CHARACTERIZING *FUSARIUM GRAMINEARUM* RESISTANCE OF CIMMYT BREAD WHEAT GERMPLASM

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Introduction

Fusarium head scab head of small grain cereals is a severe disease in warmer and humid areas of the world. Developing of resistant germplasm is a big challenge for developing countries in regions such us South America (Brazil, Argentina, Uruguay and Paraguay), Asia (Iran and China) and Africa (Ethiopia), where farmers produce grain for food and feed without controlling the level of toxin in the grains.

The CIMMYT Wheat Program has generated information on scab resistance related to the fungal penetration and spread mechanism of a large number of lines. Preliminary data has also been generated on the toxin degradation mechanism in some of this germplasm. Much work remains to be done to accumulate genes and improve total resistance.

Materials and Methods

Evaluation of resistance to fusarium head scab under artificial condition is carried out in CIMMYT at the Atizapan research station in Toluca, Mexico. Every year, segregating populations (about 7000 lines) from the traditional breeding and wide cross programs are screened; testing is carried out for resistance to fungal spread (mechanism II)(Schroeder and Christensen, 1963; Miller et al., 1985). For this purpose, a concentration of 50,000 spores per ml is applied during the inoculation period. Isolates of the fungi are increased in Mung Beans Medium (MBM) during five days. This medium broth inoculum generates significantly more disease and yields higher DON values than other inoculum methods (Dill-Macky, 1996). After five days of growing in MBM, the inoculum concentration is adjusted and applied to the plants using the cotton method. Each spike is marked when the anthers start to be visible in the center of the spike. A small piece of cotton soaked with the inoculum is introduced with a forceps between the lemma and the palea of a spikelet. Five spikes are inoculated per entry. After inoculation the spikes are covered with a glassine bag and evaluated 30 to 40 days after inoculation at physiological maturity. In 1996, we evaluated bread wheat lines for resistance to penetration (mechanism I) and toxin degradation (mechanism III). Each plot was also sprayed with a suspension of spores (50,000 p/ml). Thirty spikes were randomly selected and marked in initial flowering for inoculation and evaluation. Additionally, 15 spikes were inoculated with the cotton method to test resistance to spread. Mist irrigation was provided on dry days. An additional plot of each entry was inoculated with a spore suspension simulating natural infection conditions. These plots were harvested and a sample of 50-g of each of the best lines showing resistance mechanism I and II were sent for DON toxin analysis to the Technological Laboratory of Uruguay (LATU).

Seed was visually evaluated, using 1 to 5 scale, 1 being the best 5 being severely shriveled seed .

A intermediate susceptible variety Flycatcher, and two resistant varieties Frontana and Chinese were used as checks. The germplasm was separated into 10 groups by maturity and inoculation was carried out according to this characteristic. The data are reported as percent of healthy spikelets . Spikes were considered replications. The proportion of healthy spikelets (P) was analyzed using the Generalized Lines Model:

$P = \mu + Entry + E$

where the error, E, is assumed as a binomial random variable. Individual comparisons between entries were done using contrasts. We used the PROC CATMOD from SAS (1985).

Results and Discussion

The majority of lines tested were statistically different and superior to the susceptible check, in regards to mechanisms I and II for resistance. Many lines were not different from the resistant checks and a small number were statistically superior to the resistant checks. This latter superior group including parents and advanced lines is presented in Tables 1 and 2. Grain filling is reported for some lines. Even though this information is preliminary, it is nonetheless very useful to the breeding program. Preliminary data from Minnesota suggested that grain filling is related to toxin concentration (Hong Ma, personal communication, 1996). Hong suggested that a different mechanism of resistance may be interfering with this physiological process. We found a wide range in the ability to grain fill in the preliminary evaluations and no clear relationship with toxin concentration. A clear example of this reaction was evident in the Catbird lines, giving a range from 1 to 4 (Table 2).

References

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Table 1. Characterization of Fusarium head scab resistance of the best parents used in read wheat lines in relation to penetration, spread, toxin content and grain filling after artificial inoculation at Atizapan, Toluca, Mexico, 1996.

Line and Pedigree	% Healthy spikelets		DON(ppb)	Grain filling	Days to Flowering
	Penetration	Spread			
NOBEOKABOZU KOMUGI	92	98	---	---	86
PL 33 0JPN-2SCM	88	92	149	1	86
SODAT/SUM3//NG8201/	88	84	---	3	90
ZUO1331 5SCM	86	90	---	3	90
ZM23524 6SCM	93	81	43	---	91
BEKELE.100,244 1 FUS-0Y-3SCM	90	92	ND	3	93
NG894037 0CHN-2SCN	89	95	ND	1	93
RECURRENT SELECTION 5	92	98	---	2	111
FRONTANA (Resist Check)	93	87	106	---	104
CHINESE (Resist Check)	90	94	ND	---	104
FLYCATHER (Suscept Check)	82	52	106	---	79

ND= no toxin detected (the limit of method detection is 40 ppb). Toxin checks: high 3446 to 1723 ppb; intermediate 1077 to 862 ppb; and low 43 to 40.
Grain filling 1=very good, 5=poor.

Table 2. Characterization of Fusarium head scab resistance of the best advanced lines obtained in the wheat program related to penetration, spread, toxin content and grain filling after artificial inoculation at Atizapan, Toluca ; Mexico, 1996.

Line and Pedigree	% Healthy spikelets		DON(ppb)	Grain filling	Days to Flowering
	Penetration	Spread			
ZUO1330 -2SCM-0CHN-015Y-1SCM	84	94	ND	2	79
CBRD/5/CSTH.CU//GLEN/3/ GEN/4/L2266/1406.101//BUC/3/ VPM/MOS 83.11.4. //NAC CMBW91MO1989S-0M-040Y-015M-0Y41M-0Y-1SCM	82	84	ND	2	79
SHA4/CHIL CM91099-25Y-OM-3N-010M-0Y -3M-010Y-0FUS-1FUS-2SCM	99	99	234	2	83
SHA5/WEAVER CM95103-25Y-0M-0Y-3M-ORES -1M-0Y-3M-010Y-0M-2PZ-0Y -2SCM-0Y	91	90	43	1	86
CATBIRD CM91045-502M-0M-5SJ-0Y-2SCM -0Y-3SCM	89	85	ND	1	90
CATBIRD CM91045-5Y-0M-0Y-4M-4Y-2M -0M-4M-0Y-2SCM	87	77	40	1	90
CLLF/PCHU//SEL.P.101/BOGAF /3/-3SCM-0CHN-015Y-1SCM	86	86	ND	3	90
NG8675/CBRD CMSS92Y00639S-5-5SCM	87	95	---	3	91
MILAN/SHA7 CM97550-0M-2Y-030H-3Y-3Y-0Y 3M-010Y-0FUS-1FUS-3SCM	90	86	43	3	91
CATBIRD CM91045-9Y-0M-0Y-5M-4Y -0B-5PTZ-0Y-2PZ-010Y-0M-3SJ-0Y-2SCM	87	89	---	4	93
THB/CEP7780//SUZ9/WEAVER /3/NG8675 CMSS92Y02302T-2-2SCM-0CHN-015Y-3SCM	90	88	106	2	93
NG8675/CBRD CMSS92Y00639S-1-5SCM	91	90	426	1	93
MILAN CM75133-B-5M-1Y-05M-2Y-3B -0Y-3SCM	90	68	ND	3	93
ALTAR 84/AE. SQUAROSA (221)//3*BORL95 CIGM90.248-1Y-2B-11Y-0B-1M-22M-0Y-3SCM	85	67	40	--	97
FRONTANA (Check)	93	87	106	---	104
CHINESE (Check)	90	94	ND	---	104
FLYCATHER (Check)	82	52	106	---	79

ND= no toxin detected (the limit of method detection is 40 ppb)). Toxin checks: high 3446 to 1723 ppb the; intermediate 1077 to 862 ppb and low 43 to 40 ppb. Grain filling: 1=very good, 5=poor.