Introgression of Novel Sources of Rust Resistance from Wild *Triticum* and *Aegilops* Species into Bread and Durum Wheat Cultivars

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The Genetic base for resistance to various diseases among bread wheat cultivars in India is extremely narrow. The germplasm of wild progenitor and non-progenitor *Triticum* and *Aegilops* species comprises a huge reservoir of unexploited variability for disease resistance to various wheat diseases. The germplasm of wild *Triticum* and *Aegilops* species maintained at PAU, Ludhiana (Table 1) has been exhaustively screened under laboratory and field conditions over years and locations and a number of useful sources for resistance to leaf rust (*Puccinia recondita*) and stripe rust (*P. striiformis*) have been identified (Harjit Singh and Dhaliwal, 2000). With an aim to transfer this useful character, one or more accessions of several wild species were crossed with rust susceptible cultivars of bread and durum wheats. Backcross breeding programme with the recurrent parent was continued along with cytogenetical studies and screening for rust resistance followed by selfing till fertile and homozygous rust resistant derivatives were recovered. This introgression of new sources of resistance into cultivated wheat are reported here.

For screening at the seedling stage rust infection types were recorded according to 0-4 scale given by Stakman *et al.* (1962). The disease severity under field conditions was recorded as percentage of leaf area covered by rust following modified Cobb's scale (Peterson *et al.* 1948). For C-banding, protocol of Friebe *et al.*

Table 1. Material used for wheat germplasm enhancement

Receipient parent	Donor parent	Derivative No.	Generation	Cytological Status
T. aestivum cv. WL71	*Ae. ovata* Acc. 3547	175	BC_3F_9	5M-5D substitution
		187	BC_2F_8	5M-5D substitution
		201	BC_2F_8	2AL translocation
		206	BC_2F_8	2AL translocation
		237	BC_2F_6	2AL translocation
T. aestivum cv WL 711	*Ae. triuncialis* Acc.3549	258	BC_2F_8	5U-5A substitution
		272	BC_2F_8	5U-5A substitution
		293	BC_2F_8	No detectable alien chromatin
		297	BC_2F_8	An additional pair of acrocentric chromosomes
T. durum cv. Bijaga Yellow	*T. dicoccoides* Acc. 4656	395	BC_2F_7	Euploid (2n=28)
T. durum cv. Malvi Local	*T. araraticum* Acc. 4692	403	BC_2F_8	Euploid
T. durum vc. Malvi Local	*T. araraticum* Acc. 4697	413	BC_2F_6	Euploid
T. durum cv. Bijaga Yellow	*T. araraticum* Acc. 4699	417	BC_2F_8	Euploid
T. durum cv. MACS9	*T. araraticum* Acc.4753	422	BC_2F_7	Euploid
T. durum cv. A206	*T. urartu* Acc.5301	435	BC_1F_6	Euploid
	T. urartu Acc.5340	443	BC_4F_7	Euploid

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(1992) was followed. For molecular studies, wheat microsatellite markers were selected based on linkage map developed and STMS primers were used (Röder *et al.* 1998).

In the *Ae. ovata,* derivatives in WL 711 background, wheat chromosome 5-D has been substituted by 5M chromosome from *Ae. ovata* (derivative No. 175, 187) which has been confirmed through C-banding and microsatellite markers. Similarly in *Ae. triuncialis* derivatives 258 and 272, chromosome 5A of wheat has been substituted by 5U of *Ae. triuncialis.* In another derivative, 293, no alien chromatin could be detected with C-banding. The STMS marker gwm 368 indicated the transfer of a leaf rust resistance gene from *Ae. triuncialis* to either the A or the D genome of wheat (Aghaee–Sarbarzeh *et al.* 2001) These derivatives are maintaining resistance to leaf rust at seedling as well as field level. A third group of derivatives (297) carried an additional pair of acrocentric chromosomes. All the *Triticum durum* derivatives are with 2n=28 chromosomes with occasional univalents.

The interspecific hybridisation derivatives of cultivated bread and durum wheats were screened at the seedling stage against five prevalent pathotypes of *P. recondita* and three pathotypes of *P. striiformis* at Ludhiana and at Flowerdale, Shimla. The rust reaction at the seedling stage and in the field is presented in Table 2.

Leaf rust: All the derivatives (in *T. aestivum* and *T. durum* background) except 297 were resistant to all the *P. recondita* pathotypes used at seedling stage. Only some of the alien genes for leaf rust resistance such as *Lr* 19 and *Lr* 24 from *Agropyron elongatum* and *Lr* 28 from *Ae. speltoides* provides resistance against these prevalent and most virulent pathotypes of *P. recondita.* The resistance of most of the derivatives except 297 to all the pathotypes tested here indicate

Table 2. Seedling and field evaluation of interspecific derivatives and their parents

	Seedling Reaction*								Field Reaction**	
	Leaf Rust					Stripe Rust				
Derivative No.	IR 5 (12-2)	109R 63 (77-1)	109R 31-1 (77-2)	121R 63-1 (77-5)	21R5 (104-2)	46S 103	46S 102	46S 119	Leaf Rust	Stripe Rust
175	0;	;	;1-3	;1	;12	2	;-	;-3	R	R
182	;	;	;1	;1	;	0;	;	;	R	R
201	;	;	;1	;1	;	0;	;	3-	R	5MR
206	;	;1	;	;+	;+	;	;	2-	R	R
237	;1-	-	-	;1	;1	2	0;	2	r	r-tmr
258	;12	;12	;1	;	x	;	3	3+	10S	80S
272	x-	x	;12	;	;12	3	3	3	10S	80S
293	0;	0;-33+	0;	0;	0;	3+	3+	3	R	80S
297	0;	0;-33+	33+	0;-3	;-33+	3	3	3	10MS	20MS
395	;+	;	;	x-	;12	2	2	2	R	5R
403	;12	;	0;	x	x	3	3	3+	R	R-TR
413	0;	-	-	0;	0;	3+	3	3+	R	R
417	12	-	-	-0;	1+	2	2+	2	R	TMR
422	;1	;	0;	x	;12	2+	2+	2-	R	-
443	;1	;	;+	x+	2	2	2	2	R	R
WL711	x	3	33+	33+	3	3	3	3	60S	80S
Ae. ovata Acc. 3547	;	-	;1	;	2	-	0;	-	R	R
Ae. triuncialis	-	-	;-	;-	;1	-	-	-	R	10MR

Contd.

Table 2. Cond.

	Seedling Reaction*								Field Reaction**	
	Leaf Rust				Stripe Rust					
Derivative No.	IR 5 (12-2)	109R 63 (77-1)	109R 31-1 (77-2)	121R 63-1 (77-5)	21R5 (104-2)	46S 103	46S 102	46S 119	Leaf Rust	Stripe Rust
s Acc.3549										
Bijaga	3c	;	0;	33+	33+	x-	3	2	F	80S
Yellow										
Malvi Local	3	-	-	-3-	3+	3+	2+	3	60S	60S
MACS 9	3	-	-	;1	3+	3+	3+	3+	60S	30S
A206	;1	-	;	0;	1	3C	3C	3+	TR	TR

* Based on Stakman *et al.* (1962)

** Based on modified Cobb's scale (Peterson *et al.* 1948)

that new genes for leaf rust resistance have been introgressed from wild *Triticum* and *Aegilops* species.

Stripe rust: The *Triticum aestivum* derivatives 182, 206, 237 and *Triticum durum* derivatives 395, 417 and 443 were resistant to all the *P. striiformis* pathotypes both at seedling and adult stage under field conditions. Derivatives 175 and 201 were resistant to pathotype 46S103 and 46S102 and susceptible to pathotype 46S119. Derivative 258 was resistant to pathotype 46S102 only. Derivatives 403 and 413 were susceptible at the seedling stage to all the three pathotypes but were resistant at the adult plant stage. These derivatives may have adult plant resistance (APR) genes for stripe rust resistance. However, *triuncialis* derivatives 272, 293 and 294 were susceptible to the new currently prevalent stripe rust pathotypes both at seedling and adult stage. The resistance of some of the derivatives against all the three prevalent and highly virulent pathotypes of stripe rust indicates that at least four new genes for stripe rust resistance from *Ae. ovata, T. dicoccoides, T. araraticum* and *T. urartu* have been transferred.

These novel hitherto unexploited sources of resistance to leaf and stripe rust successfully introgressed into the cultivated bread and durum wheats are available for use in the wheat breeding programme in the country. The work to further characterise the new genes and to tag them with molecular markers for marker aided selection (MAS) and pyramiding is in progress.

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