Mechanistic Analysis of Quantitative Disease Resistance In Brassica by Associative Transcriptomics (MAQBAT)

Dr Christopher Ridout

John Innes Centre

ERA-CAPS

ERA-NET for Coordinating Action in Plant Sciences

MAQBAT Consortium

John Innes Centre — **Dr. Chris Ridout, Dr Henk-jan Schoonbeek**

University of Hertfordshire — **Prof. Bruce Fitt**

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN — **Prof. Andreas von Tiedemann**

FACULTY OF BIOLOGY AND ENVIRONMENTAL PROTECTION; University of LODZ — **Prof. Andrzej Kononowicz, Dr Violetta Macioszek**

WAGENINGEN UNIVERSITY WAGENINGEN UR — **Prof. Bart Thomma**

Prof. Barbara Halkier

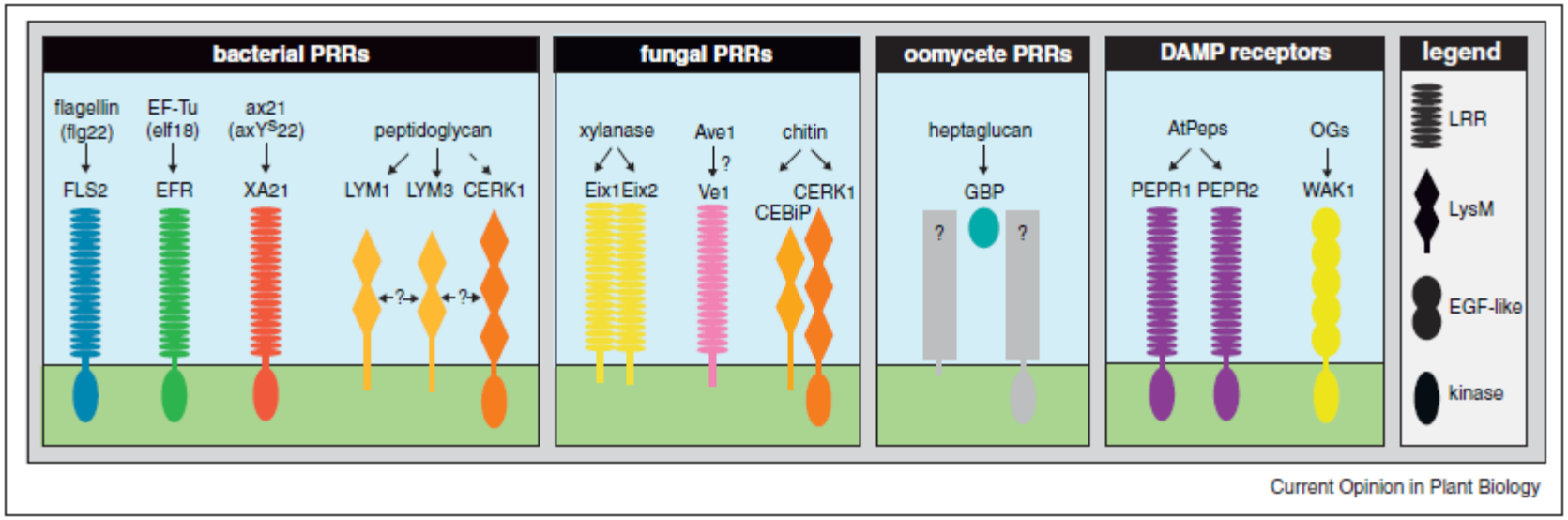
KWS — **Dr. Frank Breuer, Dr Susann Gruendig**

Building on previous ERA-NET project PRR-CROP

Pattern Recognition Receptors; discovery, function and application in crops for durable disease control (PI Prof. Cyril Zipfel)

We developed the tools and plant resources for MAQBAT

Pattern Recognition Receptors



PRRs detect PAMPS leading to PAMP-triggered immunity (PTI)

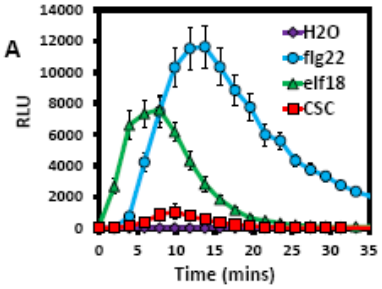
PTI is potentially broad-spectrum and durable

PTI contributes to Quantitative Disease Resistance (QDR)

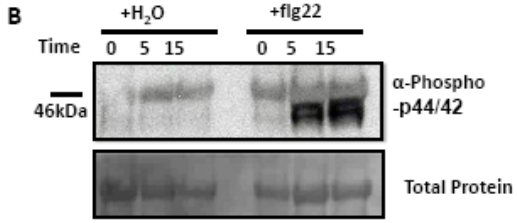
Monaghan & Zipfel 2012 COPB 15: 349-357

Methods to study PTI in *Brassica napus* *(Oilseed rape or Canola)*

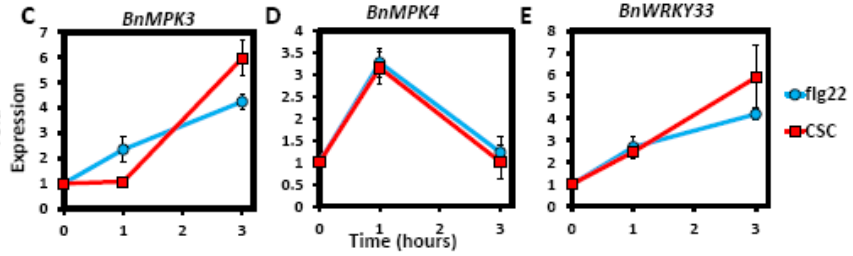
ROS

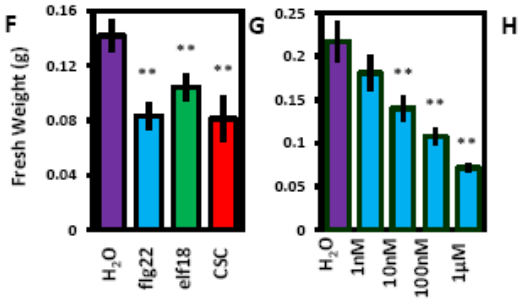


MAPK Phosphorylation

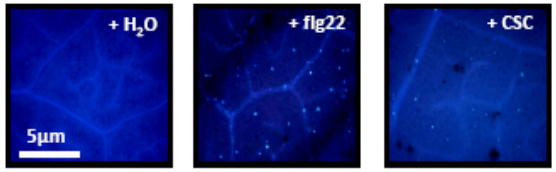


Defence Gene Expression

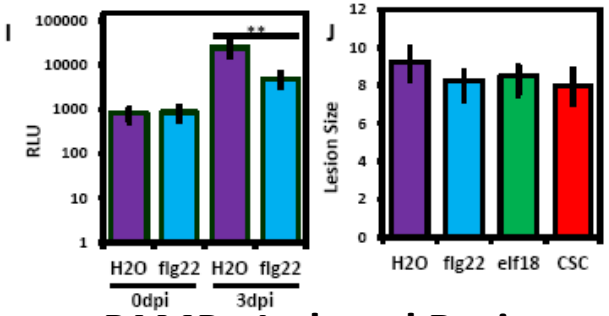




Seedling Growth Inhibition



Callose Deposition



PAMP– Induced Resistance

Lloyd S., Schoonbeek H., Trick M., Zipfel C., Ridout C. (2014) *Molecular Plant Microbe Interactions* 27 286-295

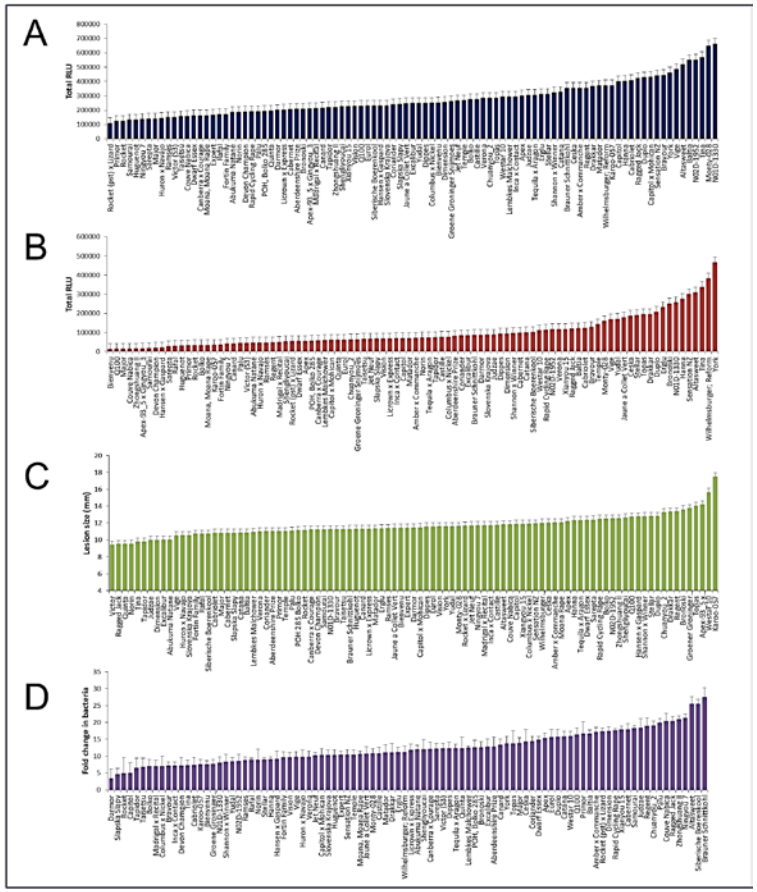
Relationships between PTI readouts and disease resistance Genome-Wide Association Studies (GWAS) in Brassicas

Fls2 ROS

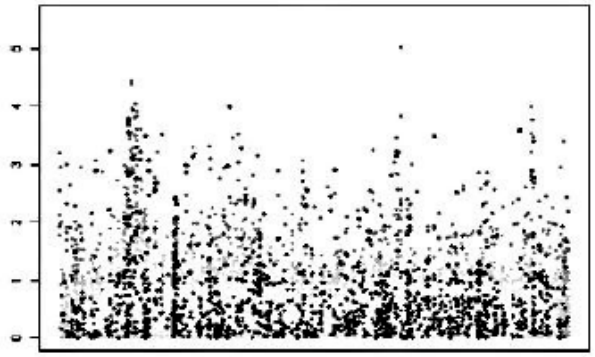
Elf18 ROS

Botrytis

Pseudomonas



Brassica diversity panel



Group SNPs associated with fls2-Triggered ROS on Chromosome A9

Simon Lloyd

Quantitative traits for PTI and disease resistance

John Innes Centre

MAQBAT: better understanding of QDR in *B. napus*

We use the Brassica diversity set to understand PTI and QDR

We will evaluate resistance to *B. napus* pathogens

Different pathogens, different lifestyles

Each consortium member has expertise in different pathogens, In the lab and field

We begin to look at associations with other traits (glucosinolate partitioning)

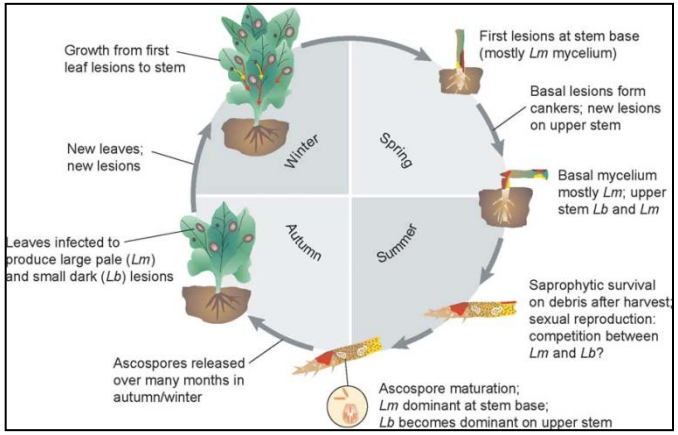
We test transfer of a *Verticillium* receptor into *B. napus*

Bulking the Diversity Set

Diversity set built by Rod Snowdon,
Transcriptome sequence generated by Ian Bancroft (OREGIN)
Currently 196 accessions, increasing to 518 (ASSYST)

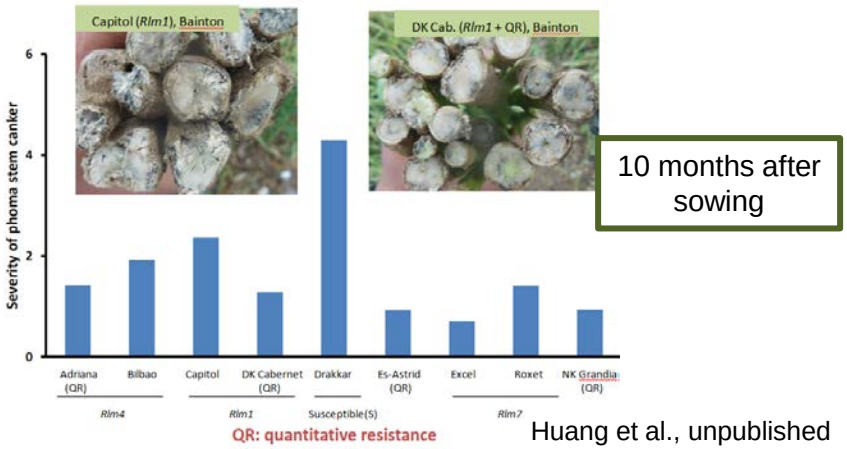
Phoma stem canker
Leptosphaeria maculans

Life cycle



Fitt et al. (2006) Ann. Rev. Phytopathol.

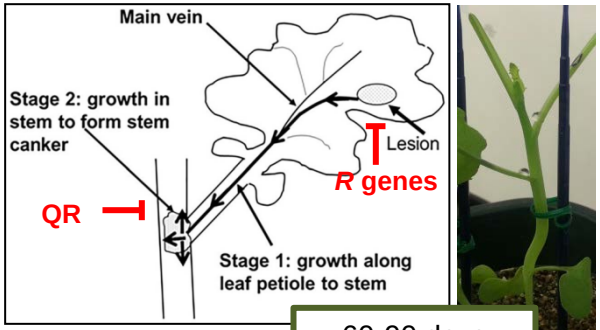
QR (field) pre-harvest assessment



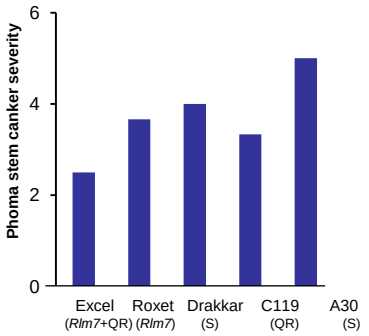
10 months after sowing

Huang et al., unpublished

QR assessment (controlled environment)



60-90 days after sowing



Huang et al. (2014) PloS One

Mitrousia et al., unpublished

Bruce Fitt

University of Hertfordshire

Brassica sp. – *Alternaria brassicicola*

University of Lodz group
PI – Prof. dr Andrzej K. Kononowicz, co-PI – Violetta K. Macioszek, PhD

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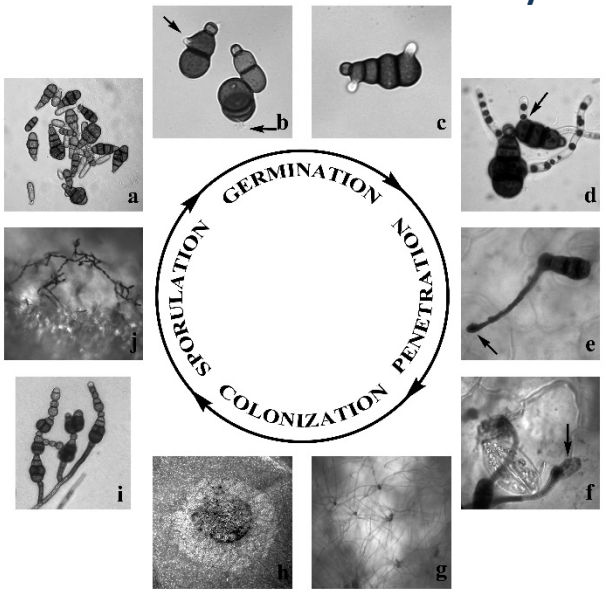
University of LODZ

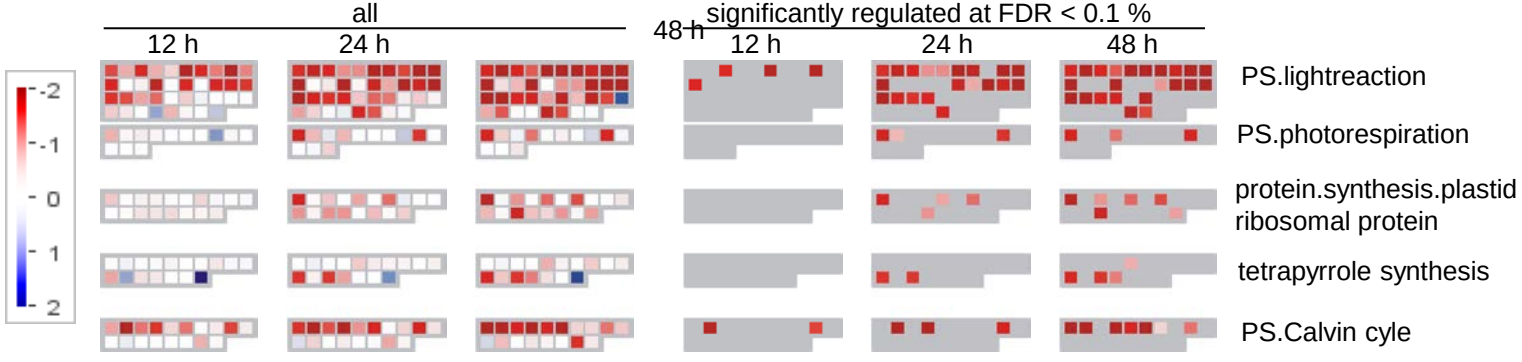
Alternaria brassicicola infection cycle



B. oleracea
Black spot disease

Characterising phenylpropanoids and lignin associated with QDR

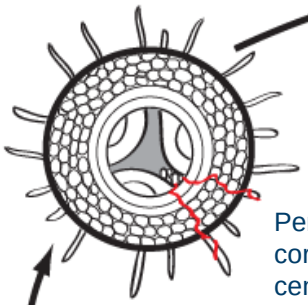
Photosynthesis and Chlorophyll metabolism related genes during infection.



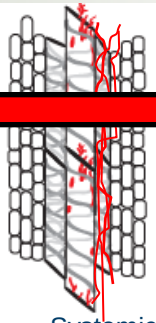
Verticillium longisporum on oilseed rape – a biphasic life cycle

Biotrophic

Necrotrophic

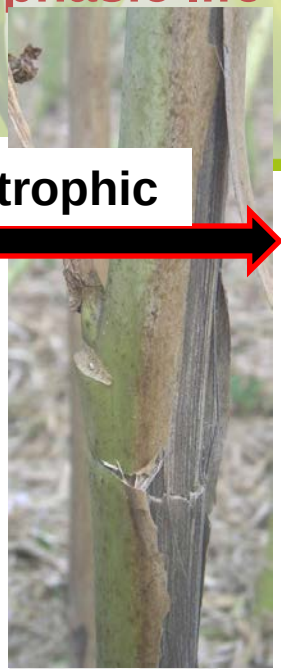


Penetration of root cortex and invasion of central cylinder

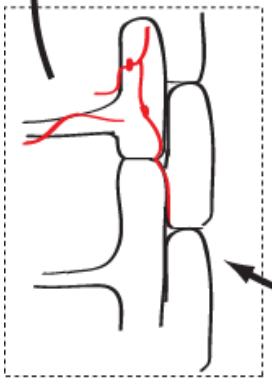


Systemic spread & sporulation

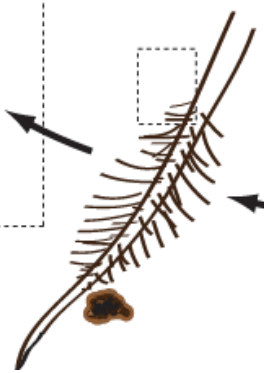
Premature senescence, brown stripes on stems
→ **no wilt!**



Rupture of stem epidermis & outbreak of microsclerotia



Direct penetration of rhizodermis



Microsclerotia in soil germinate upon root exudate sensing

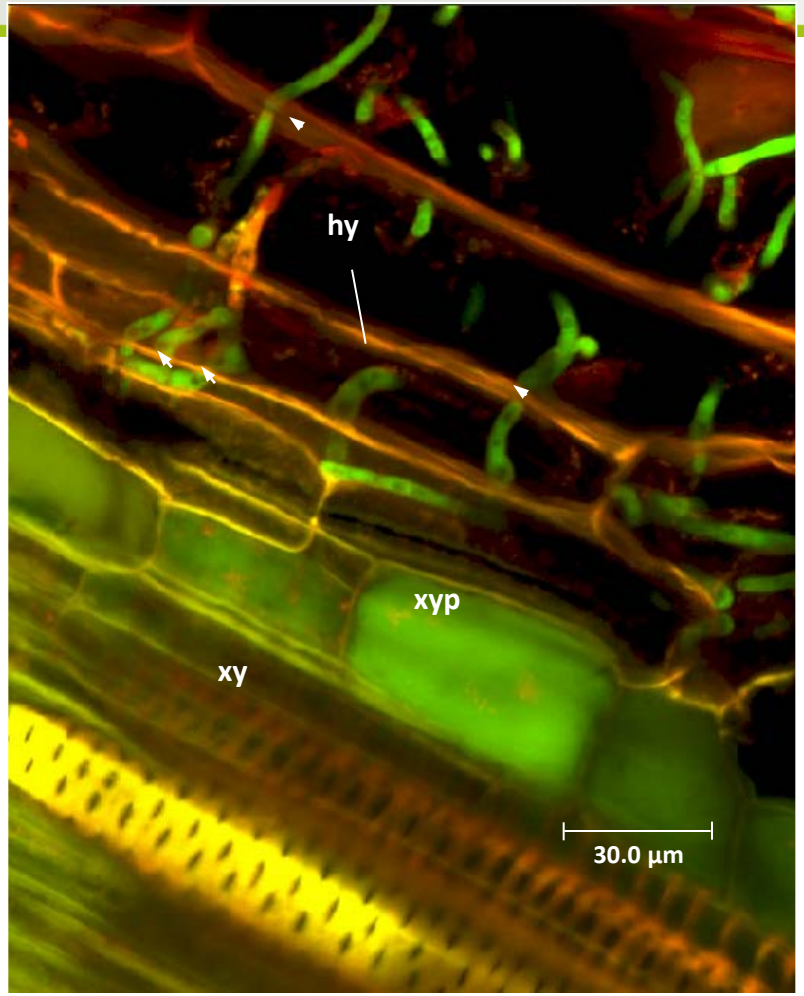
Massive microsclerotia growth on stem pith

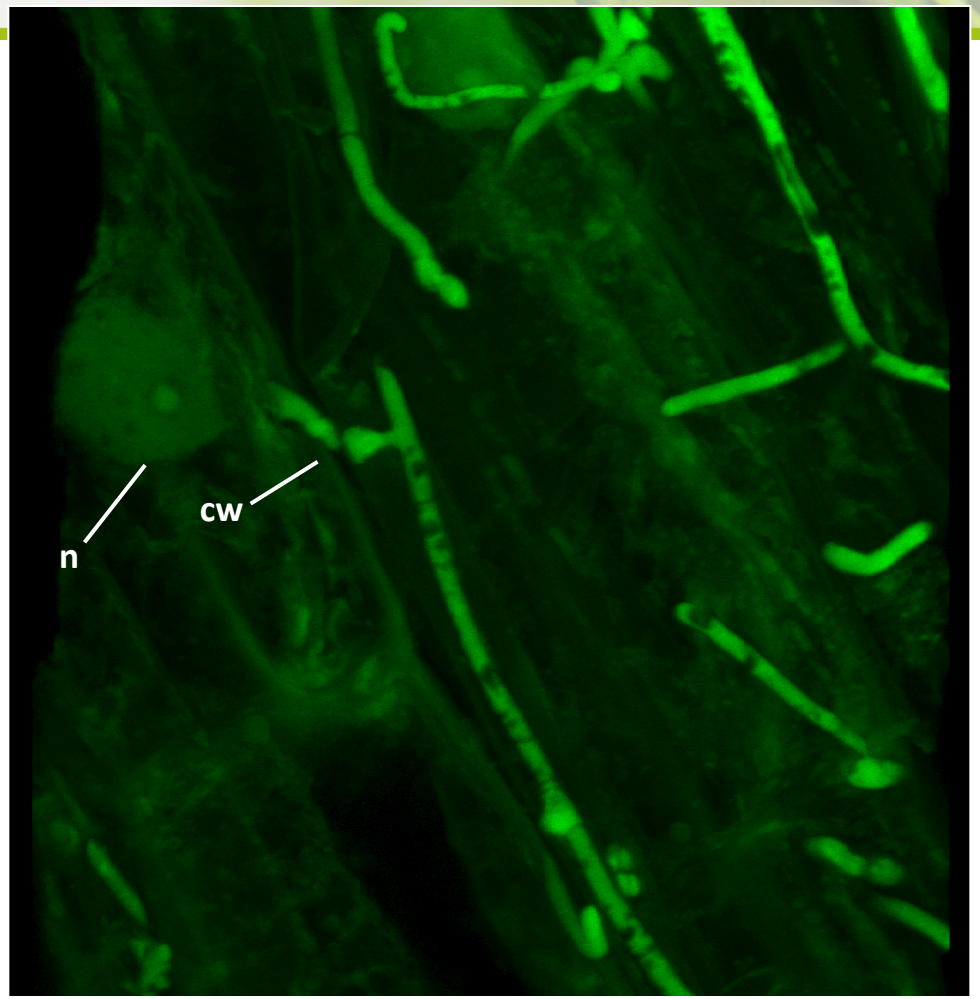
GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

Knüfer &Tiedemann, unpubl.

VL: Intracellular growth in the root cortex

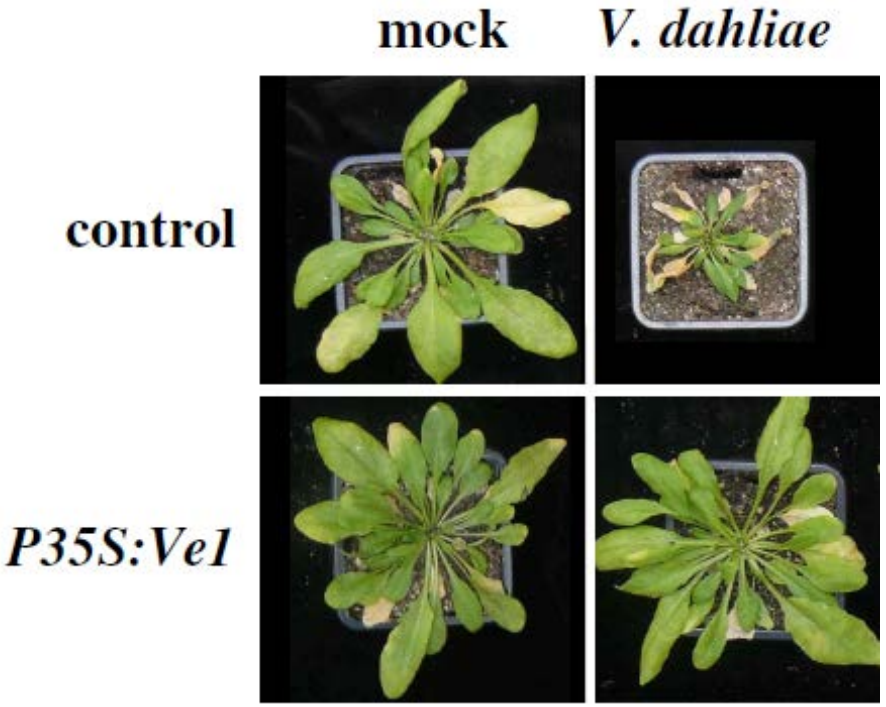
CLSM, 60 hp





xy = xylem, xyp = xylem parenchyma, hy = hypha, cw = plant cell wall, n = plant cell nucleus

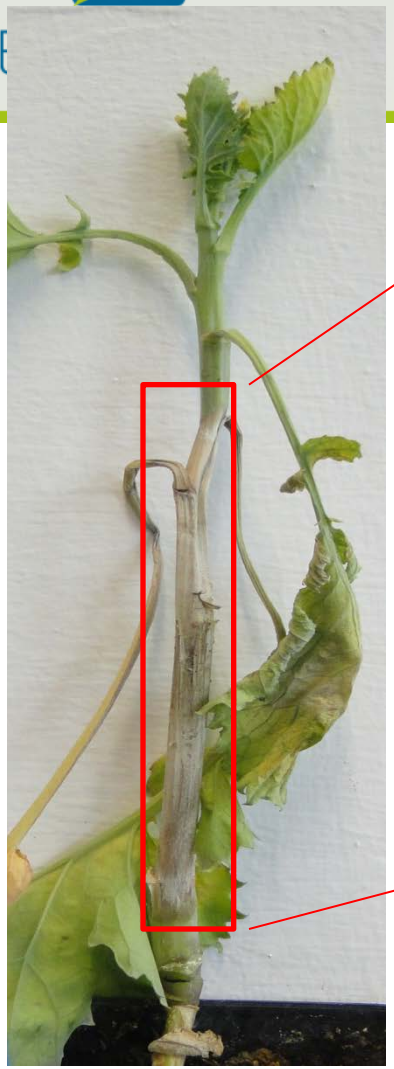
Ve1 transfer to Arabidopsis leads to resistance



Can we transfer *Ve1* to *B. napus*?

Fradin *et al.*, Plant Physiology 2011

Greenhouse screening *Sclerotinia sclerotiorum*



Loras

LL = 102 mm

Zhong You 821

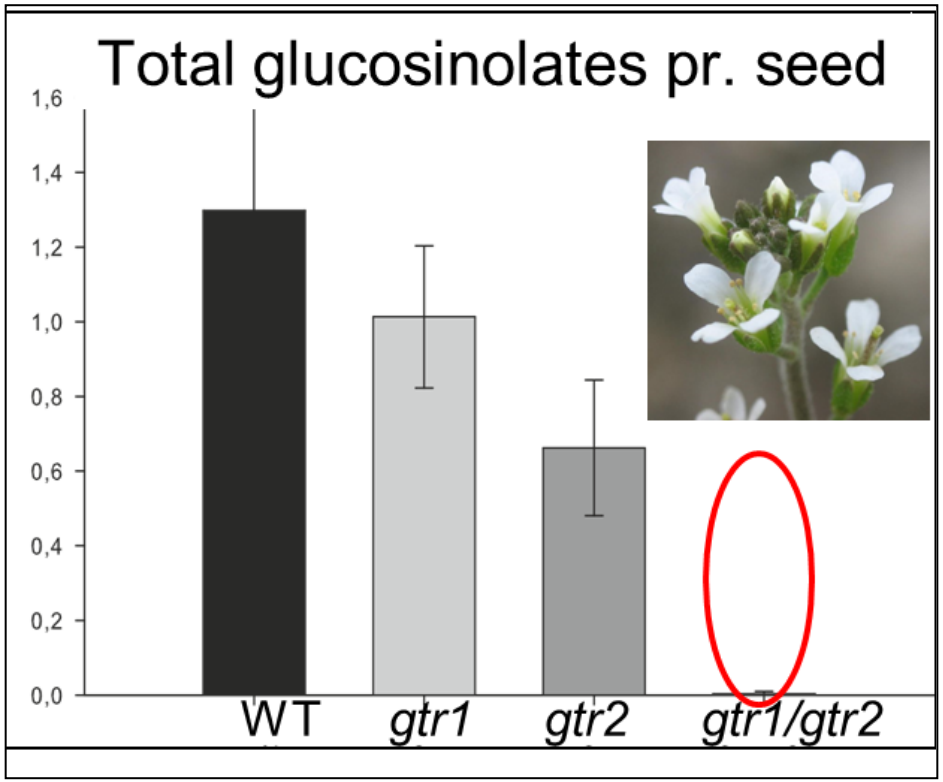
LL = 5 mm

Zhongshuang 9

LL = 26 mm

7 dpi

Glucosinolates – Good (pest resistance), bad (feed quality)



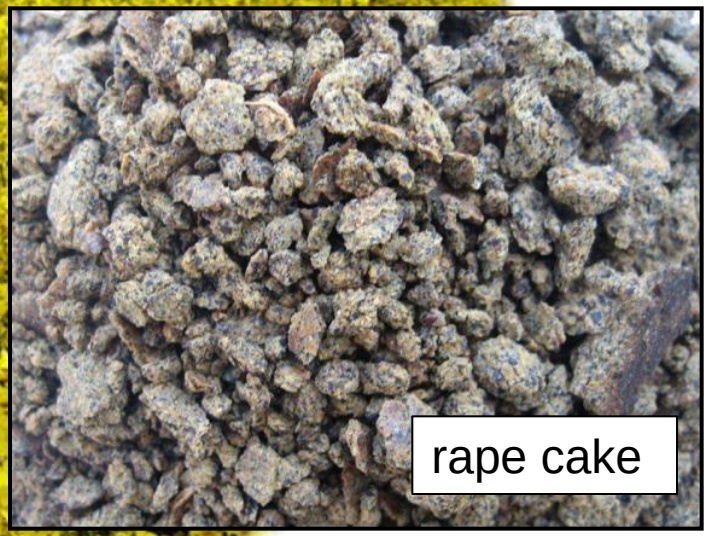
Barbara Halkier

GTR1 and GTR2 are essential for transport of glucosinolates to seeds

Aliphatic and indole glucosinolates are absent in gtr1/gtr2 mutant seeds

Quantify glucosinolates in diversity set

Elimination of antinutritional glucosinolates from rapeseed?



- Protein-rich waste product
- Added to fodder pills (max. 20%)
- Specific growth inhibitory glucosinolates

Field testing at KWS

MAQBAT workpackages

WP1. Quantification of disease resistance to multiple pathogens

WP2. Characterisation of PAMP Triggered Immune responses

WP3. Characterisation of defence mechanisms induced in QDR

WP3a. Quantification and localisation of phenylpropanoids, lignols and lignin

WP3b. Quantification and localisation of indole alkaloids and glucosinolates

WP4. Identification of QDR loci by genome-wide association transcriptomics

Searching for Quantitative Disease Resistance

Thanks to all members of MAQBAT for their enthusiastic contributions to this project

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