Artificial Screening for Resistance to *Tilletia indica*

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Summary

Advanced bread wheat lines (*Triticum aestivum*), durum wheat (*T. durum*), hybrids derived from *T. aestivum* with *Agropyron* spp. and lines from basic germplasm were evaluated for resistance to *Tilletia indica*. Plants were artificially inoculated during boot stage with a sporidial suspension of 10^4/ml on three planting dates at CIANO, Cd. Obregon, Sonora, Mexico, during 1990-91. Percentages of lines with levels of infection below 5% were 33.3 for lines derived from inter-generic crosses, 36.4 for bread wheats, 59.5 for lines from the basic germplasm development program and 80.8 for durum wheats. The average percent infection of the susceptible check was 73%.

Key words: *Tilletia indica* - karnal bunt - *Triticum aestivum* - *T. durum* - *Agropyron* - inoculation - resistance

Introduction

Karnal bunt of wheat caused by the fungus *Tilletia indica* was first reported from India (Mitra, 1931), and later from Mexico (Duran, 1972), Pakistan (Munjal, 1975) and Nepal (Singh et al. 1989). It generally affects part of the grain and yield loss is not serious; however, the adverse effect on quality of wheat subproducts is important when the level of infected grains is high.

In the affected wheat-growing areas of northwestern Mexico, other factors that cause economic losses include: wheat planting restrictions, loss of seed exports, the cost of importing seed from KB-free areas, seed treatments and fumigation of commercial grain. According to Brennan et al. (1990), Karnal bunt represents an annual loss of US$7.02 million dollars in Mexico. In addition, in many countries there are quarantines against *T. indica*, which limit germplasm exchange and distribution of wheat and triticale.

The International Maize and Wheat Improvement Center (CIMMYT) initiated a project on breeding for Karnal bunt resistance about 10 years ago, with the objectives to a) identify sources of resistance, b) incorporate resistance genes into suitable genotypes, and c) evaluate and select progenies to develop resistant advanced lines that could be used by national agricultural programs.

This paper presents the results of artificial inoculation of the 7th karnal bunt screening nursery.

Materials and Methods

The field work was carried out at CIANO (Centro de Investigaciones Agrícolas del Noroeste) in the Yaqui valley, Sonora (27°20'N, 105°55'W, 39 m asl), during 1990-1991. The germplasm evaluated consisted of 256 lines: 173 bread wheats, 42 lines from the basic germplasm development program(DBG), 26 durum wheats and 15 lines from inter-generic crosses, each line planted on double row 1 m long.

Inoculum preparation. Teliospores from infected grains were isolated by agitation, filtration and centrifugation. After disinfestation with sodium hypochlorite 0.5% for 2 min and double rinse with sterile water, they were plated on water-agar (1.5%) and incubated at room temperature (20-22°C). Pieces of colonized agar, were transferred onto the lids of glass Petri plates with potato-dextrose-agar (PDA). Sporidia were collected every 24 h, counted under a hemacytometer and adjusted to a concentration of 10^4/ml.

Inoculation and evaluation. Ten spikes per line at boot stage (Zadoks et al., 1974) were inoculated by injecting 1 ml of sporidial suspension. To favor fungal development, an overhead mist irrigation system was used after inoculations and 3-5 times/day during 8 min. Susceptible cultivar WL-711 was used as a check. At harvest, inoculated spikes were threshed by hand, and the percentage of infection was based on the number of healthy and infected grains.

Results and Discussion

The highest levels of infection, 51.2 and 32.6%, were obtained with bread wheats and inter-generic, respectively (Table 1). Planting date had an effect on disease intensity, since the highest percentage of infection for all groups was obtained during the first date. The average infection of the different groups ranged from 1.3 to 5.8, and the average infection by date was 7.4, 2.9 and 1.4 for the first, second and third dates, respectively.

The percentage of lines with infection levels below 5% was 80.8 for durum wheats, 59.5 for DBG, 36.4 for bread wheat and 33.3 for inter-generic material (Table 2). These results indicate that the level of resistance in durum wheat is greater.

One line from bread wheat, DBG, and two from durum did not show any infection; twenty three lines in total from the four groups showed incidence ranging from 0.1 to 1%, while the susceptible check showed 73% infection average. Pedigree of lines with infection levels below 1% are presented in Table 3.

The methodology conducted at CIMMYT to identify sources of resistance starts with screening of progenitors from breeding programs, introductions, advanced lines, or commercial

Table 1. Range and average percent infection of groups from the 7th screening nursery for resistance to Karnal bunt (*Tilletia indica*)[a].

Group[b]	Range of Infection (%) Dates[c] I	II	III	Mean
Bread Wheat	0-51.2	0-24.3	0-8.9	5.8
	8.9[d]	3.2	1.6	
DBG	0-20.2	0-19.4	0- 8.4	3.1
	4.0	3.1	1.6	
Durum Wheat	0-15.1	0- 8.7	0- 3.0	1.3
	1.8	1.2	0.6	
Inter-generic	1-32.6	0.7- 7.5	0- 1.5	5.5
	8.1	3.6	0.5	
Overall Mean of Groups by Date	7.4	2.9	1.4	

[a]Ten spikes per experimental line were artificially inoculated at boot stage in the Yaqui valley, Sonora, during 1990-1991, by injecting 1 ml of a 10^4/ml sporidial suspension. The percentage of infection was based on the number of healthy and infected grains.
[b]Bread wheat = *Triticum aestivum*, Durum w. = *T. durum*, inter-gen. = *T. aestivum* x *Agropyron* spp., DBG = development of basic germplasm.
[c]Planting dates: November 8, 21, and December 8, 1990.
[d]Average percent infection of groups by date.

Table 2. Range and average infection of lines with levels below 5%, from groups of the 7th screening nursery for resistance to Karnal bunt (*Tilletia indica*)[a].

Group[b]	Number of Lines			Range of Infection (%) Dates[c]			
	Total	<5%	%	I	II	III	Mean
Bread Wheat	173	63	36.4	0-4.9 0.5[d]	0-4.9 1.5	0-4.9 1.2	1.6
DBG	42	25	59.5	0-4.9 2.0	0-4.9 1.6	0-3.9 1.0	1.5
Durum Wheat	26	21	80.8	0-4.5 0.7	0-3.6 0.8	0-3 0.6	0.7
Inter-generic	15	5	33.3	1-3.9 2.3	0.7-3.5 2.5	0-1.5 0.5	1.7
Overall Mean of Groups by Date				1.8	1.4	1.0	

[a]Ten spikes per experimental line were artificially inoculated at boot stage in the Yaqui valley, Sonora, during 1990-1991, by injecting 1 ml of a 10^4/ml sporidial suspension. The percentage of infection was based on the number of healthy and infected grain.
[b]Bread wheat = *Triticum aestivum*, Durum w. = *T. durum*, inter-gen. = *T. aestivum* x *Agropyron* spp., DBG = development of basic germplasm.
[c]Planting dates: November 8, 21, and December 8, 1990.
[d]Mean percentage of infection of groups by date.

Table 3. Wheat genotypes from the 7th karnal bunt screening nursery with infection levels of 0-1%, after artificial inoculation in three planting dates in the Yaqui valley, Sonora, Mexico, during 1990-1991.

BREAD WHEAT

FKN/CJ71//FKN/3/6*PF71131/4/BOW
CMH83.52-2Y-3B-1Y-1B-2Y-0B

CMH80A.253/3/CLT/H471.71A//2*CLT
CMH84.98-1Y-2B-3Y-1B-0Y

CMH80A.253/3/CLT/H471.71A//2*CLT
CMH84.98-1Y-2B-3Y-2B-0Y

W 255

LONG83-3116

SHANGAI3
-43B-0Y

SHANGAI5
-49B-0Y

SHANGAI8
-3B-0Y

ISWRN 306

DURUM WHEAT

CHEN
CD20626-6M-2Y-1M-0Y

MEMO/MEXI75
CD26132-8B-1Y-8Y-0MSCO/MEXI

6973/WARD.7463//74110/3/LDSMUT/TEAL
CD49030-3Y-1M-1Y-3M-0Y

MEMO/YAV79
CD49410-3Y-2M-5Y-3M-2Y-1M-2Y-0M

HUI/YAV79
CD52448-6M-1Y-1Y-1M-0Y

7175/71110//BOY/5/SCO/3/BD1814//
BD1708/BD1543/4/ROK/6/STN
CD55048-5Y-1M-2Y-1B-0Y

YAV/SAPI//YAV79/3/HUI
CD56174-G-1Y-2M-2M-2Y-0M

CHEN/ALTAR84
CD57005-6Y-1M-8Y-0B

CHEN/TEZ
CD57255-2B-3Y-2M-2Y-0M

RUFF/FG//FG/CR/3/YAV79/4/HUI
CD58230-2M-1Y-8M-2Y-0M

CHEN/ALTAR84
CD57005-6Y-1M-6Y-0B

CATA
CD56469-B-1Y-2M-501Y-509B-0Y

INTER-GENERIC

CS/A.CURV.//PVN/3/BUC/PVN/4/ALD/TAN
CIGM85.216-6Y-2B

DEVELOPMENT OF BASIC GERMPLASM

CMH82A.1350
CMH82A.1350-4B-2Y-2B-2Y-3B-0Y

CMH76.1330//TTURA/CMH74A.370
CMH80A.1253-3B-1Y-1B-1Y-3B-1Y-0B

CIT71/TDIC
CMH79.1563-2Y-1B-3Y-2B-2Y-
1B-1Y-0B

TDICI458/MEX75//MEX75/TMO2433
CMH84.1141-1Y-2B-1Y-1B-1Y-0B

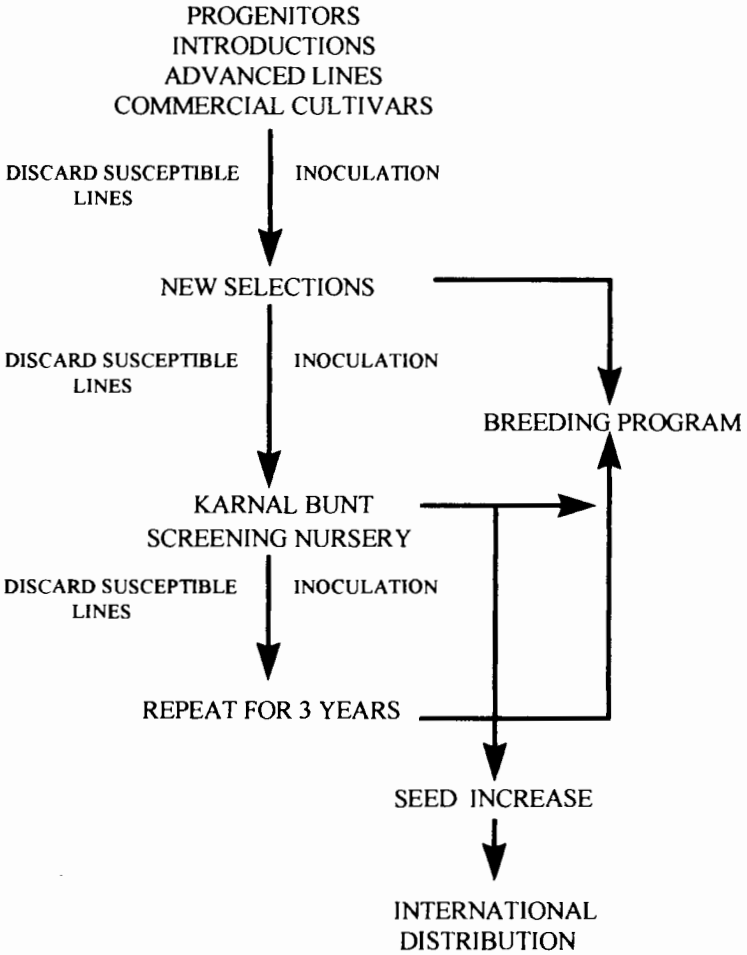

Fig. 1. Methodology to identify sources of resistance to *Tilletia indica* at CIMMYT. After inoculation by injection at boot stage, germplasm with infection levels above 5% is discarded. Selected germplasm is provided to the breeding program; at the same time, seed is increased in a Karnal bunt-free area under a strict phytosanitary scheme for international distribution.

cultivars (Fig. 1). The selected germplasm is designated as new selections which will be additionally tested for 3 years; resistant lines are provided to the breeding program for hybridization, and at the same time, they are be distributed to national agricultural programs from cooperating countries, following phytosanitary measures which include: seed multiplication in a KB-free area, applications of propiconazole during heading-flowering, seed analysis by the CIMMYT seed health unit, seed washing with water-sodium hypochlorite (as determined by the SHU), and seed treatment.

The screening nursery for resistance to *T. indica* has been formed by groups of bread and durum wheats, triticale and lines derived from inter-generic crosses which have shown low incidence in at least two cycles of testing in northwestern Mexico. This nursery is designated as the KBSN (Karnal Bunt Screening Nursery), being part of a continuous process in the identification of sources of resistance.
Although it is probable that the lines tested are not immune to *Tilletia indica*, they present good levels of resistance and could be used as sources of resistance in a breeding program.
Despite obtaining a maximum of 51.2 percent infection, it was lower than that obtained with the susceptible check (73%), which reflects that in the selection process there can be some escapes. However, this process also indicates that we have an effective selection since there are lines which consistently have showed low levels of infection.

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