

NSW GOVERNMENT Department of Primary Industries

GRDC GRASSLAND RESEARCH DEVELOPMENT CONFERENCE

# Architecture of quantitative resistance to blackleg in canola

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## NBGIP has mapped loci for race-specific resistance to blackleg

Mapping populations	Phenotyping	Genotyping
<b>Brassica napus</b>		
- Skipton/Ag-Spectrum	SSI, FE, AST	SSR, 5K Illumina SNPs
- Maxo/Westar	SSI	SSR, DArTseq
- Columbus/Westar	SSI	SSR
- BLN2762/Suppass400	SSI, FE	SSR, DArTseq
- Ag-Castle/Westar	SSI	DArTseq
- RP04/Ag-Outback	SSI, FE, AST	DArTseq
- Tapidor/Ningyou7	AST	SSR, AFLP, DArTseq
- Darmor/Yudal	SSI, FE, AST	DArTseq, 60K Illumina SNP
- Hyola50 populations (11-5107 & 11-5329)	SSI, FE	DArTseq, Resequencing
<b>Brassica carinata</b>		
- (Y-BcDH64/W-BcDH76)	FE	DArTseq, SSR
<b>2 GWAS panels</b>		
- BnASSYST (368 lines)	FE, AST	DArTseq, 60K Illumina SNP (Rod, Giessen)
- AHGDS (300 lines)	SSI (N=180), FE, AST	15K Illumina, Resequencing

QTL/GWAS analyses → MTA/Genomic regions

SSI: Single spore isolates, FE: Field Evaluation, AST: Ascospore shower test

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## QTLs for race-nonspecific resistance to blackleg have also been mapped

Population	Phenotyping	A01	A02	A03	A04	A05	A06	A07	A08	A09	A10	C01	C02	C03	C04	C05	C06	C07	C08	C09	Reference		
Caiman/Westar	Australia (field)																					Kaur et al (2009)	
Camberra/Westar	Australia (field)																						Kaur et al (2009)
Sapphire/Westar	Australia (field)																						Kaur et al (2009)
Rainbow/Sapphire	Australia (field)																						Kaur et al (2009)
Skipton/Ag-Spectrum	Australia (field)																						Raman et al (2012)
RP04/Ag-Outback	Australia (field)																						Raman et al (draft)
Topas/Ag-Castle	Australia (field)																						Larfen et al (2016)
Topas/Av-Sapphire	Australia (field)																						Larfen et al (2016)
Darmor/Yudal	Ascospore																						Raman et al (2018)
Darmor/Yudal	France (field)																						Kumar et al (2018)
GWAS panel (French)	Field																						Jevtic et al (2021)
GWAS panel (USA)	FIG-4 strain																						Rahman et al (2016)
GWAS panel (NSWDPI) Ascospore																							Raman et al (2016)
GWAS panel (NSWDPI) 12 SSI																							Raman et al (2016)

ORIGINAL RESEARCH ARTICLE  
Raman, Harsh Sci. 27 November 2020 | DOI:10.1093/iqms/ibz022

### Stable Quantitative Resistance Loci to Blackleg Disease in Canola (*Brassica napus* L.) Over Continents

Harsh Raman, Roy Raman, Simon Olfert, Yu Guo, Brent McChesie, Denise Maria Balthazar, Phil Anthony Sibley, Steve Macdonald, Rainer Deumer

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## Pair plots showing genetic correlations between different phenotypic scores for resistance to *L. maculans* in the Darmor-bzh/Yudal population (Raman et al 2018, FIPS).

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## Manhattan plots showing association for (A) resistance to PHW1223 isolate of *L. maculans*, and (B) for dwarfness (*bzh*) in the Darmor-bzh/Yudal DH population (Raman et al 2018, FIPS).

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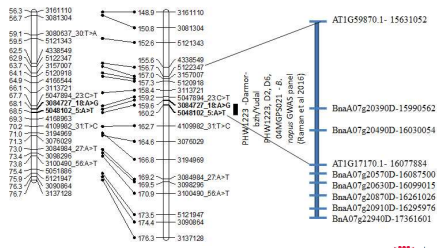
## Localization of 'stable' QTLs for resistance to *L. maculans* on the physical map of *B. napus* cv. Darmor-bzh across continents (Raman et al 2018, FIPS)

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## Genetic and physical localization of *Rlm9* locus for resistance to *L. maculans* (Raman et al 2018, FIPS)

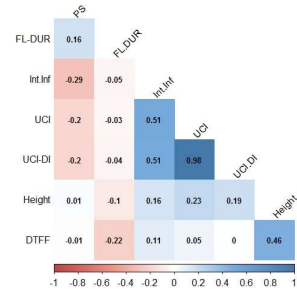
GeneticMap-A07 PhysicalMapA07 Candidate gene (Darmor-bzh coordinate)



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## Correlation between measures of blackleg resistance, flowering time & plant height



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## Phenotypic evaluation of AHGDS (300 lines) for blackleg resistance

- Ascospore shower test by DEDJTR/MGP (2016, 2017) under DAN00208
  - Stubble source: Group A, B, C, D, E (ABD), F and S
- Result summary
  - Plant mortality showed high correlation with internal infection (0.6)
  - Five lines showed less than 10% internal infection
    - Two accessions of *B. carinata* and *B. napus* (BC52622) were completely resistant to blackleg (GT42 - *Rlm1,4,6, LepR1* and *Hyola970 (Rlm7)*).
  - Ascospore shower test ≠ 100% Quantitative resistance
- Field evaluation in blackleg nursery (2017, 2018)- NSW DPI
  - 300 accessions x 2 replication (10 m rows)

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## Blackleg infection in AHGDS grown in Wagga (Aug 2018)



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## Stem/bark splitting in canola



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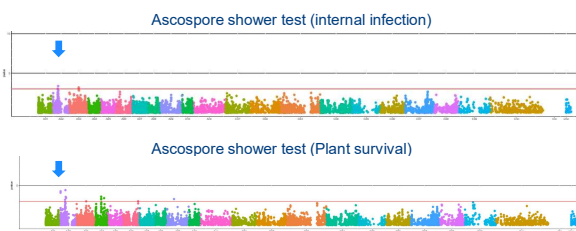
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### Field screening for blackleg resistance at Wagga (2018 season)



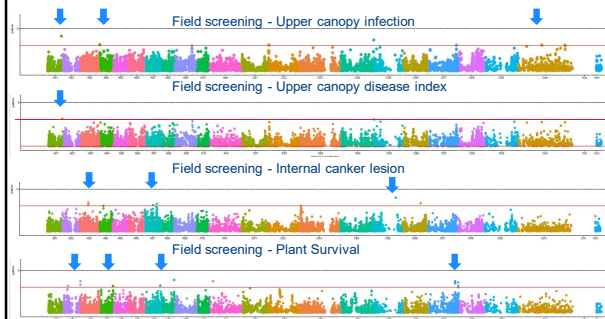
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### Genome wide association for blackleg resistance evaluated with ascospore shower test (unpublished)



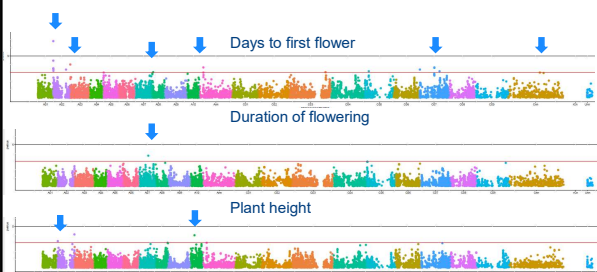
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### Genome wide association analysis for resistance to blackleg in 300 AHGDS



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### Genome wide association analysis of phenological components in 300 lines of AHGDS



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### Research (in progress)

- 20 quantitative resistance sources were sequenced (ARC-Linkage project with Jacqui Batley, UWA)
  - Integrated in pan-pan-genome assembly
- Phenotypic and genotypic data is currently being used in genomic selection at NSW DPI/UWA/UNE
  - In 2018, we made 100 crosses and being progressed in 2019
- To understand quantitative resistance better, we are utilising NSW DPI TILLING population



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## Research Team and Collaboration

NBGIP Team  
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