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SOURCES OF TRIPLE RUST RESISTANCE IN DURUM WHEAT

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India is one of the important producers of durum wheat with annual production of around 2.5 million tonnes. Durum wheat is grown mostly in the states of Madhya Pradesh, Maharashtra, Rajasthan, Gujarat, Uttar Pradesh and Karnataka in India. Indian durum wheat is typically purchased by the private traders at a premium price, mainly for processing of high value products. In addition, durum wheat is preferred over bread wheat for several local food preparations (1). Rusts are among the most important diseases which cause severe yield losses in durum wheat production. Many Indian durums showed resistance to stem rust pathotypes 40A and 40-1; and leaf rust pathotypes of race 77-group, which show high degree of virulence on bread wheat varieties. However, they are susceptible to several pathotypes of stem rust race 117-group, and leaf rust pathotypes 12-5 and 104-2 (2). Hence, an effort was made to identify durum wheat genotypes with resistance to all three rusts, which can be utilized in the improvement of durum as well as bread wheat.

Table-1 : Durum genotypes with their parentage

S. No.	Genotype	Parentage
1	HI 8702	MACS 3125 /HI 8381//HI 8498
2	HI 8708	HG 822/ HI 8498
3	HI 8709	HD 4672/ PDW 233
4	HI 8715	HG 623/HD 4672//HD 4672
5	HI 8722	BRED/PBW34//ALTAR 84

Rust responses of durum genotypes tested under co-ordinated trials at multi-locations were analysed to identify resistant genotypes, which can be utilised as resistance sources in rust resistance breeding programme. Field responses recorded in different plant pathological screening nurseries like PPSN (AVT and NIVT), Elite PPSN and Multiple Disease Screening Nursery (MDSN) from 2007 to 2013 (3) were analysed.

Table-2 : Adult-plant responses of durum genotypes to mixtures of important pathotypes of the three rusts.

Genotype	Year of testing	Trial	Stem		Leaf				Stripe		Postulated genes
			South		South		North		North		
			HS	ACI	HS	ACI	HS	ACI	HS	ACI	
HI 8702	2007 – 08	NIVT 4	10S	3.2	40S	7.2	TR	0.0	5S	0.8	*Sr11+*
	2009 – 10	AVT I	5S	2.3	10S	2.0	10MR	0.8	TMR	0.1	
	2010 – 11	EPPSN	5S	1.5	5MR	1.1	TR	0	10MS	1.8	
	2011 -12	MDSN	TS	0.4	5MR	0.7	0	0	5S	1.0	
HI 8708	2007 – 08	NIVT 5B	20S	4.2	10S	2.1	TR	0.0	10S	2.1	*Sr7b+*
	2009 – 10	AVT I	5S	1.8	10MS	2.1	TMS	0.2	10S	2.4	
	2010 – 11	EPPSN	10S	3.8	TR	0.1	TMR	0.1	5MS	0.8	
	2011 -12	MDSN	TS	0.4	TR	0.1	TR	0.0	15S	3.0	
HI 8709	2007 – 08	NIVT 5B	10S	4.0	10S	1.8	10MR	2.1	15S	2.1	*Sr9e+*
	2009 – 10	AVT I	5S	2.6	30S	5.2	10MR	0.8	5MS	0.9	
	2010 – 11	EPPSN	5S	2.5	10MR	1.1	0.0	0.0	TR	0.0	
	2011 -12	MDSN	TS	0.4	TR	0.1	0.0	0.0	0.0	0.0	
HI 8715	2009 – 10	NIVT 4	10MR	1.3	5S	1.7	5MS	0.8	5MS	1.1	*Sr11+Sr2+ Lr23+*
	2010 - 11	AVT I	40S	10.2	40MS	8.9	20MR	2.3	10S	3.0	
	2011-12	EPPSN	10S	4.0	20MR	3.8	0	0	10S	5.1	
	2012-13	MDSN	20S	6.8	30MR	4.7	0	0	0	0	
HI 8722	2009 – 10	NIVT 5B	5MR	0.5	5S	0.6	20MS	4.2	40S*	5.7	*Sr2+ Lr23+*
	2010 - 11	AVT I	20MR	2.8	20MS	3.8	10MR	1.1	10S	3.0	
	2011-12	EPPSN	TS	0.5	20MS	5.3	0	0	0	0	
	2012-13	MDSN	5S	2.0	5X	1.67	5MR	0.6	5MS	1.0	

HS = Highest Disease Score (terminal severity), ACI = Average Coefficient of Infection

Table-3 : Adult-plant responses of durum genotypes to specific pathotypes of three rusts in AVT I

Genotype	Year	Stem rust				Leaf rust				Stripe rust			
		40A		117-6		77-5		104-2		46S119		78S84	
		I	P	I	P	D	L	D	L	D	L	D	L
HI 8702	2009 – 10	0	5MR	20S	5MR	5R	-	10R	-	-	5MS	0	10MS
HI 8708		5MR	10MR	20S	0	TR	-	10R	-	-	0	0	0
HI 8709		TR	20MR	60S	5MR	TR	-	10R	-	-	0	0	0
HI 8715	2010 - 11	5MR	TR	TR	TS	TMR	5R	TR	0	0	0	0	0
HI 8722		10MR	TR	20S	TMS	TMR	5R	10R	0	TR	5R	0	0

phal = Indore, P = Pune, D = Delhi and L = Ludhiana

Table-4 : Seedling responses to individual pathotypes of the three rusts

Genotype	Year	Stem rust pathotypes																			
		40A	117-6	184-1	15-2	21A-2	117a-1	117-3	40A	42B	11A	40-2	295	40-1	24a	184	15-1	34-1	117-1	117-2	11	122
HI 8702	2009-10	R	S	R	MR	R	S	MIX	R	R	R	R	R	MR	MR	R	MR	R	MR	MR	R	R
HI 8708		R	S	R	R	R	S	S	R	MS	R	R	R	S	R	R	R	R	S	S	R	MR
HI 8709		R	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	MR	R	R
HI 8715	2010-11	R	mix	R	-	R	R	R	R	R	R	R	R	R	S	-	-	R	-	R	-	-
HI 8722		R	R	R	-	R	R	R	R	R	R	R	R	R	MS	-	-	R	R	R	R	-

Genotype	Year	Leaf rust pathotypes																						
		11	12-2	12-3	12-5	12-7	12-9	77	77-1	77-2	77-5	77-7	77-8	77-10	77-11	77A-1	104-2	104-3	104-4	104 B	106	107-1	108-1	162-1
HI 8702	2009-10	R	R	R	S	S	-	R	R	R	R	R	S	R	-	R	R	-	-	Mix	S	R	R	MS
HI 8708		R	R	R	R	R	-	R	R	R	R	R	R	R	-	R	R	-	-	MR	R	R	R	R
HI 8709		S	MS	R	S	S	-	R	R	R	R	R	R	R	-	R	MS	-	-	MR	R	R	R	MR
HI 8715	2010-11	R	R	R	MR	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
HI 8722		R	R	R	MR	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

Genotype	Year	Stripe rust pathotypes														
		P	46S119	K	78S84	L	31	38A	20A	A	T	14A	19	I	N	13
HI 8702	2009-10	S	S	S	S	R	MR	R	MR	R	S	R	R	-	-	-
HI 8708		MIX	S	S	S	R	S	R	MIX	MR	MR	R	R	-	-	-
HI 8709		S	S	MIX	S	R	S	R	R	R	R	R	R	-	-	-
HI 8715	2010-11	R	S	S	S	R	R	R	R	R	R	R	—	R	R	R
HI 8722		R	S	MIX	S	R	R	R	R	R	R	R	-	R	R	R

The genotypes with maximum average co-efficient of rust infection up to 15.0 for a minimum of four years were classified as `resistant'. Responses of the genotypes to selected pathotypes of stem, leaf and stripe rusts were also taken into account for classifying the genotypes as resistant.

Five durum genotypes out of those developed at IARI-RS, Indore *viz.,* HI 8702, HI 8708, HI 8709, HI 8715, and HI 8722 with different genetic background (Table-1) were identified as resistant to stem, leaf and stripe rusts based on their adult-plant responses to mixtures of virulent pathotypes of the three rusts (Table 2). Rust resistance genes like *Sr11+* (HI 8702), *Sr7b+* (HI 8708), *Sr9e+* (HI 8709), *Sr11+Sr2+, Lr23+* (HI 8715) and *Sr2+, Lr23+* (HI 8722) were postulated in these genotypes. However, resistance response of these genotypes indicated the presence of additional genes, as postulated ones are not widely effective against Indian rust populations (Table-2). These genotypes showed high levels of adult-plant resistance to most prevalent and virulent pathotypes like the 46S119 and 78S84 of stripe rust, 77-5 and 104-2 of leaf rust, and 40A of stem rust in isolated nurseries (Table-3). It may be noted that while the stripe rust pathotype 46S119 carries virulence to *Yr9* gene which is common in bread wheat cultivars of north India, the pathotype 78S84 is virulent to PBW 343 and several other bread wheat varieties. These genotypes showed seedling susceptibility to one or more rust pathotypes except HI 8708, HI 8715 and HI 8722 which showed resistance to all the leaf rust pathotypes tested (Table 4). This indicates that their resistance is based on adult-plant genes. It may be noted that most of the durable rust resistance in wheat has been of the adult-plant type. Thus, these genotypes can be used as potential sources of resistance against all three rusts for developing triple rust resistant wheat varieties. These durum genotypes were found to be resistant to some other important diseases like powdery mildew and flag smut as well.

CONCLUSION

Rusts are among the most important diseases which pose a major threat to the wheat production globally as well as nationally. Due to continued evolution of rust pathogens, it is highly difficult to breed a variety which has long lasting resistance. Therefore, genetic base of resistance needs to be continually broadened through incorporation of diverse resistance genes. Field responses of durum genotypes tested at multi-locations during 2007-2013 in different plant pathological nurseries under heavy inoculum pressure of virulent pathotypes were analysed for identifying sources of resistance to the three rusts of wheat. The genotypes showing maximum average co-efficient of rust infection up to 15.0 for a minimum of four years were classified as `resistant'. Accordingly, five genotypes out of those developed at IARI-RS, Indore *viz*., HI 8702, HI 8708, HI 8709, HI 8715, and HI 8722 were identified as resistant to all the three rusts. These genotypes could serve as sources of triple rust resistance for developing rust resistant varieties in durum wheat.

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