

Short Communication

Inheritance of resistance to *Tilletia indica* (Mitra) in synthetic hexaploid wheat × *Triticum aestivum* crosses

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With 2 tables

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Abstract

Inheritance of resistance to Karnal bunt was investigated in the crosses of four resistant synthetic hexaploid wheats (SH; *Triticum turgidum* × *T. tauschii*) and two susceptible *T. aestivum* cultivars. The resistance was dominant or partly dominant over susceptibility. The SH cultivars Chen/*T. tauschii* (205) and Chen/*T. tauschii* (224) have single dominant resistance genes which could be allelic to each other. 'Altar 84'/*T. tauschii* (219) appeared to have two dominant genes for resistance. 'Duergand' *T. tauschii* (214) possessed two complementary dominant genes for resistance. The work is being extended to involve diverse Karnal bunt-resistant SH and bread wheat cultivars.

Key words: *Triticum aestivum* — *Triticum tauschii* — *Tilletia indica* — resistance inheritance — Karnal bunt — synthetic hexaploid

Karnal bunt (KB) of wheat incited by *Tilletia indica* Mitra causes infection to wheat and triticale during heading. The teliospores of KB are seed-transmitted and can also survive in the soil for many years. Stubble burning also disseminates teliospores over long distances (Matsumoto 1986). Because the pathogen is seed- soil- and air-borne, successful chemical control is limited. The development of cultivars with genetic resistance appears to be the only economic and effective method of control.

High levels of resistance to the disease have been reported in durum wheat, triticale and several *Aegilops* species, which can serve as sources of resistance (Warham et al. 1986, Rajaram et al. 1991). Recently, some synthetic hexaploid wheats (SH) derived from *Triticum turgidum* × *Triticum tauschii* crosses have shown immune or highly resistant responses to the disease, and offer new genetic variability for resistance to KB (Villareal et al. 1994). Resistance to such a high degree is generally lacking in bread wheats (*T. aestivum* L.). The majority of the CIMMYT germplasm-derived bread wheats are susceptible to the KB fungus which became established in northwest Mexico in the late 1960s. For this reason, breeding of wheats with resistance to KB currently receives high priority at CIMMYT.

Knowledge of the genetics of KB resistance is a prerequisite for efficient utilization of resistance stocks in the breeding programme, but information is limited. KB genetic studies on bread wheats have shown that resistance is partially dominant over susceptibility (Chand et al. 1989, Gill et al. 1990, Singh 1994). Moreover, some studies have claimed that additive or additive × additive gene effects are very important in the inheritance

of resistance (Chand et al. 1989, Gill et al. 1990, Morgunov et al. 1994). Gill et al. (1990) reported that resistance is controlled by polygenes, while Morgunov et al. (1994) demonstrated simple monogenic inheritance. Three recent genetic studies conducted at CIMMYT have identified six different genes involved in KB resistance. In one particular wheat, up to three genes were identified (Singh 1994).

This study is an attempt to determine the genetic basis of KB resistance in six crosses involving resistant SH and susceptible *T. aestivum* cultivars.

The study was conducted using four resistant SH and two susceptible bread-wheat cultivars. The SH wheats originated from the Wide Crosses Programme at CIMMYT and were selected for their immune response to KB in earlier field screenings performed in Mexico. The resistant SH were: 'Altar 84'/*T. tauschii* (219), 'Chen'/*T. tauschii* (205), 'Chen'/*T. tauschii* (224) and 'Duergand'/*T. tauschii* (214) (Villareal et al. 1994). The susceptible parents were 'Seri 82' and 'Opata 84', which are cultivars released in Mexico.

The experimental material comprised the parents, their F₁ hybrids, and individual F₂ plant-derived F₃ progenies. These were space-planted, 10 cm apart in 90 cm-wide beds as two-row plots 1 m long, with 20 cm between rows, at the Mexican National Agricultural Research Institute for Northwest Region (CIANO), Sonora, Mexico during the 1993–94 wheat production season. The trial received high levels of agronomic input and management regarding fertilizer (150 kg N/ha and 40 kg P/ha), irrigation, weed control (selective herbicide); no insect control programme was required at any time during the season.

Artificial inoculation of the test material was done by using sporidia obtained from KB teliospores from the Yaqui Valley, Sonora, Mexico. Five randomly-selected spikes in the boot stage of each experimental entry were injected with a suspension of KB sporidia in water (10,000 sporidia/ml of water) as described by Fuentes-Davila (1992). Optimum relative humidity required for successful disease infection was applied after inoculation using overhead sprinklers with fine nozzles. At maturity, the inoculated spikes were harvested for each entry and hand-threshed to determine the percentage infection of KB fungus. The mean KB infection levels of the parents and F₁ hybrids were subjected to analysis of variance (SAS Institute 1988). Mean separation of the infection scores was conducted using the least significant difference (LSD). The χ^2 test was applied to estimate the difference between the observed and expected distributions of the F₃ random lines.

The analysis of variance showed that cultivar differences were highly significant ($P < 0.01$). The four SH lines were immune (0% infection) to KB, while the susceptible cultivars 'Seri 82' and 'Opata 84' had 16.9% and 17.3% infection, respectively

Table 1: Mean Karnal bunt infection of parental cultivars and F₁ using artificial inoculation at CIANO, Sonora, Mexico during the 1993–94 wheat season, (R, resistant; S, susceptible)

Parent–F ₁	Type	Mean % of KB-infected grains ¹
Parental cultivars		
Altar 84/ <i>Triticum tauschii</i> (219)	R	0a
Chen/ <i>T. tauschii</i> (205)	R	0a
Chen/ <i>T. tauschii</i> (224)	R	0a
Duergand/ <i>T. tauschii</i> (214)	R	0a
Seri 82	S	16.9d
Opata 84	S	17.3d
F ₁		
Altar 84/ <i>T. tauschii</i> (219)//Seri 82	R × S	0.01a
Chen/ <i>T. tauschii</i> (205)//Opata 84	R × S	1.02ab
Chen/ <i>T. tauschii</i> (224)//Seri 82	R × S	1.42b
Chen/ <i>T. tauschii</i> (224)//Opata 84	R × S	1.57b
Duergand/ <i>T. tauschii</i> (214)//Seri 82	R × S	5.67c
Duergand/ <i>T. tauschii</i> (214)//Opata 84	R × S	6.42c

¹Any two means with a common letter are not significantly different at 0.01 level of probability

(Table 1). The mean KB infection of the F₁ derived from the resistant SH × susceptible *T. aestivum* crosses ranged from 0.01% to 6.42%. Based on the F₁ reaction of the 'Altar 84'/*T. tauschii* (219)//'Seri 82', 'Chen'/*T. tauschii* (205)//'Opata 84', 'Chen'/*T. tauschii* (224)//'Seri 82' and 'Chen'/*T. tauschii* (224)//'Opata 84' crosses, the resistance appeared to be dominant over susceptibility (Table 1). The F₁ infection scores of the 'Duergand'/*T. tauschii* (214)//'Seri 82' and 'Duergand'/*T. tauschii* (214)//'Opata 84' crosses indicated partial dominance of resistance (Table 1).

The segregation of the F₃ lines for the six crosses studied is summarized in Table 2. F₃ lines were grouped into two classes: (1) homozygous or segregating for resistance, and (2) homozygous for the parental type susceptibility. The F₃ in the crosses of 'Chen'/*T. tauschii* (205)//'Seri 82', 'Chen'/*T. tauschii* (224) with 'Seri 82' and 'Opata 84' were distributed as 3 resistant: 1 susceptible, indicating a single major gene for resistance. The 'Altar 84'/*T. tauschii* (219)//'Seri 82' F₃ segregation pattern showed a good fit to 15 resistant: 1 susceptible, supporting the presence of two genes. Finally, the F₃ of the crosses of 'Duergand'/*T. tauschii* (214) with 'Seri 82' and 'Opata 84' segregated as 9 resistant: 7 susceptible, indicating that resistance is governed by two complementary genes.

Cross	F ₃ lines		Ratio R:S	χ ² Value	P
	R. ¹	S. ²			
'Altar 84'/ <i>Triticum tauschii</i> (219)//'Seri 82'	103	6	15:1	0.09	0.75–0.90
'Chen'/ <i>T. tauschii</i> (205)//'Opata 84'	88	27	3:1	0.13	0.75
'Chen'/ <i>T. tauschii</i> (224)//'Seri 82'	92	28	3:1	0.17	0.50–0.75
'Chen'/ <i>T. tauschii</i> (224)//'Opata 84'	89	31	3:1	0.04	0.75–0.90
'Duergand'/ <i>T. tauschii</i> (219)//'Seri 82'	70	50	9:7	0.21	0.50–0.75
'Duergand'/ <i>T. tauschii</i> (219)//'Opata 84'	65	52	9:7	0.01	0.90

¹Either segregating or homozygous for KB resistance, ²Homozygous for the parental type susceptibility

Because the intercrosses between the synthetic wheats were not studied, nothing is known about the KB-resistance genes present in the SH wheats. However, based on the segregation pattern, it can be postulated that a minimum of three genes for resistance could be present in the four SH wheats. This work is being continued on diverse KB-resistant SH and *T. aestivum* cultivars.

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Table 2: Segregation of random F₃ lines for reaction to Karnal bunt using artificial inoculation at CIANO, Sonora, Mexico during the 1993–94 wheat season, (R, resistant; S, susceptible)