ROTHAMSTED RESEARCH

Wheat Genetic Improvement Network

defra

www.WGIN.org.uk

WGIN – Year 2

Kim Hammond-Kosack
Wheat Pathogenesis Programme

29-11-2004

KEY OBJECTIVES

High throughput TILLING of *Rar1*, *Sgt1* and *mlo* genes in diploid wheat

Link specific gene variants in the various *T. monococcum* accessions to their resistance / susceptibility to specific pathogens

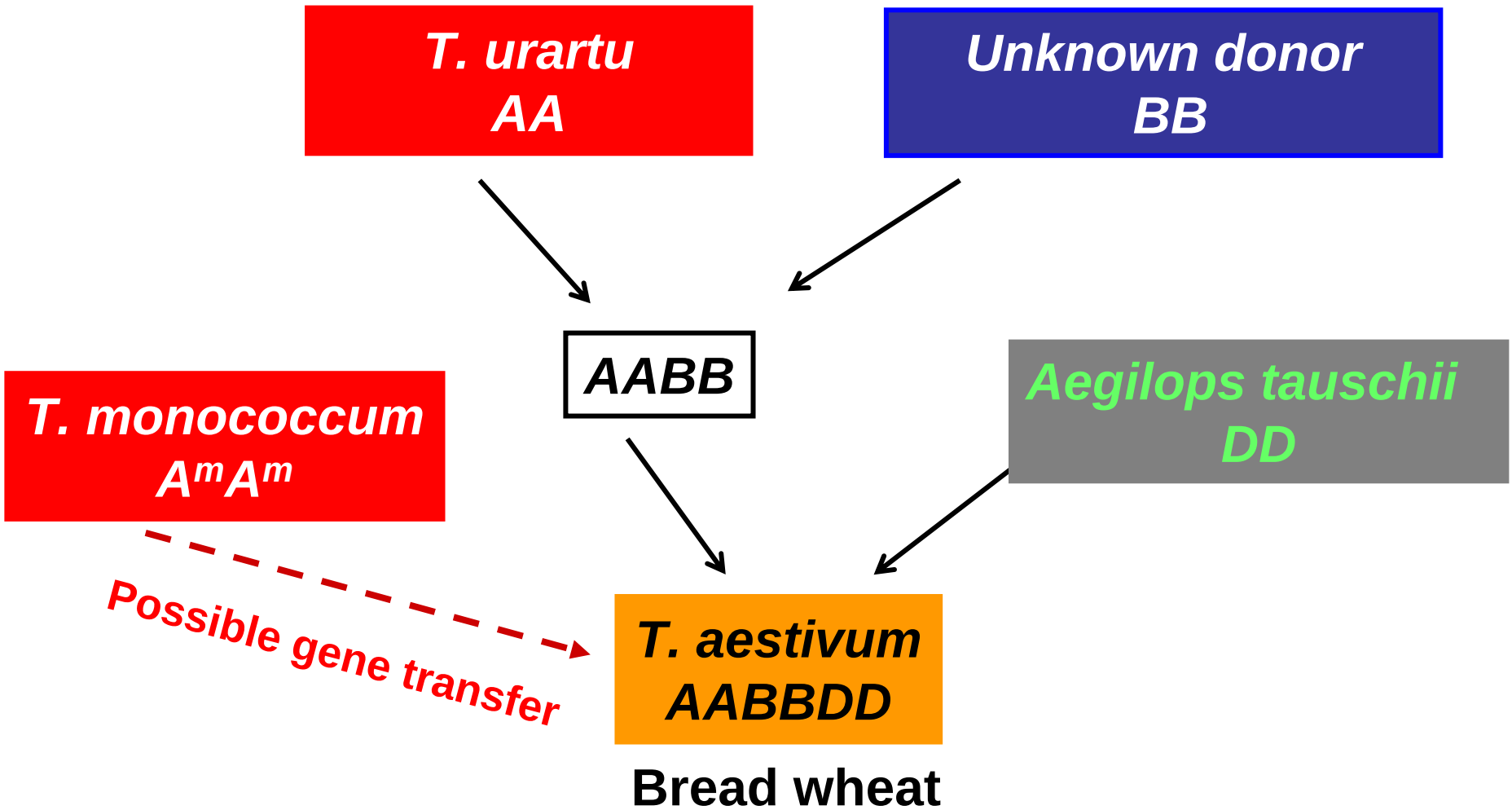
To undertake genome specific TILLING in hexaploid bread wheat (AABBDD)

KEY OBJECTIVES

To map novel resistance sources in *T. monococcum*

To start to introgress novel resistances from *T. monococcum* into bread wheat

Using *T. monococcum* (A^mA^m) as a source of novel traits



Our preferred introgression strategy

T. monococcum A^mA^m — **Diploid**

↓ **colchicine**

Autotetraploid A^mA^m A^mA^m — **(Fully fertile)** **X** ***T. aestivum AABBDD*** — **Bread wheat**

↓

F_1 ***A^mA^m ABD*** **X** ***AABBDD***

(14 + 21 = 35 Chr)

↓

BC1 → **Select by cytology + fertility for 42 Chr** **X** ***AABBDD***

↓

Trait testing ← **BC2 (42 Chr)**

Several rounds of backcrossing

Chr - chromosomes

Anastasiya Zlatska
RRes F'ship
Kostya Kanyuka

YEAR 2 :WGIN Field Trials

T. monococcum

1, 2. Autumn and Spring sown Septoria leaf blotch trials

3. Take-all and eyespot trial

4. Yellow rust trial (Leslie Boyd, JIC Norwich)

Septoria

Yellow rust

Eyespot

Take-all

YEAR 2 :WGIN Field Experiments

T. aestivum **Hexaploid wheat – Nitrogen Use Efficiency**

Analysis of samples from year 1 WGIN trial

Peter Barraclough (RRes)

Combine grain and straw yields ✓

Grain and straw % N (Total - 768 samples)

WGIN-04 YEAR 1 Yields

yields

Combine grain yield (t/ha@85%)

LSD(5%)-1.32

Split N application

kg N/ha	Mar	Apr	May
0			
50	0	50	0
200	50	100	50
350	50	250	50
	GS 24	GS 31/32	GS 37

N	Var	AR	AV	BA	BE	CZ	CP
N0		3.82	1.83	4.18	4.85	4.12	3.42
N1		4.62	3.03	5.19	5.64	4.59	3.95
N2		8.24	2.61	8.93	10.27	9.08	7.43
N3		8.79	5.47	9.25	11.55	10.16	7.46

N	Var	CD	EI	EL	EN	FL	HE
N0		4.02	3.44	2.76	3.89	3.60	3.35
N1		4.95	4.71	4.11	5.24	4.20	4.31
N2		7.35	9.48	7.03	9.76	8.11	9.12
N3		4.19	10.96	8.30	9.85	7.51	10.56

N	Var	IS	LY	MA	MW	ME	MO
N0		2.93	3.42	3.54	3.37	3.87	3.15
N1		3.65	4.76	5.04	4.47	4.83	3.77
N2		6.17	9.60	9.28	6.99	8.60	6.54
N3		6.94	10.12	10.61	5.22	8.96	7.03

N	Var	OP	PA	PB	PE	CH	RL
N0		3.62	4.37	3.32	4.05	3.64	3.41
N1		5.27	5.30	4.74	4.69	5.70	3.90
N2		10.12	8.36	9.76	8.61	7.43	8.55
N3		11.43	8.15	10.80	8.82	8.62	8.64

N	Var	RB	SC	SO	SS	SL	SP
N0		4.24	3.81	3.98	3.48	3.30	3.71
N1		5.01	5.09	4.42	3.61	4.69	5.76
N2		9.77	10.76	8.86	5.80	7.98	9.69
N3		10.51	11.84	9.62	6.79	9.12	9.90

N	Var	XI	AP
N0		3.14	3.16
N1		4.16	4.70
N2		10.22	5.79
N3		11.21	6.14

'Nitrogen Use Efficiency'

Fertiliser Use Efficiency (FUE)

% of applied fertiliser recovered by crop

Nitrogen Uptake Efficiency (NupE)

N-uptake/N-available (Nup/Nav)

Nitrogen Utilisation Efficiency (NutE)

Grain yield/N-uptake (Y/Nup)

Nitrogen Use Efficiency (NUE)

Uptake efficiency x Utilisation efficiency

NUE = Nup/Nav x Y/Nup = Y/Nav

WGIN-04

NutE rank

YEAR 1 NutE ranking (N0 only)

(Provisional)

VAR	Yield 85% t/ha	Yield 100% t/ha	Nup kg/ha	NutE kg/kg
LY	3.42	2.91	36.6	79.5
BE	4.85	4.12	58.2	70.8
RB	4.24	3.60	51.9	69.4
OP	3.62	3.08	48.3	63.8
BA	4.18	3.55	57.8	61.4
MA	3.54	3.01	49.4	60.9
AR	3.82	3.25	53.7	60.5
SO	3.98	3.38	56.5	59.9
PA	4.37	3.71	62.9	59.1
SL	3.30	2.81	47.7	58.9
XI	3.14	2.67	45.4	58.8
SP	3.71	3.15	54.1	58.3
CD	4.02	3.42	58.7	58.2
PE	4.05	3.44	59.5	57.9
SC	3.81	3.24	57.1	56.7
ME	3.87	3.29	58.0	56.7

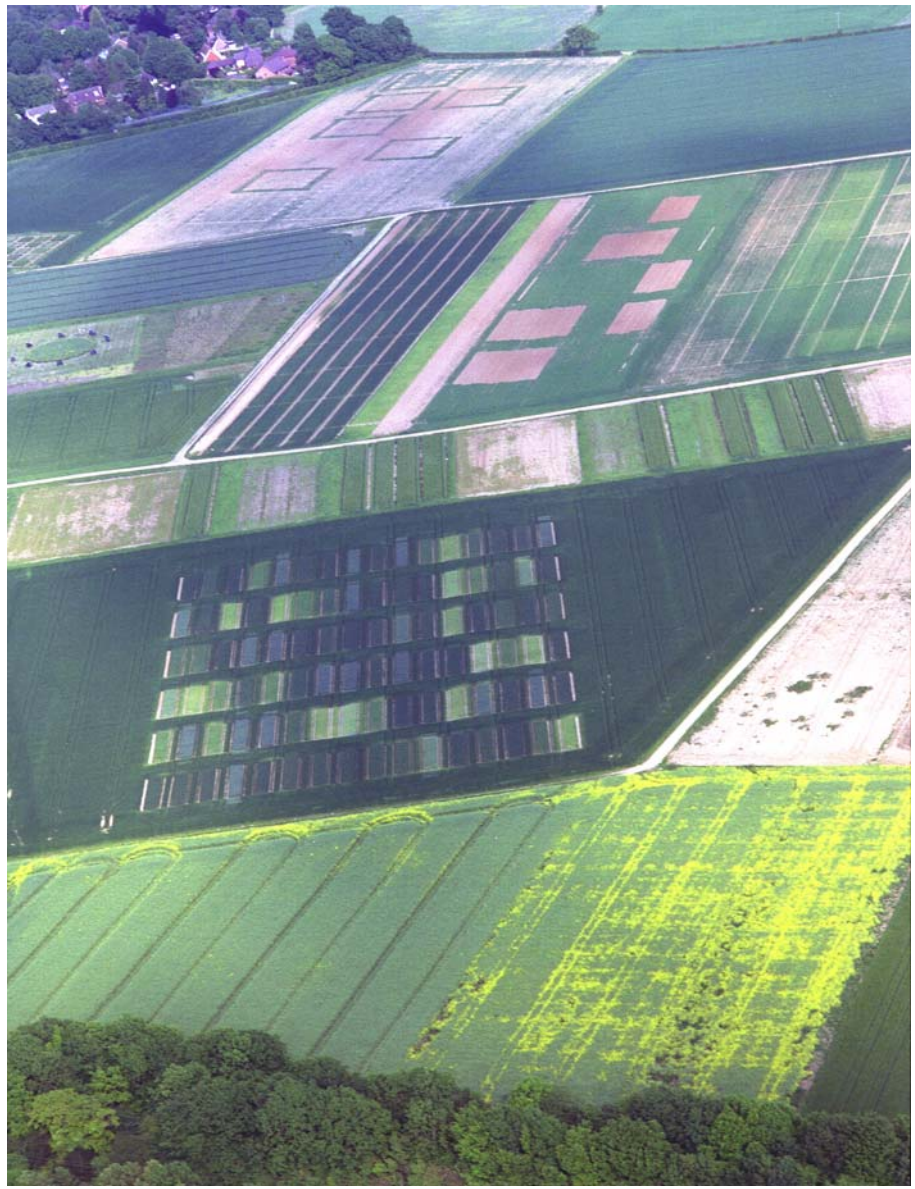
VAR	Yield 85% t/ha	Yield 100% t/ha	Nup kg/ha	NutE kg/kg
PB	3.32	2.82	51.2	55.2
EN	3.89	3.31	61.2	54.0
CP	3.42	2.91	55.1	52.8
EI	3.44	2.92	55.7	52.5
MW	3.37	2.86	54.6	52.5
RE	3.64	3.09	59.5	52.0
HE	3.35	2.85	54.9	51.9
CZ	4.12	3.50	68.0	51.5
RL	3.41	2.90	56.6	51.2
FL	3.60	3.06	60.6	50.5
AP	3.16	2.69	54.1	49.6
EL	2.76	2.35	48.8	48.1
IS	2.93	2.49	51.9	48.0
AV	1.83	1.56	33.8	46.0
MO	3.15	2.68	60.0	44.6
SS	3.48	2.96	68.3	43.3

WGIN-05

details

YEAR 2 | Rothamsted trial (Fosters)

Site: Rothamsted (Fosters)
Factors: 2 (Variety, N Rate)
Varieties: 20
N Rates: 2
Replicates: 3
Plots: 120
Plot size: 3 x 15 m
Design: Randomised blocks
Previous crop: winter oats
Sowing date: 11-13 Oct 04
Seed rate: 400/m^2
Harvest date: Aug 05



WGIN-05

objectives

YEAR 2 | Trial objectives

1. To quantify genetic variation in NUE, NupE, NutE in a range of germplasm to identify material for future studies.

2. To quantify genetic variation in selected physiological traits hypothesised to influence NUE, NupE, NutE.

WGIN-05

20 varieties

Varieties	Nabim	Rationale
Avalon	1	WGIN DH parent; DESK[1] - low NUE, NupE & NutE; WGIN-04[2] - low NutE, worst Nup
Batis	?	KHK choice; WGIN-04 - high NutE
Beaver NA	3	WGIN DH parent; High Canopy N requirement[3] ; WGIN-04 - best yield & high NutE
Cadenza	2	WGIN DH parent; WGIN-04 - best Nup
Claire	3	Best area on RL; WGIN DH parent
Hereward	1	Best protein on RL; In previous studies on N and grain quality.
Hurley	?	ELSOMS – WGIN-04
Istabraq	4	Best yield on RL; Distilling cultivar; In LINK 'Green grain'
Lynx	?	WGIN-04 - best NutE, worst Nup
Malacca	1	Best Group 1 area; DH choice; WGIN-04 - low Nup, high NutE
Maris Widgeon	1	Tall (rht), old cultivar
Mercia NA	1	DESK - low NupE & NutE; Low Canopy N requirement; In IGF micro-array
Monopol	?	KHK choice; WGIN-04 – high NupE, low NutE
Paragon	1	Spring variety; WGIN mutagenesis population; WGIN-04 - high Nup
Riband	3	WGIN DH parent; Distilling cultivar; In LINK 'Green grain'; WGIN-04 -high NutE
Robigus	3	Best Group 3 yield; DESK - best NUE, high NupE & NutE
Savannah	4	DESK - best NutE
Shamrock	1	High root length density at depth
Soissons	2	WGIN DH parent; Early maturing; WGIN-04 - best Nup, worst NutE
Sokrates	?	KHK choice; WGIN-04 - high NutE
Solstice	2	Best Group 2 area; DH choice; WGIN-04 - low Nup
Xi19	1	Best Group 1 yield; DESK - high NUE, NupE, NutE; WGIN-04 - low yield and Nup

YEAR 2 Measurements

To include:

- **Soil mineral-N (to 90 cm in February)**
- **Growth stages (GS 09, 31, 61, 92)**
- **At GS 31: N uptake in shoots; root axes per plant**
- **At GS 61: Weights, areas, numbers; %N in leaves, stems, ears; crop height**
- **At GS 92 Hand: Grain and straw yield; yield components; grain and straw %N**
- **At GS 92 Combine: Grain and straw yield; quality parameters (from sp.wt., hardness, HFN, Zeleny, Mixing, Alvin, gluten).**

ROTHAMSTED RESEARCH

Many thanks to ….

Peter Barraclough
Darren Lovell

The field team – Chris, Phil and Alan Lock
The sample processing team – Phil, Julliet and Alan
N analysis team – Jo and Ruth
Farm staff

Defra project (AR0714)
John Foulkes (Univ. Nottingham)
Malcolm Hawkesford (RRes)
Peter Barraclough (RRes)

YEAR 2 :WGIN Field Experiments

Second Wheat Syndrome

Crop sequence

Break (non-wheat) – 1st wheat – 2nd wheat

Observation

Some wheat genotypes give consistently good yields when 2nd wheat crops whilst others yield poorly

Good – Napier, Istabraq, Cordiale
Poor - Equinox, Robigus, Claire

Hypothesis to be tested

Differential sensitivity to take-all fungus

WGIN traits workshop June 2004 (UoN/ADAS)

WGIN-05

details

YEAR 2 | Second wheat syndrome field trials

Natural take-all infection
Artificial take-all inoculation

Co-ordinators

Neil Paveley (ADAS)
Rosemary Bayles (NIAB)

Technical input from

Bill Hollins (RAGT)
Geoff Bateman and Richard Gutteridge (RRes)

Thomas Jolliffe (Advanta)

WGIN Website

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

Sam Irving – Project Assistant
Sanjay Patel

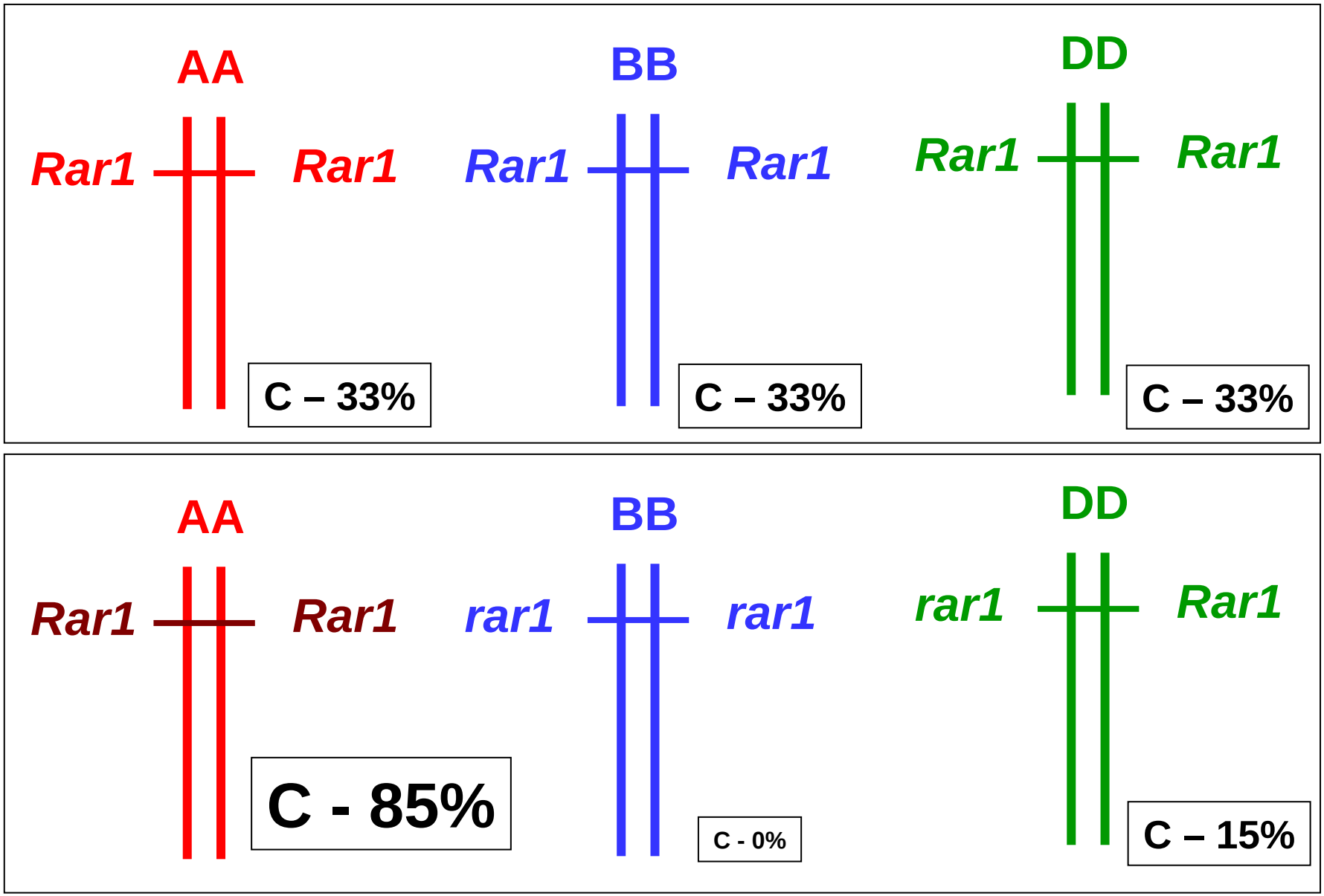
YEAR 1 Varieties

Underlined = parent of public DH mapping population

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

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

Genome specific TILLING in hexaploid wheat

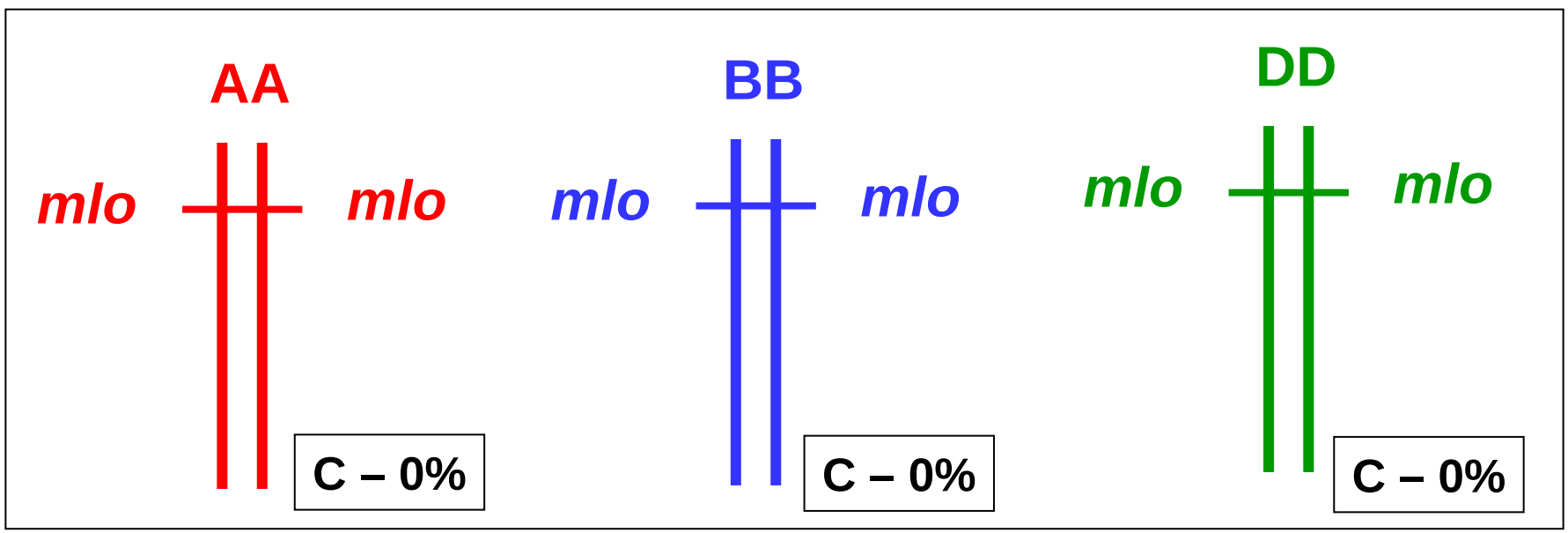


TILLING for *mlo* in hexaploid wheat

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} TILLING for B^{mlo} TILLING for D^{mlo}

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

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

$A^{mlo}AB^{mlo}BDD$ X $AAB^{mlo}BD^{mlo}D$

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

selfed

Second wheat syndrome

Recommended list yield:

	1st / 2nd wheat
Equinox	101 / 96
Robigus	106 / 99
Claire	101 / 99
Napier	103 / 104
Savannah	102 / 104
Einstein	103 / 105
Istabraq	106 / 107
Cordiale	101 / 104