Exploitation of synthetic hexaploids (*Triticum turgidum* x *T. tauschii*) for some biotic resistances in wheat

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The emphasis of CIMMYT's Wheat Breeding Program is to utilise the alien genetic diversity of the annual and perennial *Triticeae* that complements the conventional gene pool available for *Triticum aestivum* improvement. Of the many species related to common wheat, goatgrass (*T. tauschii* (Coss) Schmal; syn. *Aegilops squarrosa* L.; genomes DD, 2n = 2x =14) may be the most useful for wheat improvement. So far wheat germplasm with resistance to leaf rust (Cox *et al.* 1994), Karnal bunt (Villareal *et al.* 1995), septoria tritici blotch (May and Lagudah 1992), cereal cyst nematode (Eastwood *et al.* 1991), Hessian fly (Cox and Hatchett 1994), and greenbug (Gill *et al.* 1991) derived from this species has been developed. Goatgrass also appears to be a potent source of new variability for important yield components such as 1000-kernel weight, increased photosynthetic rate, and improved bread making quality (Peña *et al.* 1991; Reese *et al.* 1994; Villareal *et al.* 1994).

Screening the *T. tauschii* accessions is sometimes difficult because of the winter growth habit, tendency for shattering and for potential weed problems of the *T. tauschii* accessions. Hybridisation with spring durum wheats has more adequately facilitated evaluation of the resulting synthetic hexaploids (AABBDD, 2n = 6x = 42; SH) without having to deal with vernalisation (Mujeeb-Kazi 1995). To date, about 570 SHs have been developed with a majority involving a unique *T. tauschii* accession by the Wide Crosses Program at CIMMYT. A number of entries have been screened for selected biotic/abiotic conditions. Taxonomic and agronomic traits of a few synthetics such as anthesis, plant growth, biomass, harvest index, grain yield, yield components, pigmentation and pubescence have also been studied (Villareal *et al.* 1994). This report presents the results of screening SHs that have emanated from the use of the *T. tauschii* gene pool for resistance to spot blotch (*Cochliobolus sativus* Ito et Kurib), septoria tritici blotch (*Mycosphaerella graminicola* (Fuckel) Schroeter) and Karnal bunt (*Tilletia indica* Mitra) in

Table 1. Some synthetic hexaploids resistant to septoria tritici blotch (*Mycosphaerella graminicola*) at Toluca, Mexico.

Synthetic hexaploid	Cross N°	Septoria score* 1993	Septoria score* 1995
Aco89/*T. tauschii* (309)	CIGM90.525	21	21
Altar 84/*T. tauschii* (224)	CIGM86.942	31	31
Doy/*T. tauschii* (515)	CIGM90.566	11	21
D67.2/P66.270// *T. tauschii* (223)	CIGM88.1219	31	31
Gan/ *T. tauschii*(523)	CIGM90.824	21	21
Mexi/Vic//Yav/3/ *T. tauschii* (659)	CIGM90.879	11	21
Sca/ *T. tauschii* (523)	CIGM90.849	11	21
Stn/ *T. tauschii* (358)	CIGM90.818	11	31
Yar/ *T. tauschii* (493)	CIGM89.463	11	21
Yav/Dack//Rabi/3/Snipe/4/ *T. tauschii* (460)	CIGM88.1348	11	21
Esmeralda 86 (Susc. BW Check)		89	99
Opata 85 (Susc. BW Check)		99	99

* Used double-digit scoring of Saari and Prescott (1975).

various locations in Mexico.

Experiment 1. Evaluation of SH for resistance to septoria tritici blotch

The SH wheats and two susceptible bread wheat checks, Esmeralda 86 and Opata 85, were each planted in a 2 m double rows spaced at 15 cm between rows in 90 cm beds at Toluca (19° 17'N, 99°39'W, 2640 m elevation), Mexico, in May 1993 and 1995 for septoria tritici blotch screening. Inoculation was done artificially by spraying a mixture of five isolates of the pathogen. The inoculum concentration of 10^8 -10^9 spores ml^{-1} of water was applied once a week for three weeks beginning at full tillering. Septoria infection was assessed using a double digit scale (00-99) that measured foliar infestation. Disease scores were taken when at least four leaves were still alive and green (soft to mid-dough growth stage). A high frequency of resistant SHs were recorded. Some of the most resistant materials during the two years of field test are presented in Table 1.

Experiment 2. Evaluation of SHs for resistance to *Cochliobolus sativus*

Field screening of 525 durum-based SH germplasm under a natural epidemic location was conducted in Poza Rica (20°32'N, 97°26'W, 60m elevation), Veracruz, Mexico during the winter (November-March) over two years. Bread wheat cultivars BH1146 and Ciano79 were included as resistant and susceptible checks, respectively. Each plot consisted of 2 rows, 20 cm apart and 2 m long. Disease evaluations were based upon foliar infestation and grain blemish at maturity. Foliar infestation was assessed using the double digit 00 -99 scale. Grain infection at maturity was scored for severity of damage using a 1 to 5 scale. Some results highlighting a few SH wheats are provided in Table 2. More detailed information is reported by Mujeeb-Kazi et al. (1996).

Table 2. Some synthetic hexaploids resistant to spot blotch (*Cochliobolus sativus*) at Poza Rica, Mexico during the 1994-95 at 1995-96 wheat cycles.

Synthetic hexaploid	Dis. Score 94-95 Leaves*		Dis. Score 94-95 Seed**	Dis. Score 95-96 Leaves*		Dis. Score 95-96 Seed**
	a	b		a	b	
Cpi/Gediz/3/Goo//Jo69/Cra/4/*T.tauschii* (409) CIGM93.388	92	92	1	92	92	1
Doy1/T. tauschii (188) CIGM88.1175-0B	93	94	2	92	93	1
Doy1/ *T. tauschii* (333) CIGM92.1682	93	93	2	93	93	1
Doy1/ *T. tauschii* (447) CIGM88.1344-0B	92	93	2	92	93	1
Doy1/*T. tauschii* (458) CIGM92.1727	92	92	1	92	92	1
Gan/*T. tauschii* (408) CIGM90.824	92	92	1	92	92	1
Sca/*T. tauschii* (518) CIGM90.845	92	92	1	92	93	2
Scoop1/*T. tauschii* (358) CIGM90.820	92	93	2	92	92	1
Snipe/Yav79//Dack/Teal/3/*T.tauschii* (877) CIGM90.906	92	93	2	93	93	2
68.111/Rgb-U//Ward/3/Fgo/4/Rabi/5/ *T. tauschii* (629) CIGM90.590	92	92	1	92	92	1
68112/Ward//*T. tauschii* (369) CIGM88.1313	92	93	2	92	93	1
Ciano 79 (Susc. BW Check)	97	99	5	97	99	5
BH1146 (Res. BW Check)	95	97	3	95	97	3

*Used double-digit scoring of Saari and Prescott (1975); a = data recorded at milk stage; and b = data collected during soft dough stage. ** Grain infection scored for the severity of damage using a 1 to 5 scale (5 = 81 to 100% of grains have black point).

Experiment 3. Evaluation of SHs for resistance to Karnal bunt(KB)

More than three cycles of field screening SHs for KB resistance were conducted at Yaqui Valley, Cd. Obregon (27°20'N, 105°55'W, 39 m elevation), Sonora, Mexico. WL711 a susceptible cultivar from India was used as the bread wheat check. Ten random tillers from each test entry were inoculated during the boot stage, injecting 1 ml $tiller^{-1}$ of the sporidial suspension with a hypodermic syringe. At maturity, the 10 spikes from each plot were harvested and hand threshed to determine the percentage of kernels infected with KB. A list of selected KB resistant synthetics is shown in Table 3. A few of these SHs have been registered (Villareal *et al.* 1996).

Table 3. Some synthetic hexaploids resistant to Karnal bunt (*Tilletia indica*) for more than two cycles of screening at Yaqui Valley, Cd. Obregon, Sonora, Mexico.

Synthetic hexaploid	Cross N°.	% KB Score*
Altar 84/*T. tauschii* (188)	CIGM87.2765	0
Altar 84/*T. tauschii* (198)	CIGM87.2768	0
Altar 84/*T. tauschii* (221)	CIGM87.2761	0.87
Altar 84/*T. tauschii* (223)	CIGM87.2762	0
Croc1/*T. tauschii* (224)	CIGM86.949	0
Doy1/*T. tauschii* (188)	CIGM88.1175	0.25
Duergand/*T. tauschii* (221)	CIGM86.953	0
Yuk/*T. tauschii* (217)	CIGM90.561	0
68.111/Rgb-U//Ward/3/Fgo/4/Rabi/5/*T. tauschii* (890)	CIGM89.564	0
68112/Ward//*T. tauschii* (369)	CIGM88.1313	0.45
WL711 (Susc. BW Check)		65

*Mean KB score for more than two cycles of screening (1993 to 1995)

Summary

Wide diversity of resistance in the various SH wheats was observed during the field screening in Mexico. In most cases, the durum cultivars involved in these SH combinations were generally susceptible (data not presented). A resistant SH wheat is hence interpreted to be so because of the respective *T.tauschii* accessions involvement. The resistant SH germplasm identified in the present study are all spring types and can readily be crossed to bread wheats. It is anticipated that this approach will contribute to the availability of additional genetic variability for wheat breeding efforts for resistance to septoria tritici blotch, spot blotch and Karnal bunt. The SH bridge also allows not only the *T. tauschii* resistance to be exploited but also incorporates the genetic diversity of the A and B genomes of the respective durum cultivars. Based upon the agronomic evaluations (Villareal *et al.* 1994) and disease screening data, elite SH types have been identified for wheat improvement.

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