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Wheat defence signalling components WGIN year 1 field trial

Kim Hammond-Kosack
Wheat Pathogenesis Programme

29-11-2004

3 components to inducible defence

Plant-pathogen recognition



**Defence signalling - Rar1/Sgt1
Npr1**

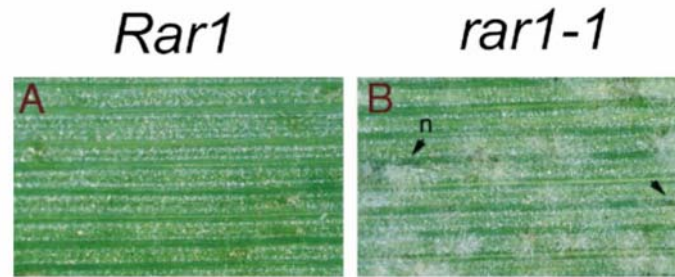


Multiple-component defence responses

Functional Rar1/Sgt1 proteins required for disease resistance

Barley powdery mildew (*Blumeria graminis* f.sp. *hordei*)

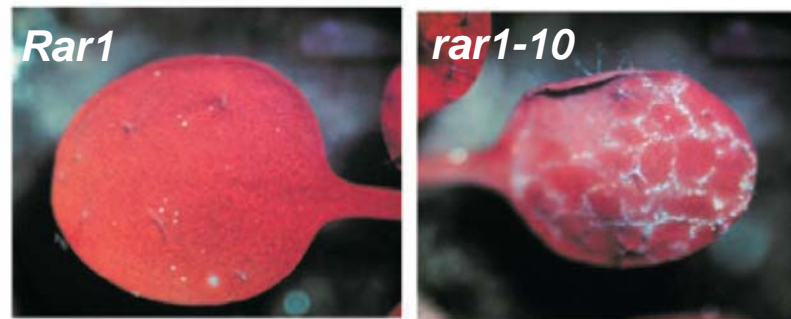
Mla12



Shirasu et al., (1999) Cell, 99:355-366

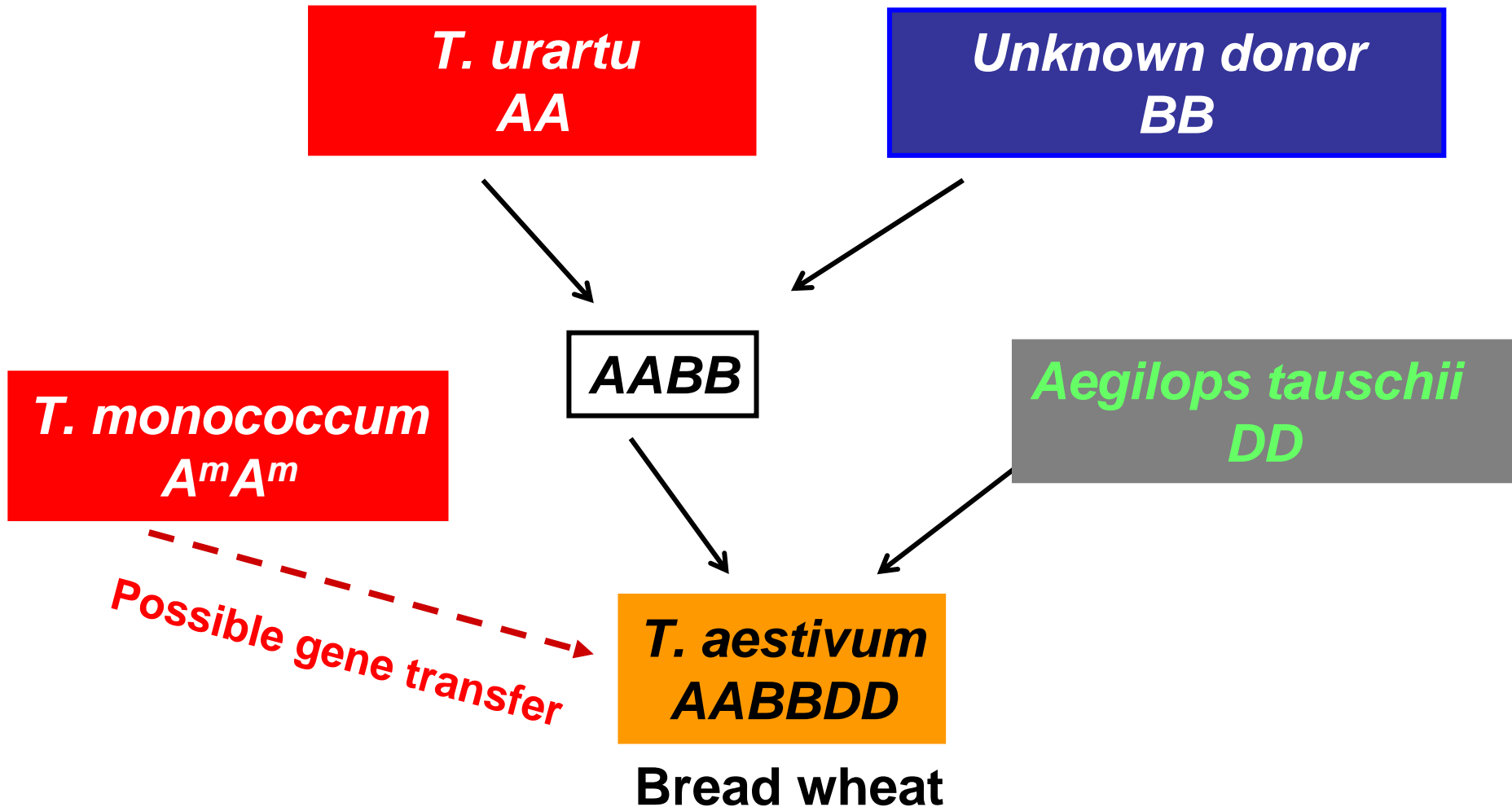
Arabidopsis downy mildew (*Peronospora parasitica*)

RPP5



Austin et al., (2002) Science, 295:2077-2080

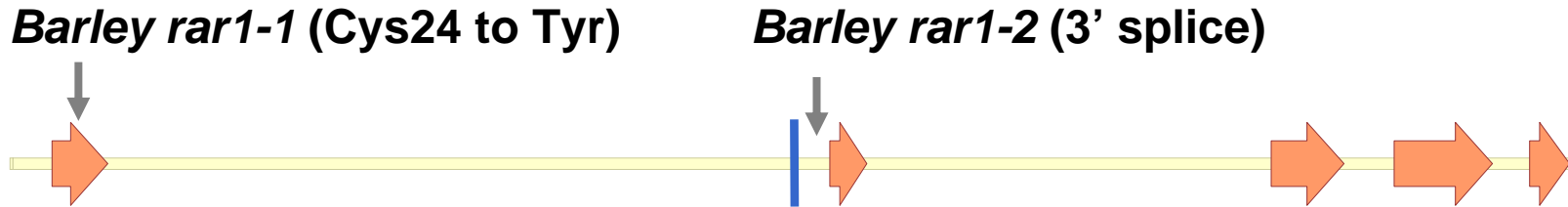
Using *T. monococcum* ($A^m A^m$) to understand gene function and as a source of novel traits



Rothamsted *T. monococcum* accession lines

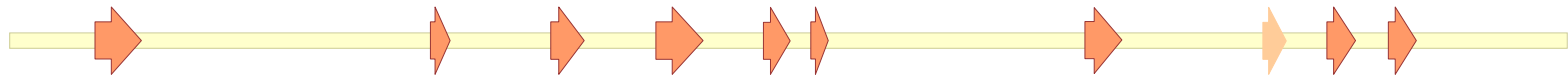
Total number	124
Countries and regions	50
Original collection time	since 1904
Line with BAC library	1
Lines transformable by <i>Agrobacterium</i>	2
Line with EMS population	1

T. monococcum RAR1/SGT1 gene structure



TmRAR1

Genomic 3520, cDNA 696bp



TmSGT1

(Genomic 5210kb, cDNA 1134bp)



exon



intron

TmRAR1 variation

540

MDR0308 GAGAAGGATA
MDR0050 GAGAAGGATA
MDR0001 GAGAAGGATA
MDR0002 GAGAAGGATA
MDR0030 GAGAAGGATA
MDR0037 GAGA**G**GGATA
MDR0042 GAGAAGGATA
MDR0303 GAGAAGGATA

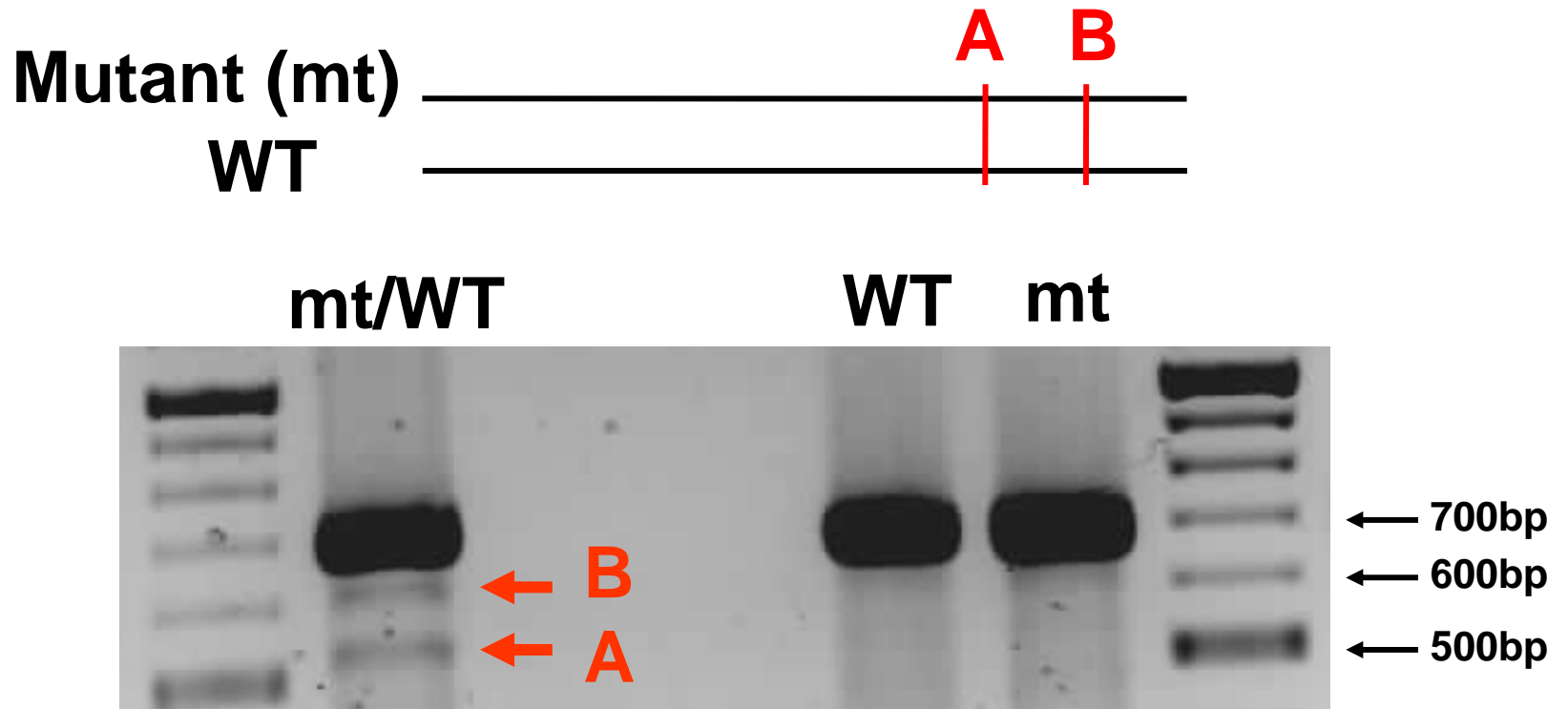
LYS (K) to ARG (R)

621

MDR0308 GCGATGTCCA
MDR0050 GCGATGTCCA
MDR0001 GCGATGTCCA
MDR0002 GCGATGTCCA
MDR0030 GCGATGTCCA
MDR0037 GCGAT**A**TCCA
MDR0042 GCGATGTCCA
MDR0303 GCGATGTCCA

VAL (V) to ILE (I)

TmRAR1 sequence variants identified by CEL I mismatch specific nuclease



Data generated by Dr Hai-Chun Jing

TmRAR1 AA alignment

↓ *Barley rar1-1* ↓ *Barley rar1-2*

Barley (1) MSAETERSAAAPAPAPMRCQRIGCDAMFTDDDDNPDGSCHYHPSG^LLFHDGMKEWSCCKQRSHDFSLFLAI
TmRAR1 (1) MSAETE^TSAAAPAPAPMRCQRIGCDAMFTDDDDNPDGSCHYHPSG^PMFHDGMKEWSCCKQRSHDFSLFLAI
MDR0037 (1) MSAETE^TSAAAPAPAPMRCQRIGCDAMFTDDDDNPDGSCHYHPSG^PMFHDGMKEWSCCKQRSHDFSLFLAI

CHORD I

Barley (71) PGCATGKHTTEKPVTKAVSLN^SSKATPPK^SAP^VQSSKQGVETEACSR^RCRQGFFCSDHGSQPKA^QK^PVAVN
TmRAR1 (71) PGCATGKHTTEKPVTKAVSLN-SKATPPK^LA^PT^QSSKQGVETEACSR^RCRQGFFCSDHGSQPKA^QK^TVAVN
MDR37 (71) PGCATGKHTTEKPVTKAVSLN-SKATPPK^LA^PT^QSSKQGVETEACSR^RCRQGFFCSDHGSQPKA^QK^TVAVN

CCCH

Barley (141) GTNTE^SV^QK^SS^VP^EP^KK^KV^VD^INEPRVCKNKGC^GKTYKE^KDNHDAAC^DYHPGPAVFHDRNRGWKCCD^VHV
TmRAR1 (140) GTNTE^PV^EK^CS^VP^QP^KK^KV^VN^INEPRVCKNKGC^GKTYKE^KDNHDAAC^EYHPGPAVFHDRNRGWKCCD^VHV
MDR0037 (140) GTNTE^PV^EK^CS^VP^QP^KK^KV^VN^INEPRVCKNKGC^GKTYKE^RDNHDAAC^EYHPGPAVFHDRNRGWKCCD^IHV

CHORD II

Barley (211) KEFDEFMEIPPCTKGWHNADAV-
TmRAR1 (210) KEFDEFMEIPPCTKGWHNADAV-
MDR0037 (210) KEFDEFMEIPPCTKGWHNADAV-

T. monococcum (00037)

Correlate with resistance phenotype?

Lines	<i>SBCMV</i>	<i>Mycosphaerella graminicola</i>	Eyespot <i>O. yallundae</i>	<i>Fusarium culmorum</i> / <i>F. graminearum</i>
MDR0001	R	R	M	M
MDR0303	R	R	R	-
MDR0040	R	R	S	M

*

*

MDR0033	S	R	R	M
MDR0034	S	R	R	M
MDR0036	S	R	R	M
MDR0042	S	R	R	M
MDR0047	S	R	R	M
MDR0028	S	R	S	S
MDR0037	S	R	S	S
MDR0049	S	R	S	S
MDR0025	S	R	S	S

*

*

MDR0002	S	R*	R	S
MDR0030	S	R*	S	M

*


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MDR0050	R	R*	M	-
MDR0308	R	-	M	-

*

*





Most *Triticum monococcum* L. accessions exhibit NO Septoria leaf blotch disease symptoms under the field

**Darren Lovell
Dmitry Korniyukhin**

**Control bread wheat variety Consort
100% Septoria infected plants (5th May 2004)**



infected leaves



YEAR 1 : Rothamsted Variety Trials

Site: Rothamsted (Black Horse)

Factors: 2 (Variety and Nitrogen Rate)

Varieties: 32

N Rates: 4

Replicates: 3

Plots: 384

Plot size: 3 x 10 m

Design: 3 blocks of 4 plots split into 32 sub-plots

Previous crop: spring oats

Sowing date: 11-19th Nov 03

Seed rate: 320- 400/m²

Harvest date: 31 Aug, 1-2 Sep 04

Nitrogen rates 0, 100, 200 and 350kg N / Ha

YEAR 1 | Trial objectives

To measure Nitrogen Use Efficiency NUE ✓

To measure canopy architecture traits ✓

To provide grain samples for the WGIN store ✓

To provide a test bed for other researchers ✓

To provide data for the Sirius crop model

To compare grain quality parameters

YEAR 1 Varieties

Underlined = parent of public DH mapping population

Arche	Flanders	Petrus
<u>Avalon</u>	Hereward	<u>Rialto</u>
Batis	Isengrain	<u>Riband</u>
<u>Beaver</u>	<u>Lynx</u>	Scorpion
<u>Cadenza</u>	Malacca	Sokrates
Caphorn	Maris Widgeon	<u>Soissons</u>
Capelle-Desprez	Mercia	Solstice
Chablis (Sp)	Monopol	<u>Spark</u>
Einstein	Opus	Xi19
ELS - Hurley	Paragon (Sp)	Zyta
Enorm	PBIS	

Blue = public molecular data available
Green = Broadbalk long term exp RRes



WGIN Website



<http://www.wgin.org.uk/>

Sam Irving – Project Assistant
Sanjay Patel

RAR1/SGT1 interaction

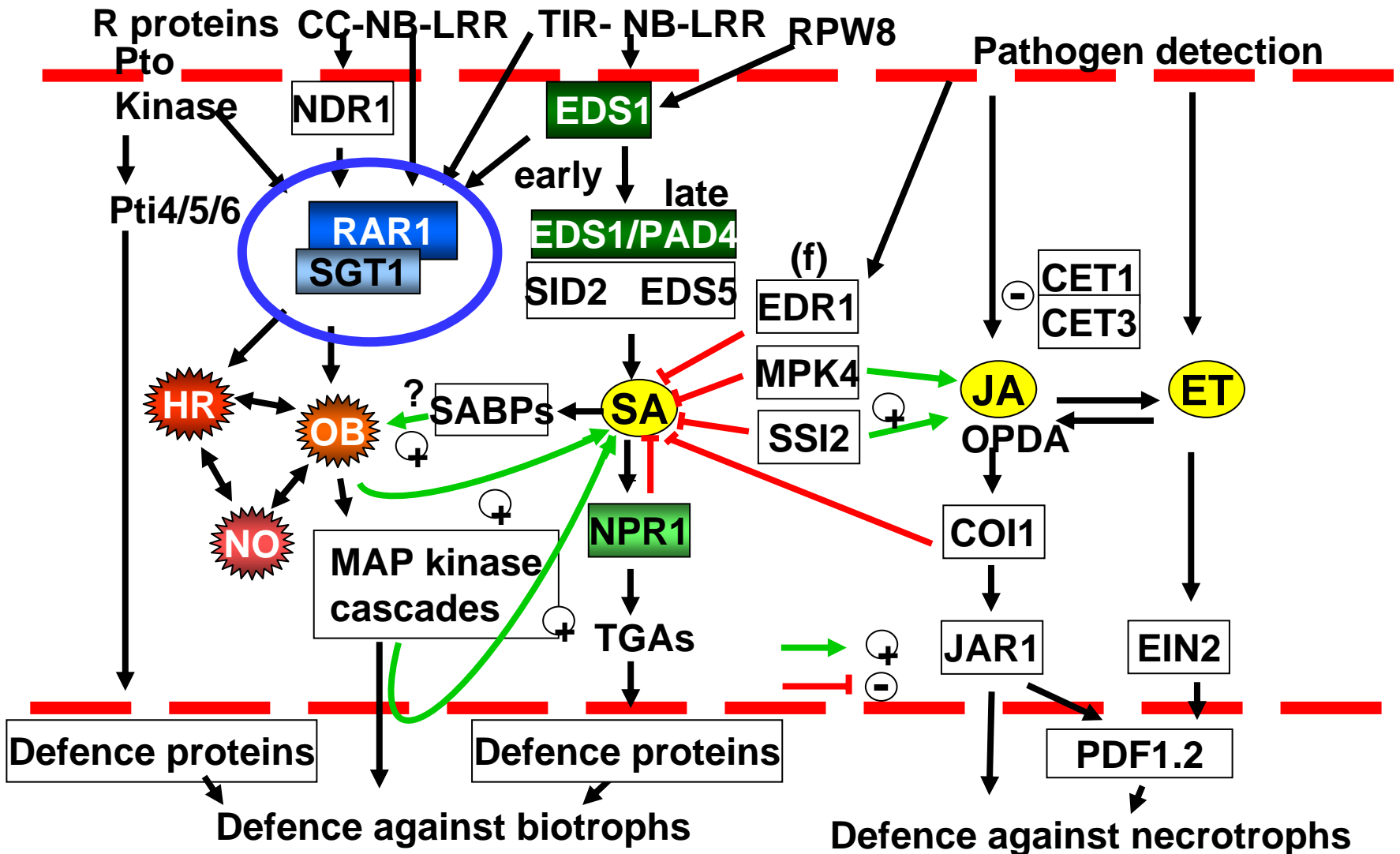
Plant
RAR1



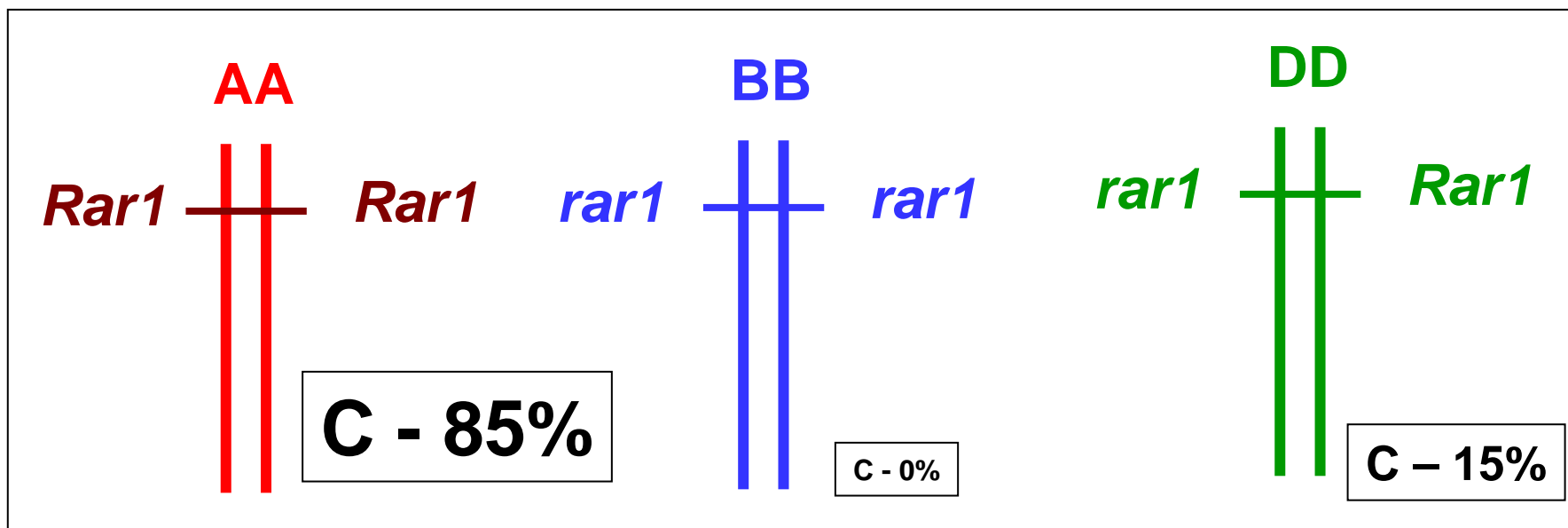
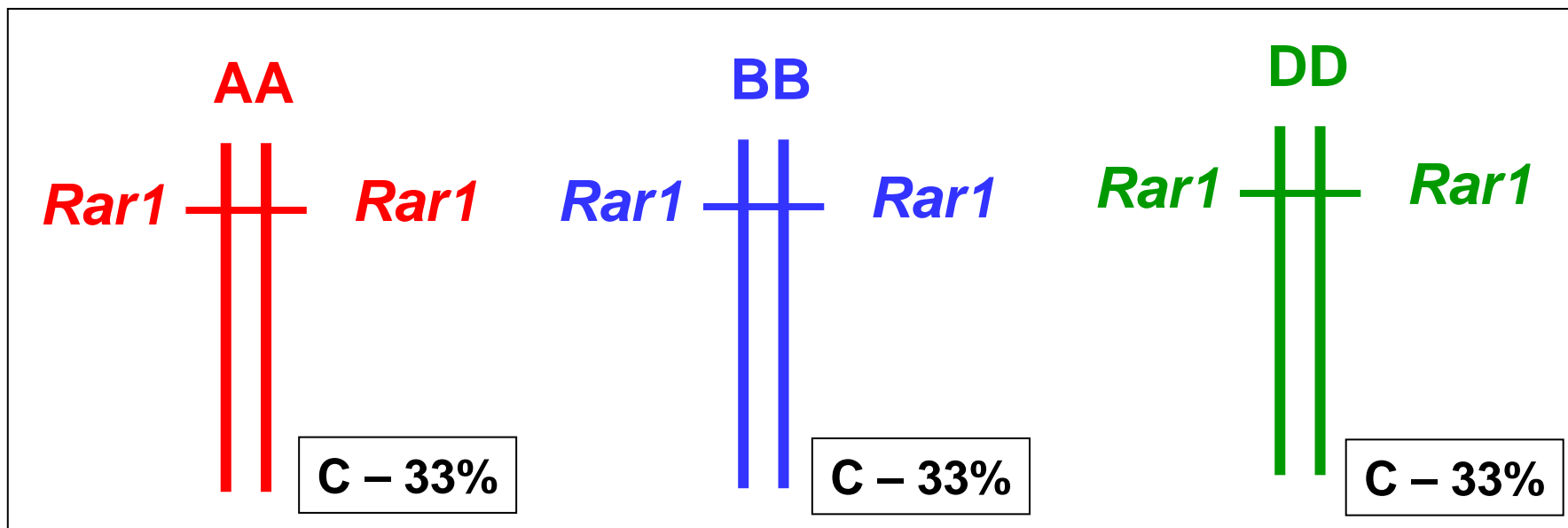
Plant
SGT1



Key defence signalling components



Genome specific TILLING in hexaploid wheat

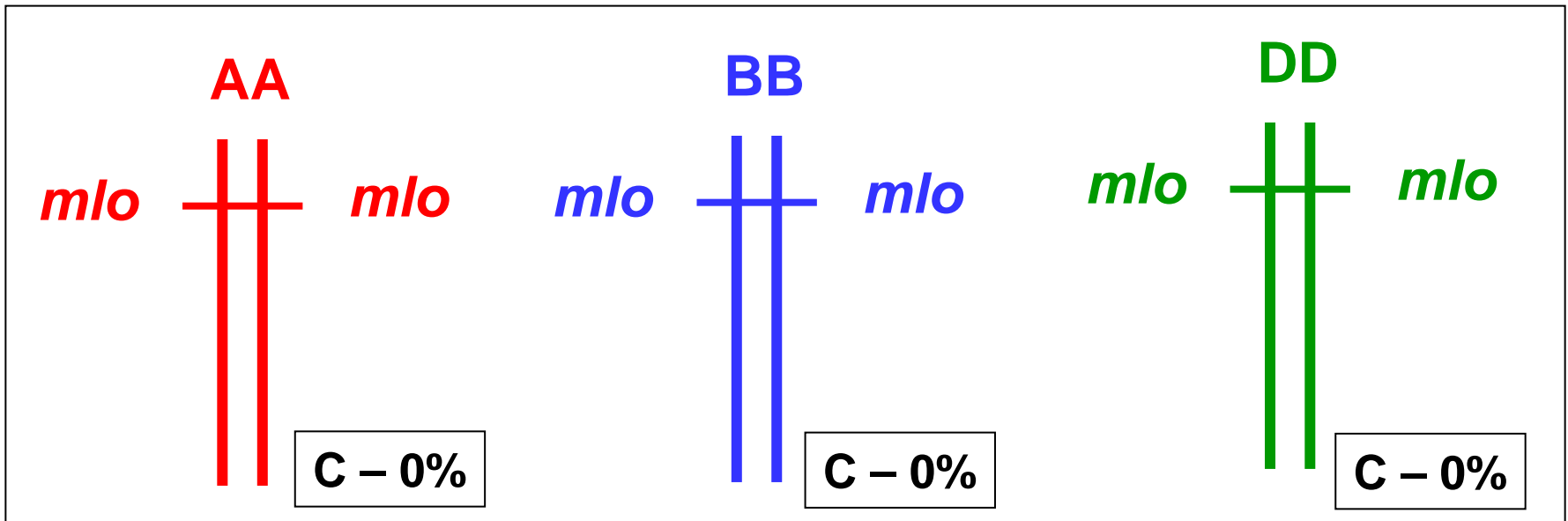


TILLING for *mlo* in hexaploid wheat

In barley the recessive gene *mlo* confers resistance to **all** barley powdery mildew isolate (race-non specific)

The wheat *mlo* gene functions in barley (2002)

In hexaploid wheat – the triple NULL is required



TILLING for A^{mlo}



$A^{mlo}A^{mlo}BBDD$ X

TILLING for B^{mlo}



$AAB^{mlo}B^{mlo}DD$

TILLING for D^{mlo}



$AAB^{mlo}B^{mlo}DD$ X

$AABB^{mlo}D^{mlo}D^{mlo}$



$A^{mlo}AB^{mlo}BDD$

X

$AAB^{mlo}BD^{mlo}D$



alleles	ABD	$AB^{mlo}D$	$AB^{mlo}D^{mlo}$	$AB^{mlo}D^{mlo}$
ABD				
$AB^{mlo}D$				
$A^{mlo}BD$				
$A^{mlo}B^{mlo}D$				

selfed



$AA^{mlo}B^{mlo}B^{mlo}DD^{mlo}$