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RESISTANCE TO *PUCCINIA RECONDITA TRITICI* IN SYNTHETIC HEXAPLOID WHEATS

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ABSTRACT

Sixty seven elite synthetic wheats were evaluated at seedling and adult plant stages in the greenhouse and field , respectively. 77-5, a most virulent leaf rust pathotype was used in both seedling and adult plant studies. Out of 67 accessions, 40 were highly resistant at seedling and adult plant stages, while 24 synthetic hexaploid were highly resistant as adult plants and highly susceptible as seedlings. Only 3 accessions were observed to be susceptible at both the stages. A high degree of genetic variability for leaf rust resistance was observed at both seedling and adult plant stages in these synthetic wheats. The study revealed the presence of a number of genes for seedling and adult plant resistance in synthetic hexaploid wheats. These new sources of resistance could be incorporated in hexaploid wheats to diversify the existing gene pool for leaf rust.

Key words : Synthetic hexaploid wheats, *Triticum turgidum, Triticum tauschii, Thinopyrum ponticum,* Leaf rust *(Puccinia recondita)*

Leaf or brown rust of wheat (*Puccinia recondita* Rob. ex. Desm f.sp. *Tritici)* is the most important and damaging disease of wheat (*Triticum aestivum* L.) on worldwide basis. The single most economic and environmentally viable method to manage this disease is the cultivation of resistant varieties of wheat. Genetically determined resistance to leaf rust has been used widely to control the disease. To date, 46 leaf rust resistance (*Lr*) genes have been identified in cultivated wheats and its wild relatives [1] , several of which are race specific in nature. In order to remain ahead of constantly changing rust pathogens it has been necessary to maintain genetic diversity by seeking resistance from sources other than common wheat. However, for diversification of genetic resistance some synthetic hexaploid wheats were produced from *T. turgidum* × *T. tauschii* crosses with the objective to exploit new genetic variability available for resistance or tolerance to abiotic and biotic stresses in D-genome of *T. tauschii*.

The objective of the present study was to evaluate the genetic diversity for leaf rust resistance in the synthetic hexaploid wheats.

MATERIALS AND METHODS

Sixty seven elite synthetic hexaploid wheats (*T. turgidum* × *T. tauschii*) received from CIMMYT, Mexico were used in this study. Agra local a susceptible wheat variety was used as susceptible check. All the entries were tested in glass-house and field condition with *Puccinia recondita* race 77-5.

Glasshouse testing : Nine days old seedlings of 67 accessions with the susceptible wheat check Agra local were inoculated with urediospores suspended in Tween 20. The inoculated seedlings were placed in humidity chambers overnight and then transferred to glass house bench. The glass house temperature was kept between 20-22°C. Observations on infection type (IT) were recorded 12 days after inoculation following 0-4 scale similar to that described by Stakman *et al.*, 1962 [2].

Field testing : Field evaluation was carried out by planting two rows 1 m long for each test entry with row to row spacing of 30 cm and plant to plant spacing of 5 cm in isolated single race nursery. Every 10th entry was the rust susceptible spreader row and four rows of which were planted as border rows surrounding the whole block where these sixty seven hexaploids were grown. Three rows of oat were also planted surrounding the spreader wheat rows for protecting from movement of spores from other wheat fields. Artificial epiphytotic condition was created by syringe inoculating the border rows plants at the time of beginning of culm elongation at interval of 6 days with leaf rust race 77-5. Eight irrigations were provided during crop season to keep high level of humidity required for development of rust epidemics.

RESULTS AND DISCUSSION

Sixty seven elite synthetic hexaploid wheats were grouped into three sets based on their infection types (ITs) at seedling stage and field response at adult plant stage with *Puccinia recondita* race 77-5.

Group 1 : The group comprised of 40 (59.7%) accessions displaying high level of resistance both at seedling and adult plant stage with infection types (ITs) ranging between 0-2 and field score between 10R to 30 MR, respectively (Table 1). It is well established that most genes, which confer rust resistance at seedling stage also confer adequate levels of resistance at adult plant stage. *T. tauschii* the D-genome progenitor of wheat and *T. turgidum* source of AB genome, are known to be a rich reservoir of valuable genes for resistance to diseases and pests of wheat [3-5]. *T. tauschii* (DD) and *T. turgidum* (AABB) which share chromosome homologies with bread wheat were used as

Table 1. Synthetic hexaploids showing resistant reactions both in seedling and adult plant stage against race 77-5

S.No.	Genotype (Pedgree)	Seedling Reactions	Field score
1.	ALTAR 84/AE. SQUARROSA (193)	1-1+	10MR
2.	ALTAR 84/AE. SQUARROSA (198)	12	TMR
3.	CROC 1/AE. SQUARROSA (205)	0;	TR
4.	D 67.2/P66.270//AE. SQUARROSA (218)	1+	10TMR
5.	D 67.2/P66.270//AE. SQUARROSA (220)	1+	TR
6.	DVERD 2/AE. SQUARROSA (221)	1+	TR
7.	CROC 1/AE. SQUARROSA (224)	1+2	TR
8.	68.111/RGB-U//WARD/3/AE. SQUARROSA (316)	;: 1-1	TR
9.	68.112/WARD//AE. SQUARROSA (369)	;1-	TR
10.	10.DOY1/AE. SQUARROSA (447)	1-	TR
11.	YAV3/SCO//JO69/CRA/3/YAN79/4/AE. SQUARROSA (498)	1 1+	TR
12.	68.111/RGB-U//WARD/3/AE. SQUARROSA (511)	0	10R
13.	68.111/RGB-U//WARD/3/FGO/4/RABI/5/AE. SQUARROSA (629)	1-	TMR
14.	FGO/USA/2111//AE. SQUARROSA (658)	0;	TMR
15.	68.111/RGB-U//WARD/3/FGO/4/RAB/5/AE. SQUARROSA (878)	1-	TR
16.	68.111/RBG-U//WARD/3/FGO/4/RABI/5/AE. SQUARROSA (878)	1-1	TR
17.	CROC 1/AE. SQUARROSA (879)	1	TR
18.	CETA/AE. SQUARROSA (895)	1-	TR
19.	YAR/AE. SQUARROSA (518)	1	TR
20.	BOTNO/AE. SQUARROSA (625)	0	TR
21.	SNIPE/YAV 79/DACK/TEAL/3/AE. SQUARROSA (700)	0;	TR
22.	TRN/AE. SQUARROSA (700)	1-	TR
23.	SNIPE/YAV 79/DACK/TEAL/3/AE. SQUARROSA (877)	;1-	TR
24.	GAN/AE. SQUARROSA (897)	;1-	TR

(*Table 1 contd.*)

25.	YAV 2/TEZ//AE. SQUARROSA (895)	;	TR
26.	FALCIN/AE. SQUARROSA (312)	0	TR
27.	68.111/RGB-U//WARD/3/AE. SQUARROSA (454)	;	TR
28.	GREEN/AE. SQUARROSA (458)	1	10MR
29.	CETA/AE. SQUARROSA (174)	1-	10MR
30.	SCA/A. SQUARROSA (409)	0;	TR
31.	CPI/GEDIZ/3/GOO/JO69/CRA/4/AE. SQUARROSA (409)	0;	TR
32.	STY-US/CELTA//PALS/3/SRN 5/4/AE. SQUARROSA (502)	0;	TR
33.	ALTAR 84/AE. SQUARROSA (502)	0;	TR
34.	CROC 1/AE. SQUARROSA (517)	0;	TR
35.	CETA/AE. SQUARROSA (1024)	0;	TR
36.	DVERD 2/AE. SQUARROSA (1027)	0;	TR
37.	CETA/AE. SQUARROSA (1927)	0;	TR
38.	DOY 1/AE. SQUARROSA (1030)	0	TR
39.	68.111/RGB-U//WARD/3/AE. SQUARROSA (452)	1-	10MR
40.	68.111/RGB-U//WARD/3/FGD/4/RABI/5/AE. SQUARROSA (890)	1+2	30MR

resistance gene donors, either in direct crosses, via bridging crosses or as amphidiploids. Many such genes have been directly transferred from *T. tauschii* to wheat [6]. Direct transfer of resistance genes from diploid and tetraploid species to hexaploid wheat require cytological follow-up [7]. Therefore, synthetic hexaploid wheats provide an excellent opportunity in easily transfer of these resistance genes from *T. tauschii* and *T. turgidum* to the cultivated wheats without cytological analysis. Expression of high degree of resistance indicates that the resistance genes present in these 40 synthetic hexaploids might have come from either *T. turgidum* or *T. tauschii* parents, or from their combinations.

Group 2 : Twenty four (35.8%) synthetic hexaploid wheats in this group exhibited susceptible ITs (3 to 3^+) on seedlings and low disease severity on adult plants (TR-10 MRMS) in field tests with leaf rust race 77-5, suggesting that these accessions posses adult plant resistance (APR) (Table 2). Adult plant resistance is not expressed at seedling stage but develops as the plant reaches headings. Detection of APR is

Table 2. Synthetic hexaploids showing seedling susceptibility and adult plant resistance in field against race 77-5 during 1995-96

S.No.	Genotype (Pedgree)	Seedling Reactions	Field score
1.	ALTAR 84/AE. SQUARROSA (188)	x+	TMR
2.	DOY1/AE. SQUARROSA (188)	3+	TMR
3.	ALTAR 84/AE.'SQUARROSA (205)	33+	5MR
4.	CPI//3/GOO//J069/CRA/4/AE. SQUARROSA (208)	3+	TR
5.	5 ALTAR 84/AE. SQUARROSA (217)	33+	TR
6.	D 67.2/P66.270//AE. SQUARROSA (211)	3+	TR
7.	D 67.2/P66-270/AE. SQUARROSA (213)	3+	5R
8.	YUR/AE. SQUARROSA (217)	3+	5R
9.	ALTAR 84/AE. SQUARROSA (219)	3+	5MRMS
10.	A;TAR 84/AE. SQUARROSA (220)	3+	TR
11.	D 67.2/P66.270//AE. SQUARROSA (221)	3	TR
12.	D 67.2/P66.270//AE. SQUARROSA (222)	3	TR
13.	ALTAR 84/AE. SQUARROSA (224)	3+	TR
14.	AC089/AE. SQUARROSA (309)	33+	TR
15.	DOY1/AE. SQUARROSA (515)	3+	TMR
16.	68.111/RGB-U/WARD RESEL /3/STIL/4/AE. SQUARROSA (783)	33+	TR
17.	YAR/AE. SQUARROSA (783)	3	TR
18.	YUK/AE. SQUARROSA (864)	3+	TR
19.	68.111/RGB-U/WARD/3/FGO/4/RABI/5/AE. SQUARROSA (882)	3	TR
20.	SORA/AE. SQUARROSA (884)	3+	TR
21.	YAV 2/TEZ//AE. SQUARROSA (249)	33+	TR
22.	SNIPE/YAV79//DACK/TEAL/ AE. SQUARROSA (629)	3	TR
23.	D 67.2/P66.270//AE. SQUARROSA (659)	3	IDMRMS
24.	ALTAR 84/AE. SQUARROSA (JBNGOR)	3+	IDMRMS

difficult because of variable expression of genes conferring adult plant resistance, however it has become clear that interaction of these genes provides an important component towards durability of resistance. Adult plant resistance to leaf rust has been reported to be present in many wheat varieties from Indian subcontinent when tested with Mexican pathotypes [8]. Genes *Lr 12, Lr 13, Lr 22a, Lr22b and Lr 34* confer adult plant resistance but some of these sources are known to be race- specific. The South American cultivar Frontana is considered to be best source of durable resistance, and three wheats with partial resistance are reported to have adult plant resistance due to additive interaction of *Lr34* and two or three additional slow rusting genes [9]. This group of elite synthetic hexaploid wheats possessing APR provides an opportunity to search for new sources of resistance, some of which could be durable in nature.

Group 3: Of the four entries included in this group, three are synthetic hexaploids and one, Agra local, a susceptible check with field reaction as high as 90S indicative of the fact that rust development in field condition was of very high order. All the four entries showed high susceptibility in seedling (IT 3^{+}–4) and high disease severity on adult plants in field tests (40MSS - 90S) (Table 3).

Table 3. Synthetic hexaploids showing susceptibility in seedlings as well as in adult plants against race 77-5 during 1995-96

S.No.	Genotype (Pedgree)	Seedling reactions	Field score
1.	GAN/AE. SQUARROSA (180)	3+	40MSS
2.	BOTNO/AE. SQUARROSA (620)	33+	60S
3.	D 67.2/P66.270//AE. SQUARROSA (633)	3+	50S
4.	AGRA LOCAL	4	90S

The present study with sixty seven elite synthetic hexaploid wheats indicate that these synthetic hexaploids are new sources of genes for seedling and adult plant resistance accumulated from *T. turgidum* and *T. tauschii* parents. In India, *Lr9, Lr19* and *Lr24* are providing high level of seedling resistance to all the pathotypes of leaf rust. However, genes *Lr19* and *Lr24*, are known to be present in the D genome of wheat, have been contributed by *Thinopyrum ponticum* suggesting that some of the genes identified in synthetic hexaploids might be new sources of leaf rust resistance. Therefore, allelic test may be conducted to ascertain the allelic relationship of resistance genes identified in synthetic hexaploids with already known genes. For exploring the additional variability for resistance, these accessions may be tested with multipathotypes of *P. recondita*.

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