

Triticum aestivum* x *Triticum timopheevii
**introgression lines as a source of
pathogen resistance genes**

Utilization of potential of wild relatives or distantly related wheat species

Search for new sources of resistance to biotic stresses



Transfer genes from wheat relatives to common wheat cultivars



**Identification of chromosomal regions with introgressed fragments
(molecular markers, C-banding, GISH)**



**Mapping of disease resistance genes by means of molecular markers
Search and validation of markers linked with resistance genes**



**Development of intermediate lines containing minimum number of
introgressions (backcrossing and selection with molecular markers)**



**Transfer of disease resistance genes to elite wheat cultivars via
marker-assisted selection**



Tetraploid wheat
T. timopheevii
 $2n=4x=28$ GGA^tA^t

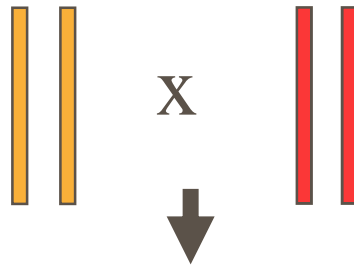
Leaf rust
Stem rust
Powdery mildew
Fusarium head blight
Septoria blotch

Development of *T. aestivum* x *T. timopheevii* introgression lines



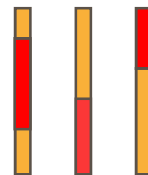
Saratovskaya 29
Skala
Irtyshtanka 10
Tselinnaya 20
Novosibirskaya 67

AABBDD AtAtGG



F₁ x *T. aestivum*

BC₁F₄₋₇
(2n=42, resistance)



BC₁F₇₋₂₀





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Resistance of *T. aestivum* x *T. timopheevii* introgression lines to different fungal diseases

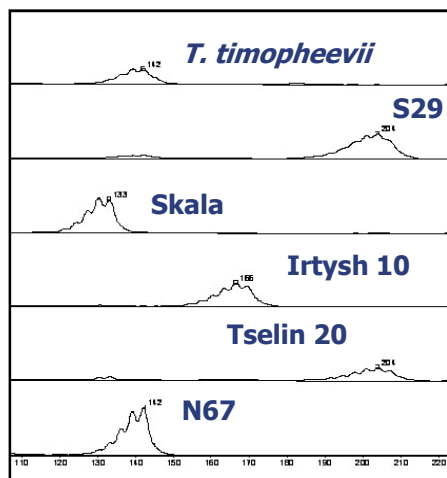


Wheat cultivar	Total number	Diseases					
		Leaf rust (<i>Puccinia triticina</i>)		Stem rust (<i>Puccinia graminis</i>)	Powdery mildew (<i>Blumeria graminis</i>)	Spot blotch (<i>Bipolaris sorokiniana</i>)	Loose smut (<i>Ustilago tritici</i>)
		R	MR				
S29	28	25	3	3	5	3	5
Skala	7	2	5	1	4	1	3
Irtysh 10	14	10	4	0	5	0	3
Tsel 20	7	3	4	0	3	1	2
N67	12	5	7	0	3	0	3

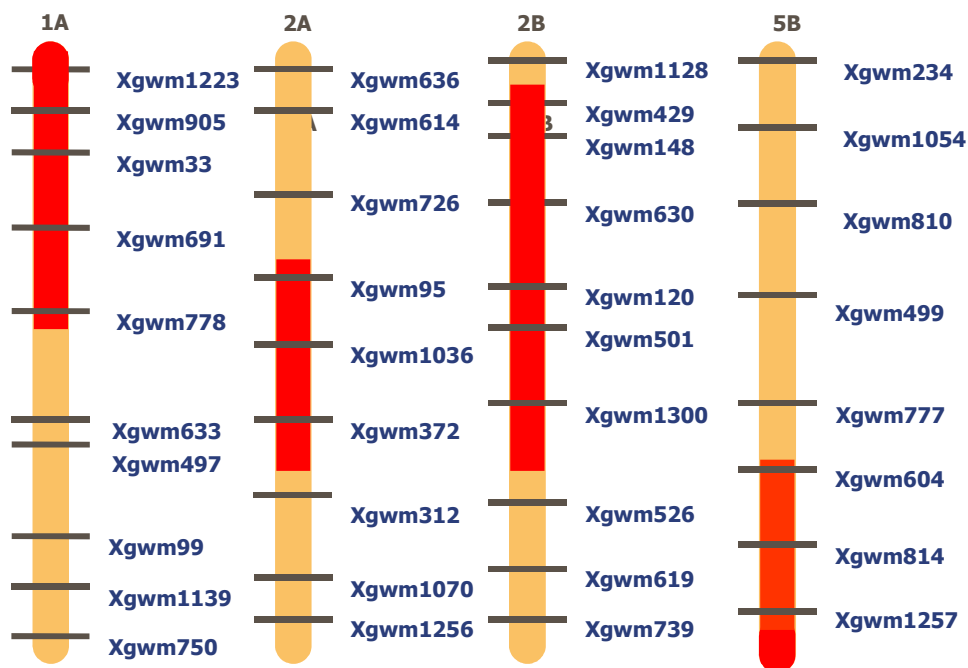
Molecular analysis of *T. aestivum* x *T. timopheevii* introgression lines

<i>Xgwm</i>	340
<i>Xgdm</i>	10
<i>Xbarc</i>	4
<i>Xwmc</i>	2

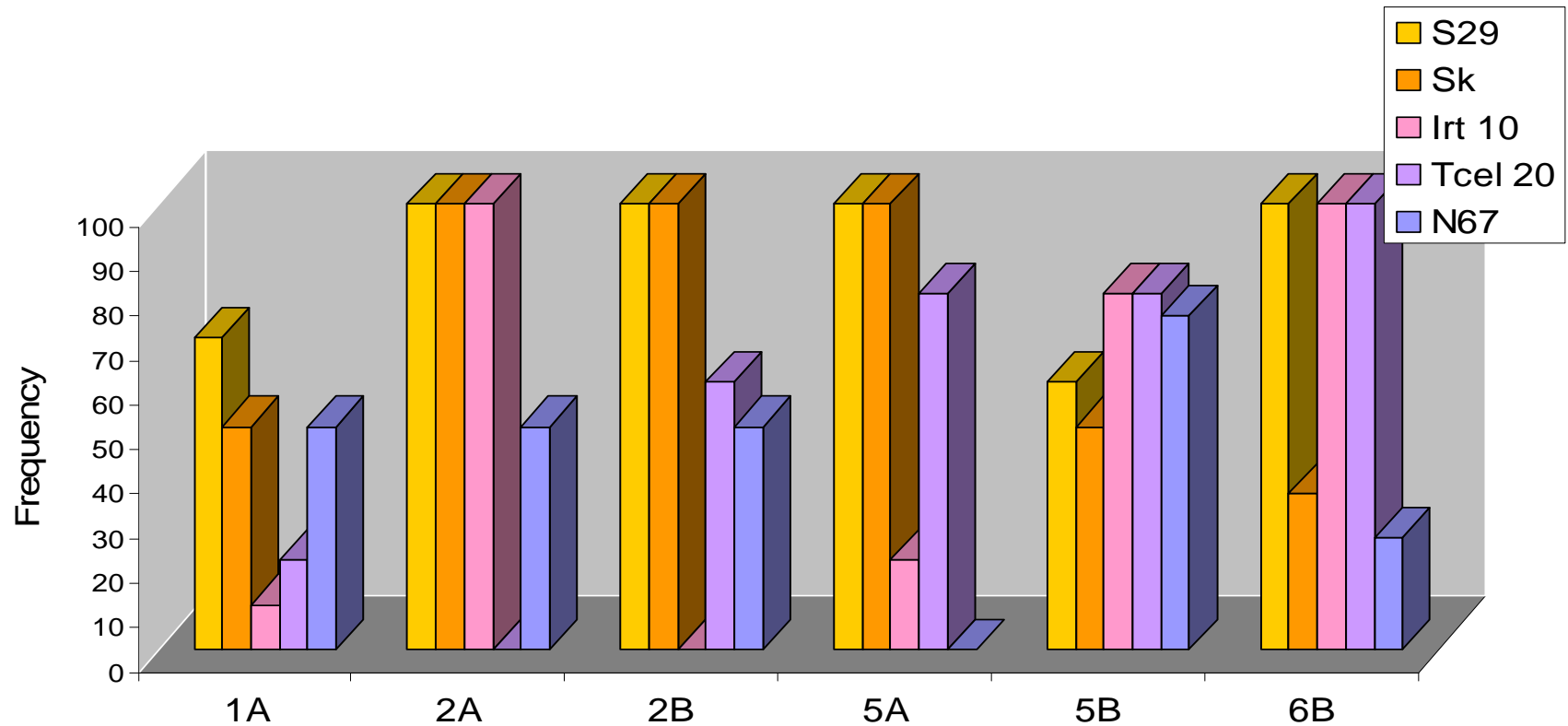
1A, 2A, 2B, 5A, 5B, 6B	15-22
1B, 1D, 2D, 3A, 3B, 3D, 4A, 4B, 4D, 5D, 6A, 6D, 7A, 7B, 7D	6-8



285



Frequency of substitutions and translocations in introgression lines



Cultivar	1B	3A	3B	4A	4B	6A	7A	7B	Σ
S29	15%	10%	30%	–	25%	–	–	–	5.3
Skala	10%	–	–	–	–	–	–	–	4.8
Irt 10	25%	–	15%	–	10%	–	–	–	4.2
Tsel 20	10%	–	–	–	15%	–	–	–	3.7
N67	15%	–	–	–	–	–	40%	–	3.0

List of microsatellite markers used for localization of QTL associated with leaf rust resistance

Chromosome	Marker
1A	Gwm 33*, 99*, 497*, 633*, 691, 750, 778, 752, 905, 1097, 1139*, 1104, 1148, barc263*, wmc24*
2A	Gwm 71, 95, 275, 296, 312, 359, 372*, 382, 497b*, 515, 614*, 636*, 726*, 846, 830, 1036*, 1054a*, 1070*, 1198, 1256*
2B	Gwm 120, 133a*, 148, 257, 429, 501, 526, 619, 630, 739, 785a*, 972, 1027, 1067*, 1128, 1177*, 1249, 1300*
4B	Gwm 165, 513, 495, 736a*, 898, 910, 925, 930, 935, 940, 946
5A	Gwm 126*, 129, 205a*, 291*, 293, 304, 617, 666, 736b, 982*, 995*, 1171
5B	Gwm 118, 205b*, 234, 371*, 408, 497*, 499*, 540, 604, 639*, 777, 810, 814*, 880, 1016, 1043, 1054b, 1072, 1246*, 1257*
6B	Gwm 219, 133c, 518*, 608, 790*, 785b, 816, 889*, 1076, 1199, 1233, 1255

* markers mapped in *T. timopheevii* (Salina et al., 2006)

Reactions of introgression lines to different isolates of *Puccinia triticina*

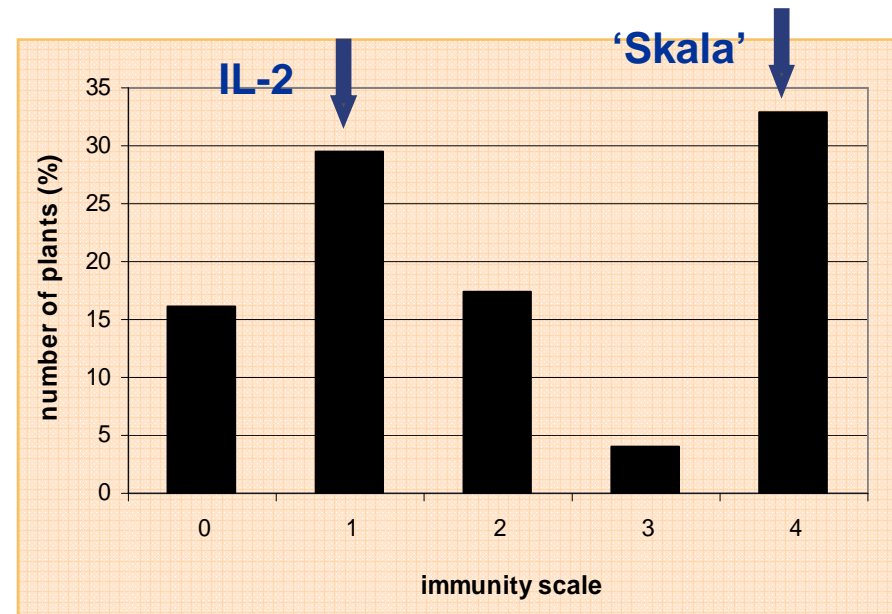
	681-13	625-1	683-3	492-8	558-3	621-5	556-5	624-1	595-4	685-5
IL-2	3	0;	0;	0;	2-3	2-3	X+	3	X	1-2
IL-3										
S29	4	4	4	4	4	4	4	4	4	4

<i>P. triticina</i> isolates	Virulences
681-13	1,2b,2c,3a,3bg,3ka,10,11,14a,17,18,20,25,26,27+31,30,33,36,39,40,B
625-1	1,2a,2b,2c,3a,3bg,3ka,10,11,14a,14b,17,18,19,20,21,23,25,26,30,33,39,40,B
683-3	1,2b,2c,3a,3bg,3ka,10,11,14a,15,16,17,18,20,23,25,26,27+31,30,32,33,36,39,40,B
492-8	1,2a,2b,2c,3a,3bg,3ka,10,11,14a,14b,17,18,19,20,21,23,25,26,27+31,28,30,33,39,40,B
558-3	1,2a,2b,2c,3a,3bg,10,11,14a,14b,17,18,19,20,25,26,27+31,30,32,33,36,39,40,B
621-5	1,2a,2b,2c,3a,3bg,3ka,10,11,14a,14b,17,18,19,20,21,25,26,27+31,28,30,32,33,36,40,B
556-5	1,2c,3a,3bg,3ka,10,11,14a,14b,17,18,20,21,25,26,27+31,30,33,40,B
624-1	1,2b,2c,3a,3bg,3ka,10,11,14a,15,16,17,18,20,23,25,26,27+31,30,32,33,36,39,40,B
595-4	1,2a,2b,2c,3a,3bg,3ka,10,11,14a,14b,17,18,19,20,21,23,25,26,27+31,30,32,33,40,B
685-5	1,2b,2c,3a,3bg,11,14a,16,17,18,20,26,27+31,30,32,33,36,40,B

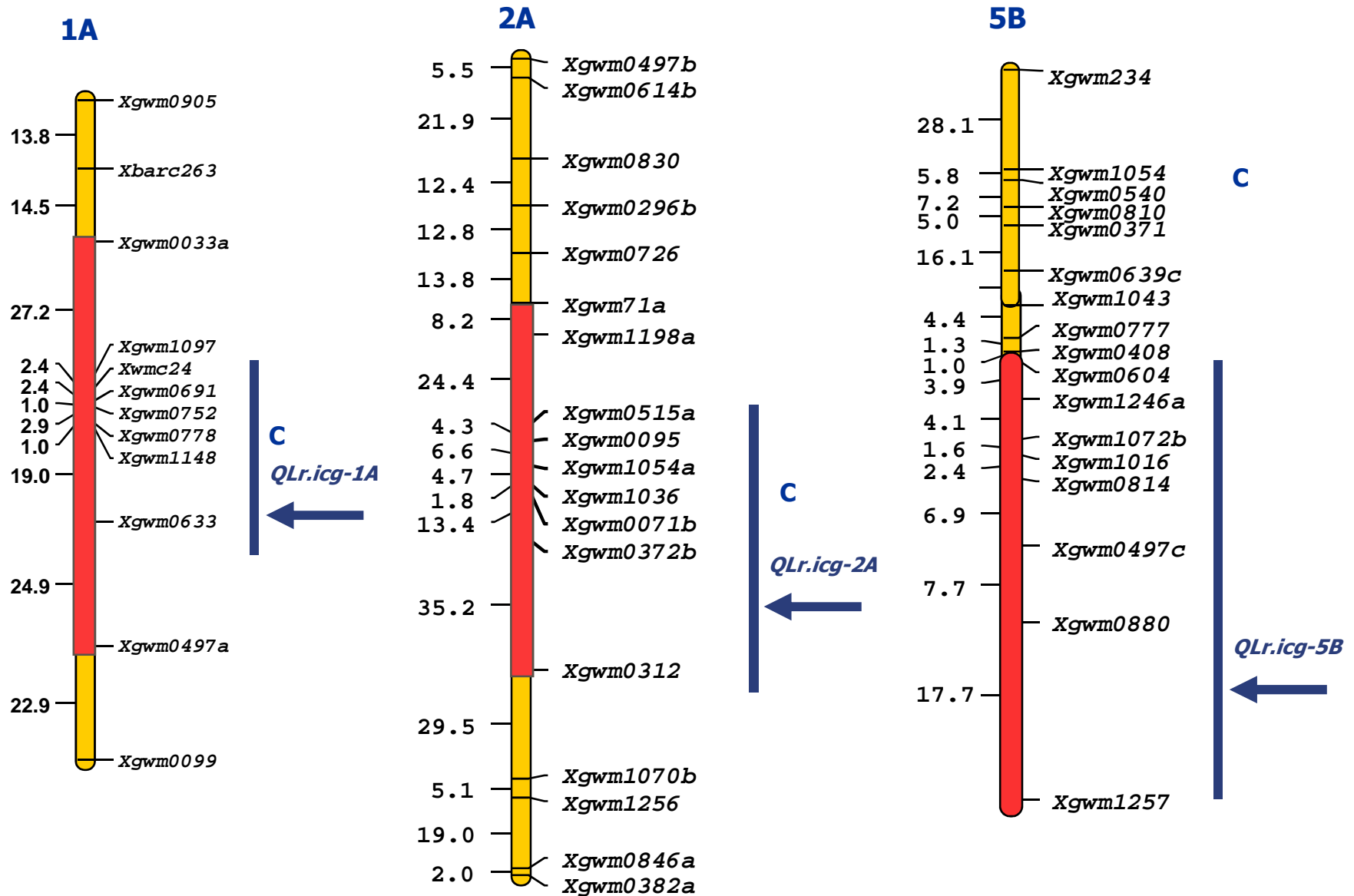
Resistance test was performed by Zhemchuzhina AI , All-Russian Institute of Phytopathology, Russia

Disease resistance test

F_{2-3}

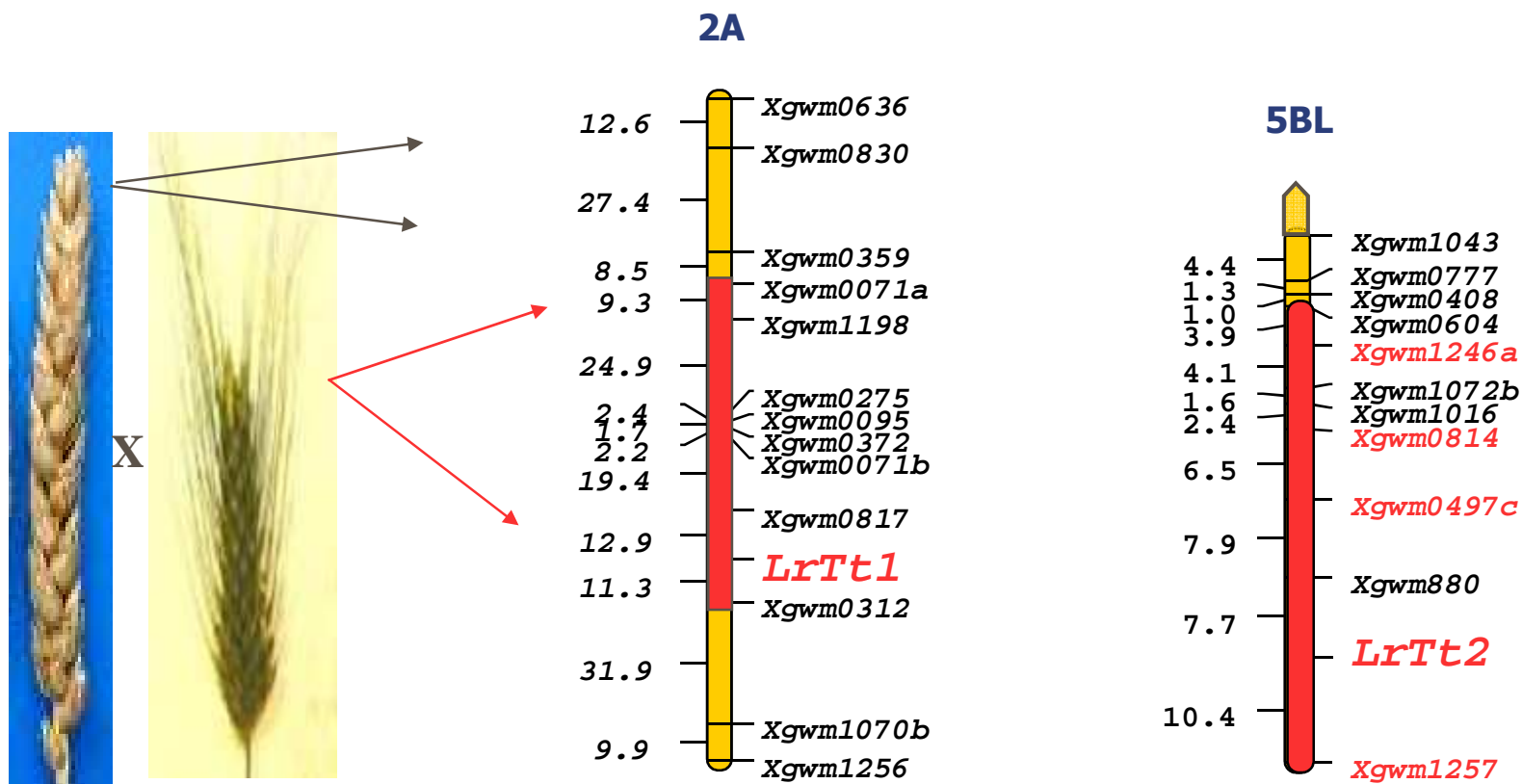


Location of leaf rust resistance loci on genetic maps of chromosomes 1A, 2A and 5B



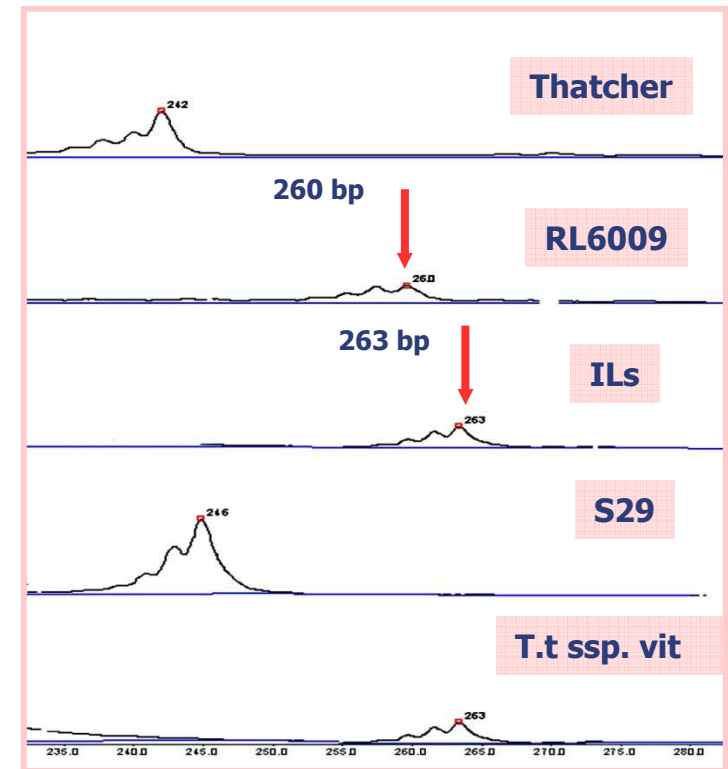
C – centromere

	Chromosome		
	1A	2A	5B
	flanking markers <i>Xgwm1097-Xgwm633</i>	flanking markers <i>Xgwm71a-Xgwm1070</i>	flanking markers <i>Xgwm408-Xgwm1257</i>
R²	8.0	11.5	64.0
LOD	2.5	2.5	17.0



Comparative analysis of ILs (*LrTt2*) and 'Thatcher' (*Lr18*) line

Marker	Fragment size (base pairs)	
	ILs/cv. 'S29'	'RL6009'/cv. 'Thatcher'
<i>Xgwm0234</i>	246/246	244/244
<i>Xgwm0540</i>	124/124	124/124
<i>Xgwm0499</i>	133/133	Null/null
<i>Xgwm0777</i>	110/110	108/108
<i>Xgwm0408</i>	null/182	180/180
<i>Xgwm0604</i>	Null/112	118/118
<i>Xgwm1246a</i>	222/236	232/232
<i>Xgwm1072b</i>	180/195	180/195
<i>Xgwm0814</i>	120/145	126/145
<i>Xgwm1257</i>	263/246	260/242

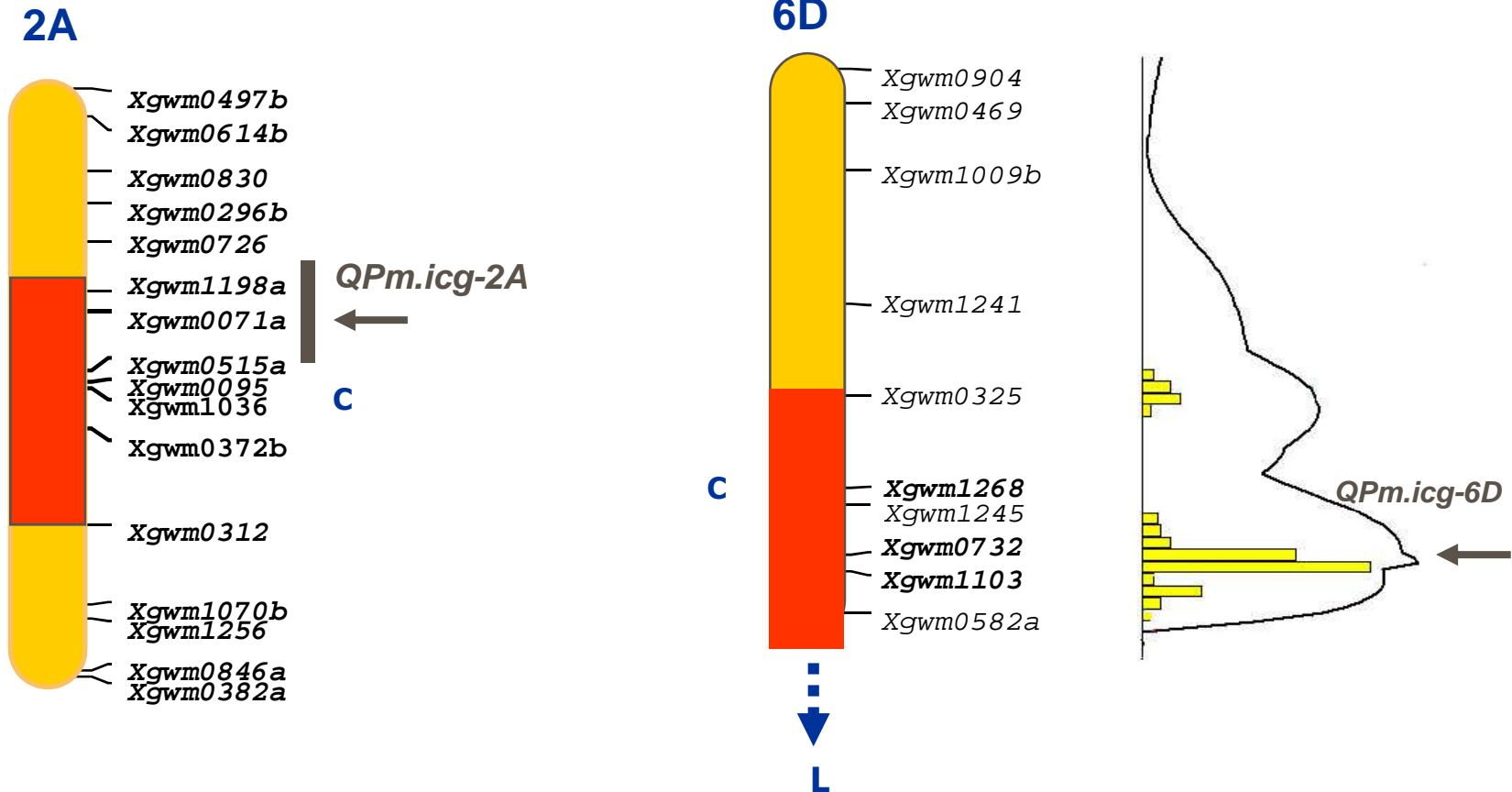


Line	Scoring of the leaf rust reaction against (0-6 scale)		
	Isolate 1 7147661074	Isolate 3 7747660174	Isolate 9 263701675
RL6009 (<i>Lr18</i>)	4.5	5.1	4.6
IL-2 (<i>LrTt2</i>)	2.3	3.0	2.2

0-3 – Resistant 4-6 – Susceptible

Resistance test was performed in Institute for Plant Protection in Field Crops and Grassland, Germany

Quantitative trait loci for reaction to *Blumeria graminis*



	Linkage group	
	2A	6D
	flanking markers <i>Xgwm0726–Xgwm0515a</i>	flanking markers <i>Xgwm0325–Xgwm1103</i>
R2	25.0	31.0
LOD	4.4	5.5

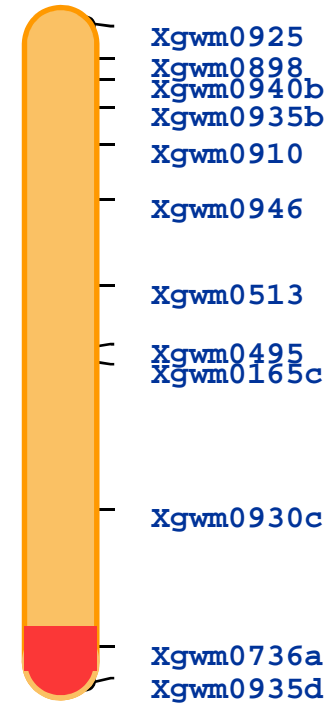
Quantitative trait loci for resistance to *Puccinia graminis*

Puccinia graminis race **TKNTF** (*Sr* 5, 21, 9e, 7b, 6, 8a, 9g, 36, 30, 9a, 9d, 10, *Tmp*, 48, *Wld*)

S29 **IL-3** **T.t**



4B/4G



	Linkage group	
	4B/4G	6B/6G
	flanking markers <i>Xgwm0736, Xgwm0935d</i> –	flanking markers <i>Xgwm0790b–Xgwm0518</i>
R2	30.0	12.0
LOD	3.5	2.5

Resistance test was performed by Skolotneva E , Lomonosov Moskow State University

Summary

Puccinia triticina



2AL		5BL	
LrTt1 (<i>T.timopheevii</i> ssp. <i>viticulosum</i>)	no loci from <i>T.timopheevii</i>	LrTt2 (<i>T.timopheevii</i> ssp. <i>viticulosum</i>)	Lr18 (<i>T.timopheevii</i> ssp. <i>timopheevii</i>)

Blumeria graminis



2A		6D	
QPm.icg-2A (2AS)	no loci from <i>T.timopheevii</i>	QPm.icg-6D	no loci from <i>T.timopheevii</i>

Puccinia graminis



6BS		4BL	
QSr.icg-6B	no loci from <i>T.timopheevii</i>	QSr.icg-4B	Sr37 = SrTt2 (<i>T.timopheevii</i> ssp. <i>timopheevii</i>)



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Thank you for your attention

