IN *ARABIDOPSIS THALIANA* AND *BRASSICA RAPA* ROOTS

Authors
T.T. Doan, D. Jäschke, J. Ludwig-Müller



Gene regulation in plant cells after pathogen infection

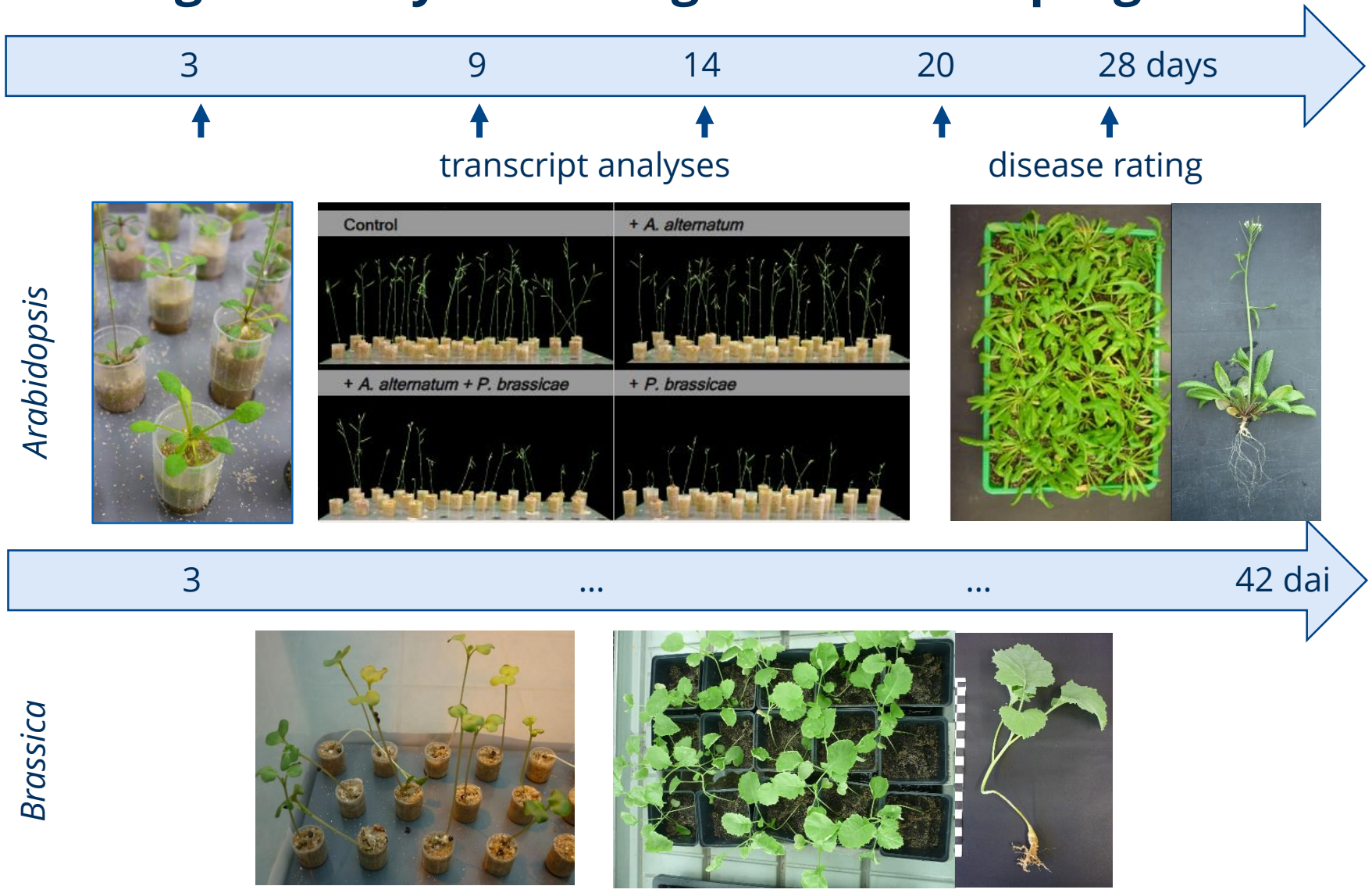


MAMPs - microbial associated molecular patterns, PTI – pathogen triggered immunity

Resistance genes

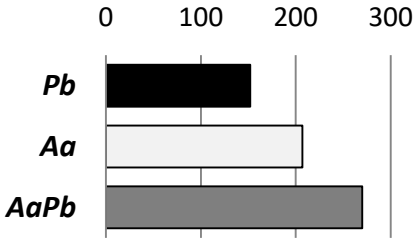
Hormones

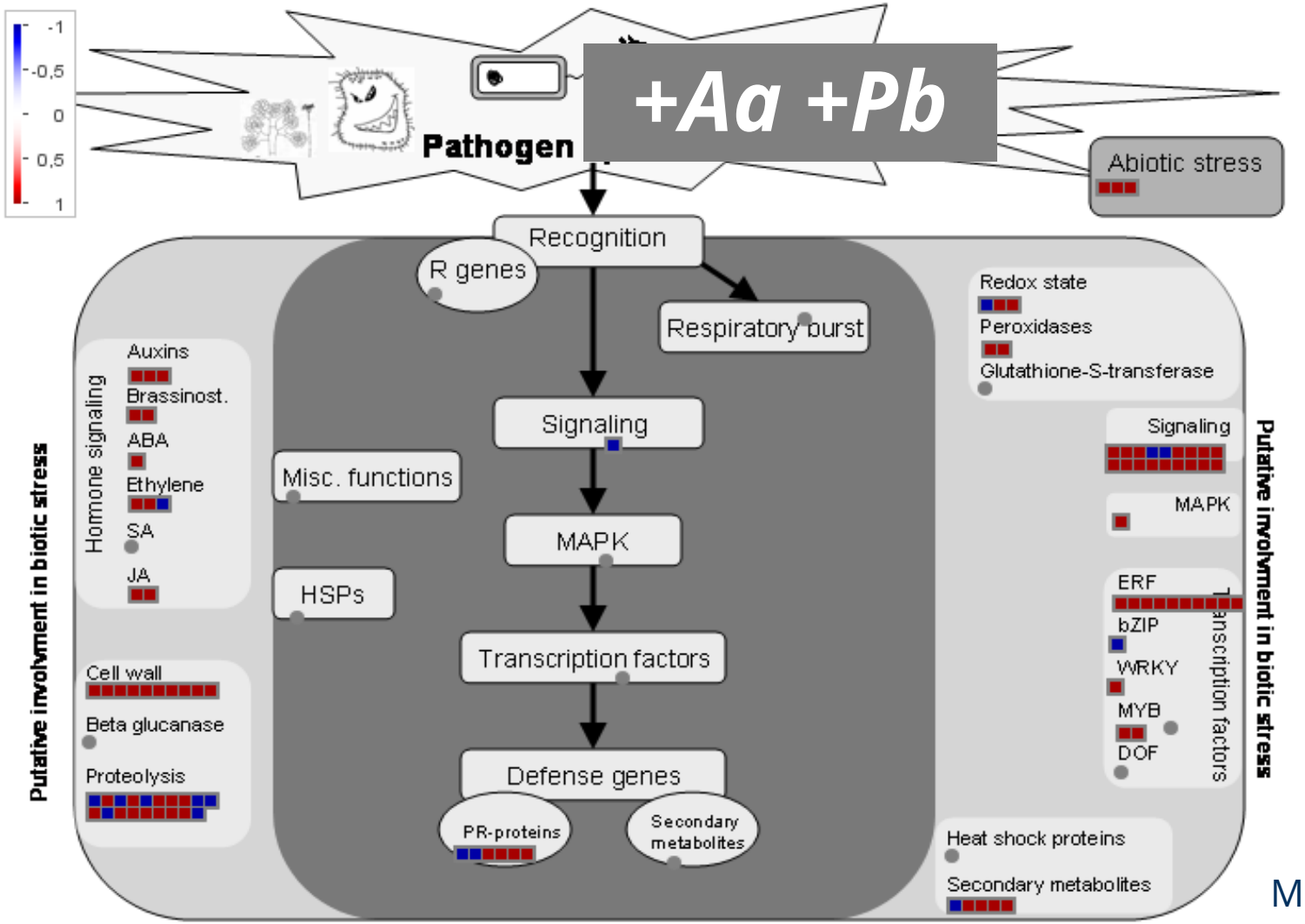
Phytopathological analyses throughout disease progression



Early response in Arabidopsis roots

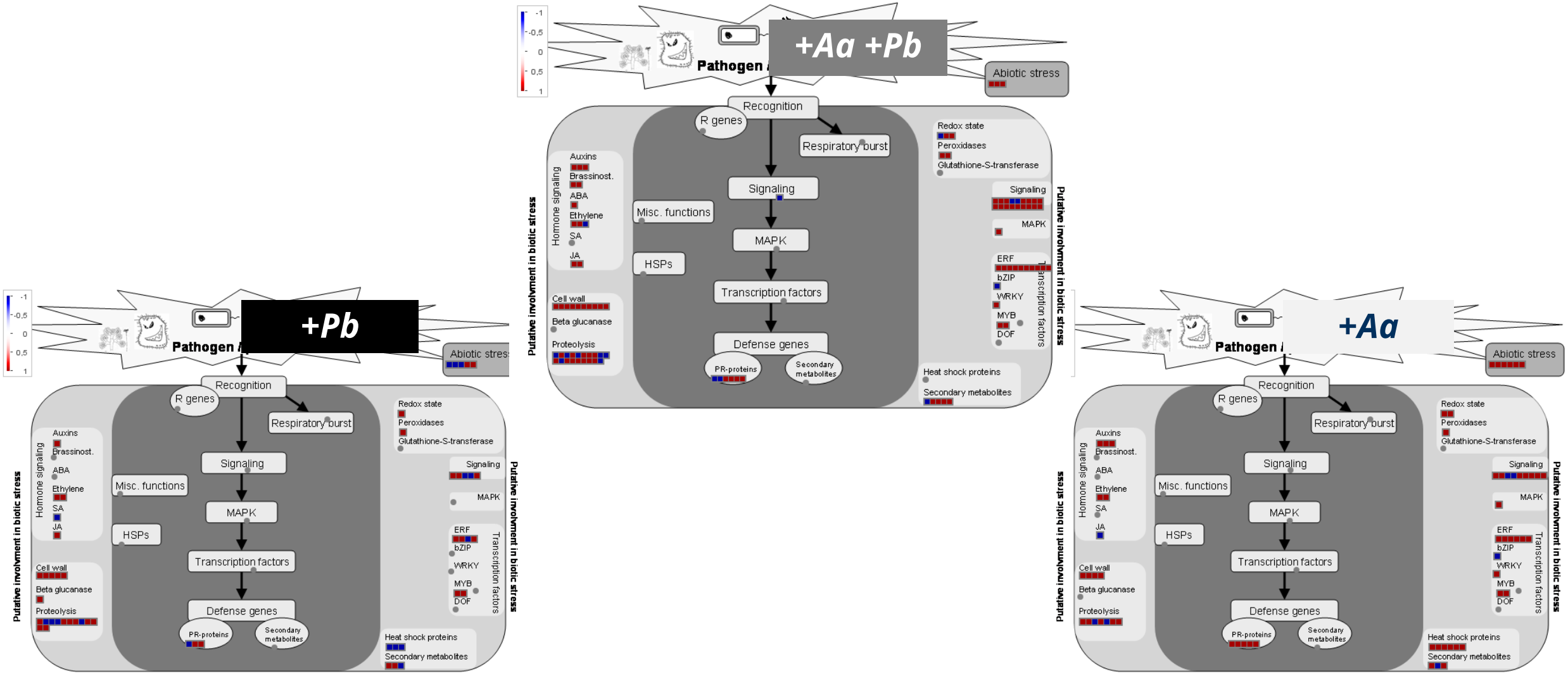
Differentially expressed genes



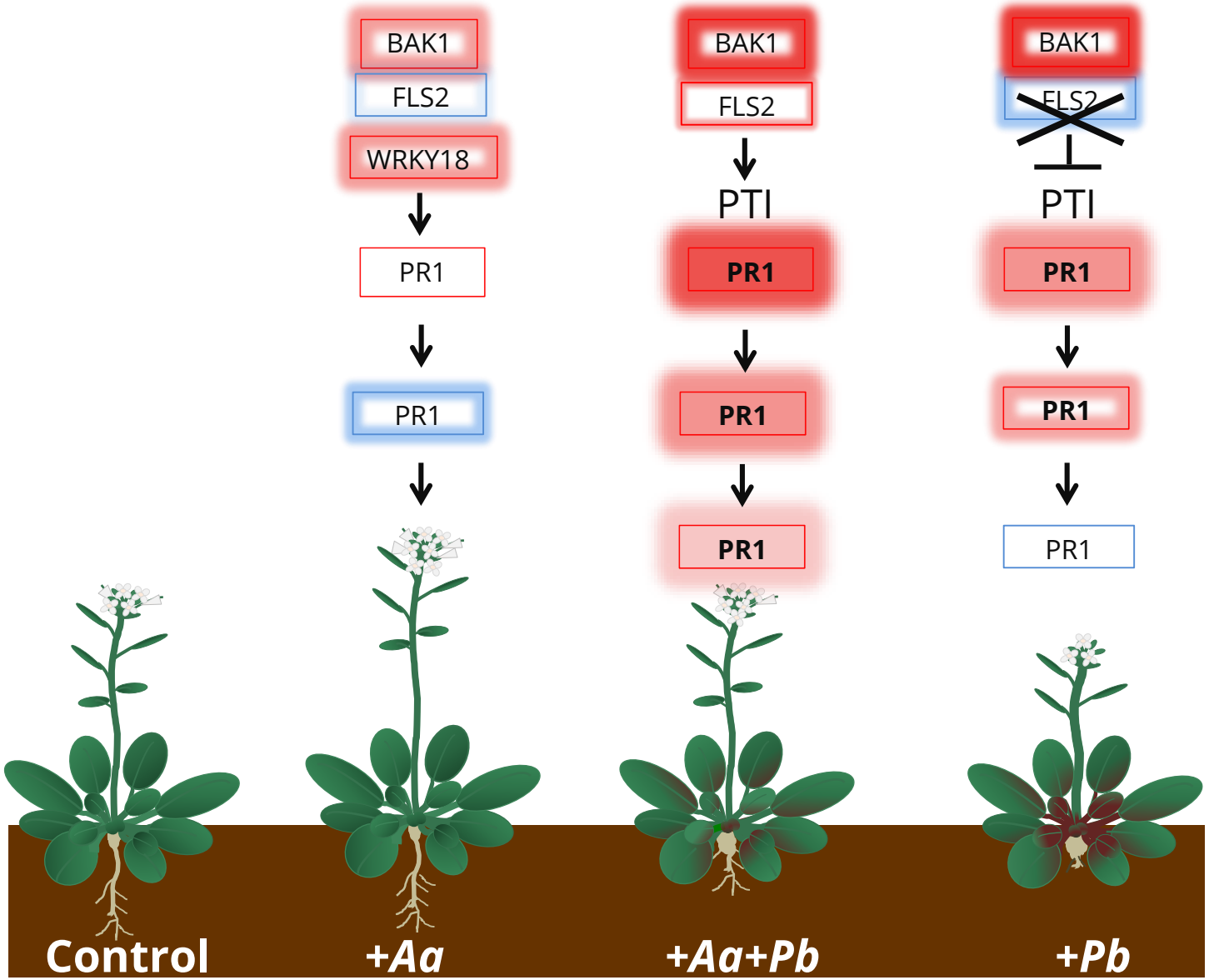


Mapman

Early response in Arabidopsis roots

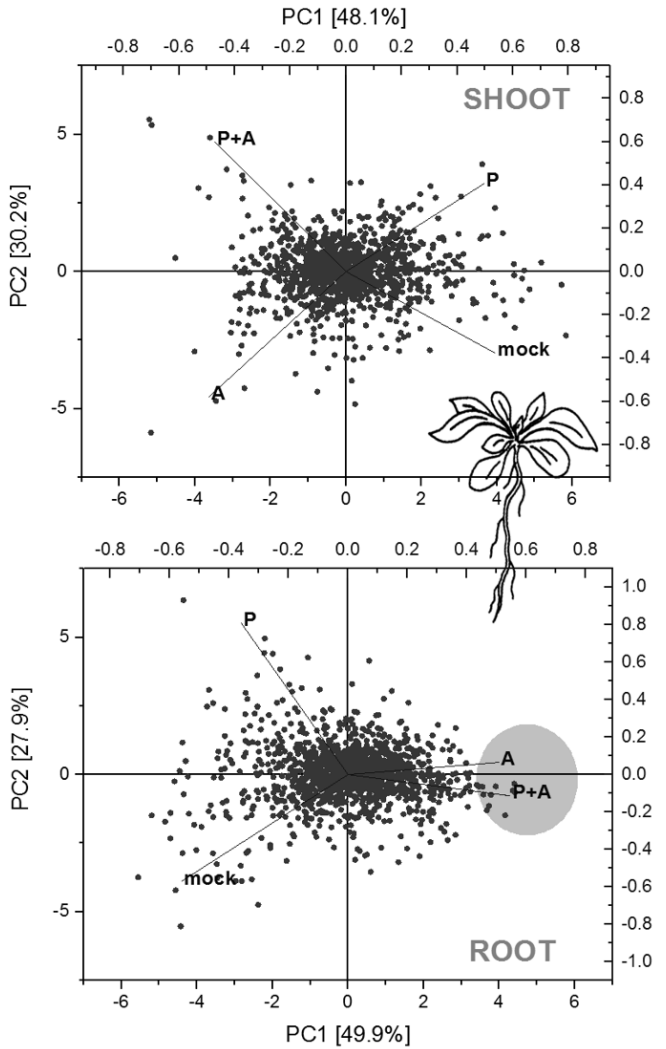


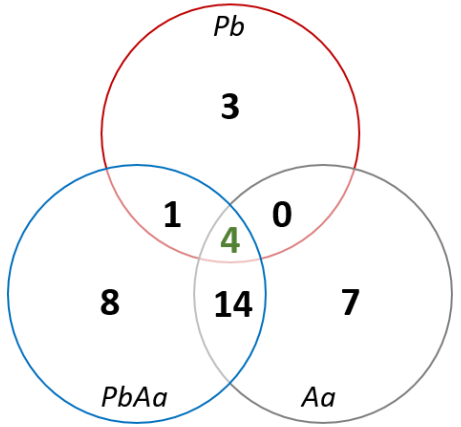
Early and intermediate response in Arabidopsis roots

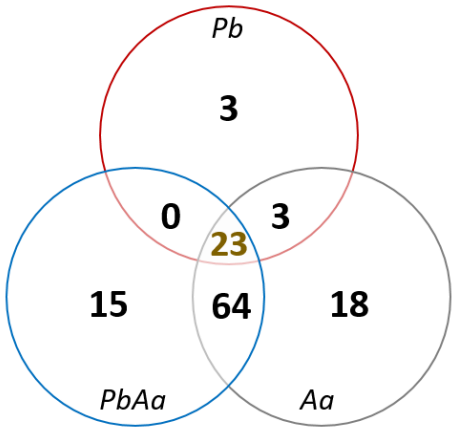


Intermediate responses in Arabidopsis

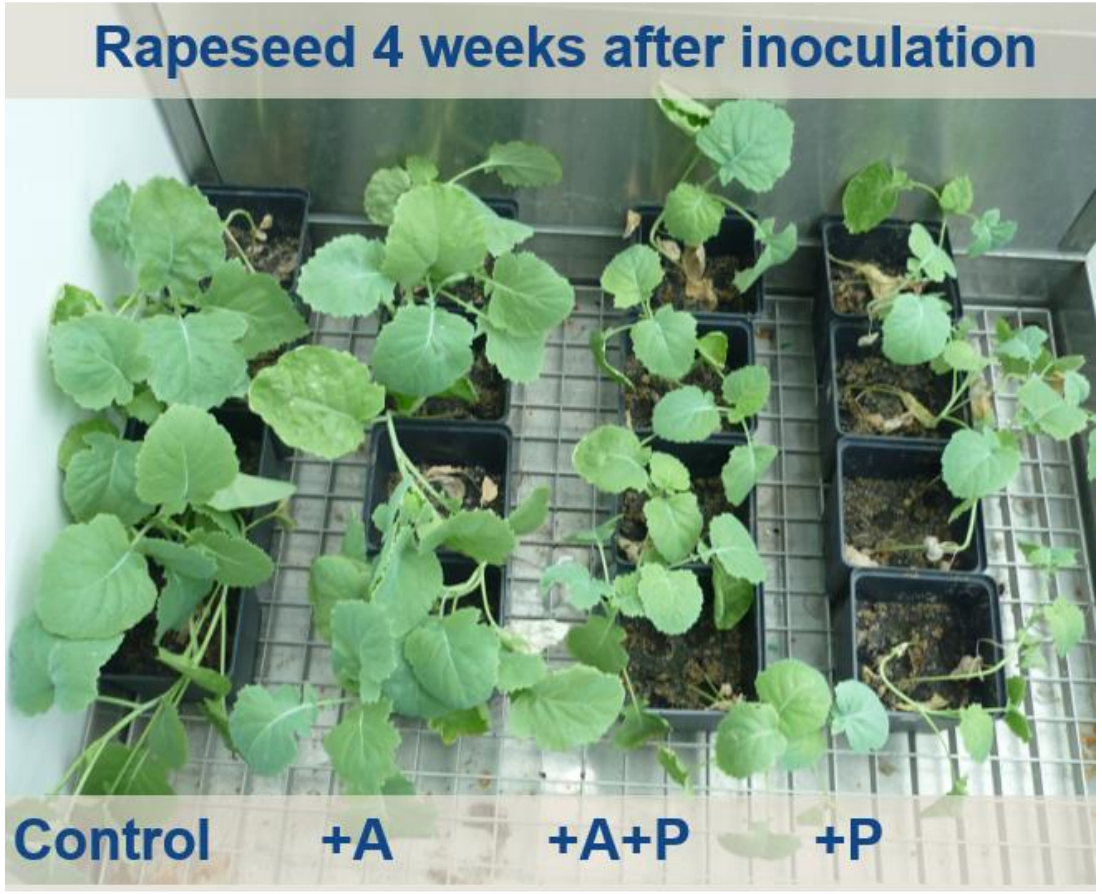
- 150 proteins identified in shoots and roots that were differentially abundant/enriched
- better coverage in roots (lacks RubisCO)
- Functional analysis: enrichment of plant proteins involved in in secondary metabolite and hormone pathways
- Interesting candidates:
  - *Pb*-treated: (root) — root endochitinase ↑
  - *PbAa*-treated: (shoot) — shoot CHLI1 (CK responsive) ↓
  - *Aa*-treated: (root) — GRR1-like (auxin binding and defense response) ↑; AT1G64520 (CK responsive) ↑

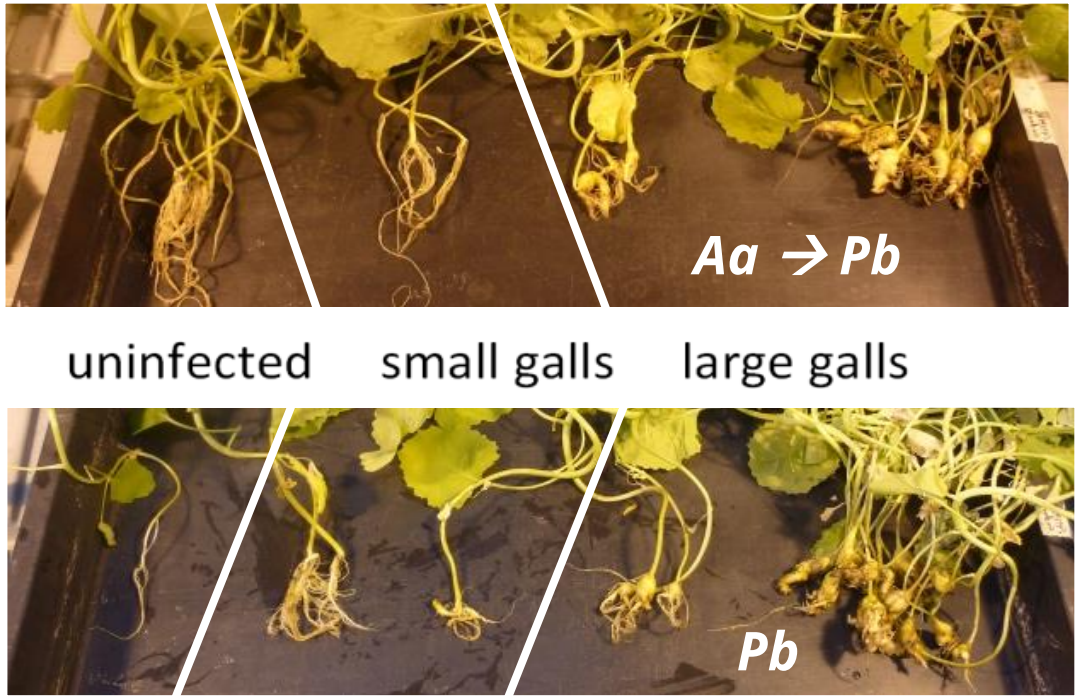






Clubroot suppression in *Brassica napus*





Future paths to go with colleagues from collaborations…

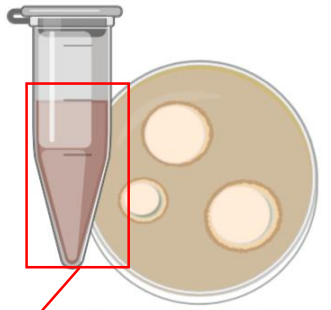
Arabidopsis

Proteomics

Metabolomics

Lipidomics

Hormone related transcripts

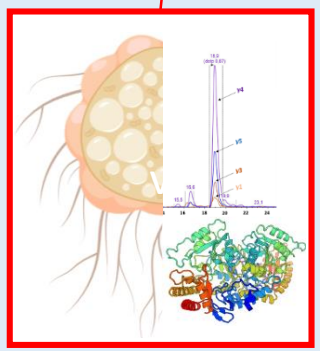


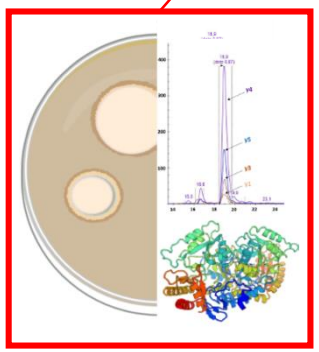
Microbial pathogens

Proteomics

Metabolomics

Pb transcripts





Proteomics

Metabolomics

Thank you for tuning in! Please stay safe and healthy.

Questions? Collaboration ideas? Contact me!

Susann.Auer@tu-dresden.de, @SusannAuer

The Chicken

Runner

Caterpillar

All picture show OSR galls with Pb, 6 weeks old.