

Integrated genomic approaches to decipher quantitative partial resistances

*Régine Delourme, Antoine Gravot
and Maria J. Manzanares-Dauleux*

UMR 1349 INRA - Agrocampus Ouest - Université Rennes 1
Institute of Genetics, Environment and Plant Protection
Rennes - Le Rheu

Different types of resistance

Complete resistance

- Nearly no symptoms
- Qualitative
- Monogenic
- Over-activation of defense responses by *R* genes
- Easy to use
- Rapidly overcome

Partial resistance

- Reduction of symptom severity
- Quantitative
- Oligo- or Polygenic
=> mediated by QTLs
- Unknown molecular bases
- Toughness of exploitation
- Potentially more durable

Use of **Quantitative Resistance** alone or in combination with *R* genes
= An effective way to get varieties with improved potential durability

Durability assessment in OSR/Stem canker model

Rlm6 in two genetic backgrounds,
Eurol (**susceptible**), Darmor (**QR**)

(Brun et al 2010)

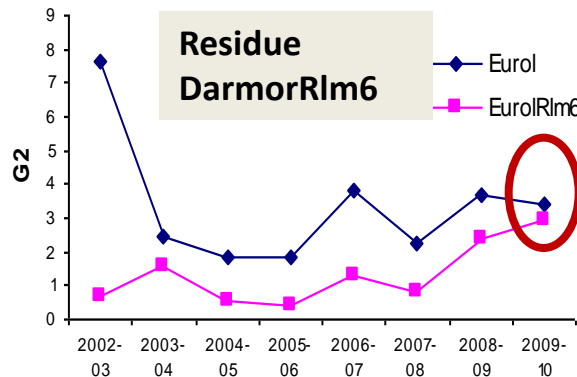
After 5
years of
recurrent
selection

➤ *Rlm6* is no more effective with
recurrent Lm selection on Eurol-
Rlm6 residues

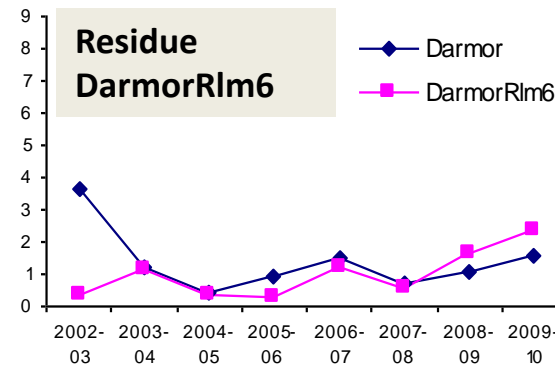
➤ *Rlm6* remained effective with
recurrent Lm selection on
Darmor-*Rlm6* residues

Three more years of recurrent selection

Rex ENDURE project



- Loss of *Rlm6* Resistance effectiveness was delayed
- But the size of virulent population increased



- Darmor resistance remained high when faced to virulent populations selected on Darmor*Rlm6*

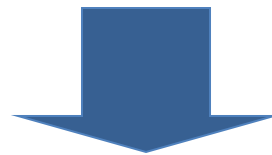
Decipher Quantitative Resistance

Accumulation of diverse genetic factors

Different genes/alleles

Distinct resistance mechanisms

would enhance resistance durability



Assess the genomic localization of QTL

Stem canker

Decipher mechanisms and metabolic pathways

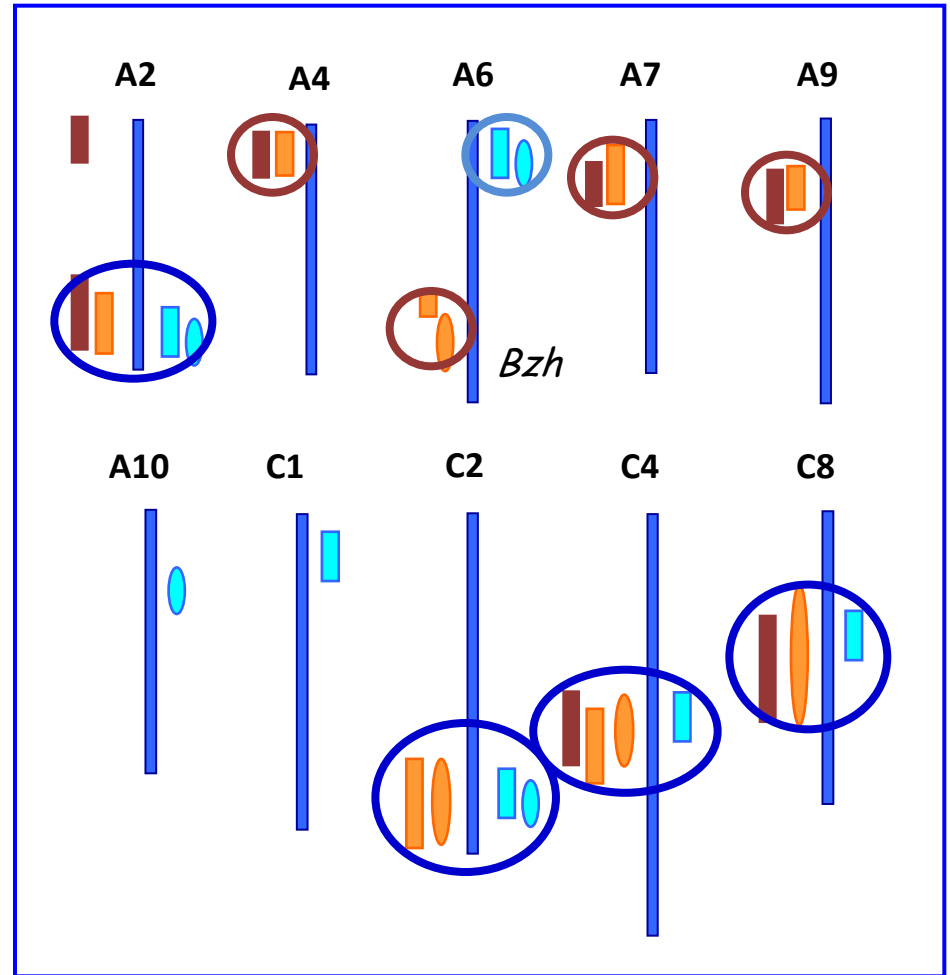
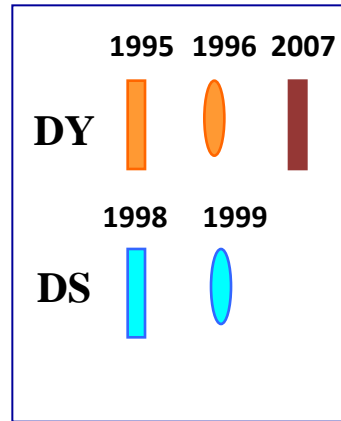
associated with partial resistance

Clubroot

Quantitative Resistance to *Leptosphaeria maculans*

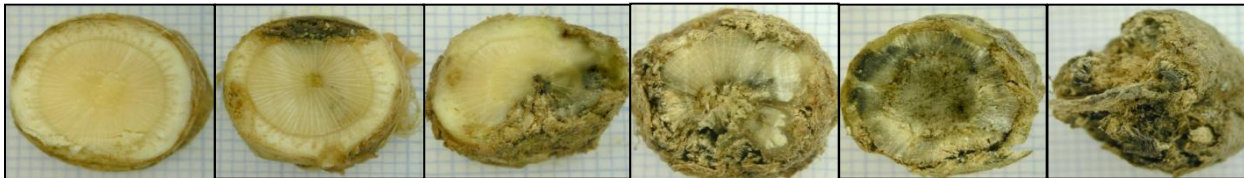


Resistance QTL in two progenies:
 Darmor-*bzh* x Yudal
 Darmor x Samourai



G2 index

1: 0% 2: <25% 3: <50% 4: <75% 5: <100% 6: 100%



Pilet et al, 1998; 2001

Jestin et al, 2012

Quantitative Resistance to *Leptosphaeria maculans*

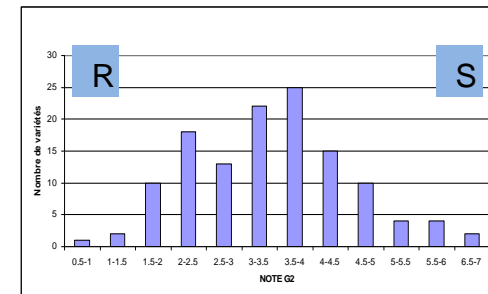
Diversity of quantitative resistance factors?

- What is the genomic organisation of QTL for stem canker resistance in WOSR ?
- What is the allelic diversity at these QTL ?
- Are 'Darmor' QTL present in other WOSR varieties ?

A combined approach of association mapping and linkage mapping using a connected multicross design (C. Jestin PhD Thesis)

Collection of WOSR

- Phenotyping for *Lm* resistance in the field
- Genotyping with SSR/SNP markers



➤ Association mapping

➤ Choice of R parents

Quantitative Resistance to *Plasmodiophora brassicae*

■ Structural analysis



Brassica oleracea



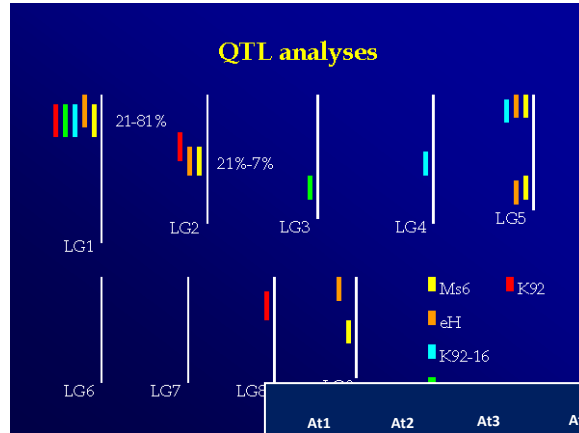
Brassica napus



Arabidopsis thaliana

■ Genetical genomics

Deciphering associated mechanisms



Integrative analysis



I

Microarray



NI

Transcriptomic variations



I



NI

Enzymatic / Metabolic variations

Manzanares-Dauleux et al, 2000

Rocherieux et al, 2004

Jubault et al, 2008

Metabolic changes associated to partial resistance

Role of primary and secondary metabolisms ?

- i) carry out a **global metabolic profiling** to study the metabolic responses linked with clubroot partial resistance and susceptibility
- ii) **identify biochemical markers**, which can be used to refine and complete our knowledge on the genetic architecture of clubroot partial resistance.

PhD Wagner, 2012
Wagner et al, 2012
Wagner et al, in prep

Conclusions

Complementary approaches to investigate the diversity of QTLs

- ... draw hypotheses on partial quantitative resistance functioning
- ... provide molecular or metabolic markers for discovery of new resistance genotypes or alleles and for breeding

... and prospects

- ... need to study the stability of the identified QTL/metabolic response in various environments (climate and/or lower N input)
- ... need to investigate interaction between diseases and pests

The Brassica group at IGEPP



Describe and use genetic diversity

- Genetic Resources
- Genetic mapping and genome sequencing
- Polyploidy, recombination

*AM Chèvre, S Paillard, C Falentin,
G Lassalle, A Label, M Renard*

Disease resistance

- Organisation/regulation of genetic factors
- Associated mechanisms
- Epidemiology, Durability

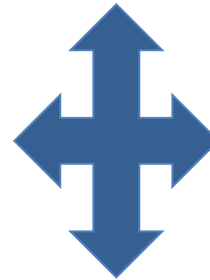
*R Delourme, A Gravot,
M Manzanares-Dauleux,
M Jubault, L Bousset, H Brun*



Oil yield under biotic constraints

- Oils, proteins, NUE, WUE
- Organisation of genetic factors
- Associated mechanisms

*A Bouchereau, N Nesi, A Laperche,
MF Niogret, F Lecahérec, L Leport,
C Deleu*



Ecology of Insects

- Attractiveness
- Insect behavior

*AM Cortesero,
S Dugravot*

Microbial Ecology of Rhizosphere

*A Sarniguet, C Mougel
S Daval, L Lebreton*



UMR IGEPP Le Rheu



Régine Delourme
Maria Manzanares-Dauleux

Lydia Bousset	Anne Laperche
Hortense Brun	Christine Lariagon
Anne-Marie Chèvre	Anne Levrel
Claude Domin	Jocelyne Lemoine
Philippe Duffé	Séverine Lemarié (PhD)
Frédérique Eber	Bruno Marquer
Magali Ermel	Henri Miteul
Pascal Glory	Patrick Vallée
Antoine Gravot	Geoffrey Wagner (PhD)
Berline Fopa Fomeju (PhD)	
Christophe Jestin (PhD)	
Mélanie Jubault	

Collaborations

INRA - BIOGER-Grignon

Mylène Balesdent
Thierry Rouxel
Isabelle Fudal

Univ. Hertfordshire, UK

Bruce Fitt
Yongju Huang

