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Diversity of grain mold fungi on selected sorghum genotypes

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Grain mold is the most important biotic constraint to sorghum [(*Sorghum bicolor* (L) Moench)] improvement and production worldwide. It is a major problem, particularly of early maturing sorghum hybrids that flower and mature during wet weather. A large number of non-specific fungi infect and colonize grains affecting quantity, quality and market value of the produce (2,4). Efforts to produce sorghum genotypes with tolerance to grain mold by conventional breeding have been only partially successful (4,5). The present study was undertaken to determine the diversity in mold fungi on selected sorghum genotypes both under field and laboratory conditions against which genetic resistance could be identified.

Fourteen sorghum genotypes, including six inbreds, one released hybrid and seven varieties (Table 1) of varying levels of resistance to grain mold were selected for the study. These were grown in field during the 2001 rainy season in one-row plot of 4 m long with two replications in a randomized block design. On rain-free days overhead sprinkler irrigations were provided from the milk stage to post-physiological maturity to create high humidity necessary for grain mold development. The days to 50% flowering were recorded for each genotype to identify the maturity groups. !n each plot, randomly selected 10 panicles were scored at post-physiological maturity for mold severity using a progressive 1-9 scale, where 1 = no mold; 2 = 1-10%; 3 =11 - 20%; 4 = 21 - 30%; 5 = 31 - 40%; 6 = 41 - 50 %; 7 = 51 - 60 %; 8=61 - 75 %; and 9 > 75% grains on panicle colonized by mold fungi. From each plot, 100 g grain sample was obtained from a bulk of threshed grain from the 10 panicles in each genotype, and scored under stereo-binocular microscope for infection by various fungi using the above scale.

Grain samples (200 grains from each replication of each genotype from the above field experiment), surface-sterilized with 2% NaOCl, washed twice thoroughly with sterile distilled water, were used for plating. Two plating methods, the standard blotter paper and potato carrot agar (PCA) (2) were used. In each plate, 25 seeds were placed and incubated at 22 ± 2°C with a cycle of 12 h near-ultraviolet light and 12 h dark for 5 and 7 days for PCA and blotter methods, respectively. Mold fungi on grains were observed under stereo-binocular microscope and identified by comparing with the standard fungal identification keys (1). The frequency of individual fungi on grains of each genotype was also recorded.

In field screen, the over all grain mold severity varied from 1.9 (IS 23599) to 9.0 (Bulk Y and SPV 104) (Table 1). The mold complex comprised mainly of species of *Alternaria, Curvularia, Fusarium* and *Phoma.* Among these, *Curvularia lunata* appeared most severe (severity range up to 7.5) and *Fusarium* species the least severe (severity up to 2.0). Four sorghum genotypes,(IS 8545, IS 14332, IS 14384 and IS 23599) were highly resistant (mean severity ≤ 2.0), and three (C 43, Sepon/79-26 and AKMS 14 B) resistant (mean severity 2.8 to 3.9). All these genotypes had late flowering (days to 50% flowering from 74 to 79) except IS 8545 (days to 50% flowering 58) compared to the highly susceptible genotypes Bulk Y 51 and SPV 104 that had days to 50% flowering of 51 and 73, respectively (Table 1).

Table 1. Days to 50% flowering (DTF) and grain mold reactions of 14 sorghum genotypes at post physiological maturity stage during the 2001 rainy season.

Genotypes	DTF[a]	Grain infection[b] by				
		Mold sev.[b]	*Alternaria alternata*	*Curvularia lunata*	*Fusarium moniliforme*	*Phoma sorghina*
IS 23599	79	1.9	1.0	1.9	1.0	1.0
IS 8545	58	2.0	1.3	1.0	1.0	1.0
IS 14332	77	2.0	1.2	1.5	1.0	1.5
IS 14384	77	2.0	1.2	1.0	1.0	1.0
C 43	76	2.8	1.1	2.3	1.0	2.0
Sepon/79-26	74	3.3	2.0	2.2	1.0	1.5
AKMS 14B	74	3.9	2.0	2.4	1.0	2.0
Sepon/78-1/SPV 350	87	4.3	1.8	2.9	1.0	2.0
PVK 801	70	4.6	2.0.	3.0	1.0	2.0
IS 18758C-618-2	56	5.3	1.3	3.5	1.0	1.5
Swarna	66	7.4	2.0	5.6	1.0	3.1
CSH 9	69	7.6	2.0	5.3	1.0	2.6
Bulk Y	51	9.0	1.0	7.5	2.0	1.5
SPV 104	73	9.0	2.5	6.8	2.0	3.2
Mean	70	4.6	1.6	3.3	1.1	1.8
LSD(P<0.05)	3.7	0.94	0.55	1.0	0.0	1.1

[a]Mean of 2 replications

[b]Mean of 2 replications, based on 1-9 scale where 1=no mold and 9 >75% grain surface colonized by mold fungi

In the two plating methods, *Alternaria alternata, Exserohilum rostratum, Bipolaris sorghina, Fusarium moniliforme, Phoma sorghina* and *Curvularia lunata* were identified on grains of various sorghum genotypes (Fig. 1). Analysis of variance indicated significant effects of plating methods, host genotypes and their interactions on overall grain mold infection and infection by individual fungi. Generally, more than one fungus were involved in causing infection to the grains. Grain infection by the fungi varied significantly across the 14 genotypes (Table 2). The overall mean grain infection ranged from 20% (IS 23599) to 97% (Swarna). *A. alternata* was the most predominant (>10% grain infection in 11 genotypes) and the least was P. *sorghina* on only 5 genotypes (Table 2). Two genotypes (IS 23599 and IS 14332 were resistant (≤10% infection) to all six fungi whereas three (IS 8545, IS 14384 and C 43) were resistant to five fungi. Differential grain infection by individual fungi is evident on three resistant (IS 23599, IS 8545, and IS 14384) and three susceptible (AKMS 14B, CSH 9 and PVK 801) genotypes (Fig.1).

Diversity in fungal species causing grain mold in sorghum was detected both in field and plating tests. In the visual examination, only four fungal genera were encountered with varying severity. Among these, *C. lunata* was predominant because of its faster growing nature and having both pathogenic and saprophytic phases compared to the other fungi. In laboratory tests, however, some of the slow growing fungi were detected that were not distinctly visible in the field. *F. moniliforme,* being a major component of sorghum grain mold complex was better detected in the plating tests than in the field.

Field mold severity on sorghum genotypes was highly variable, both to overall mold infection and to individual fungi. Flowering behaviour and maturity range of sorghum genotypes are often associated with grain *mold* severity, and early maturing sorghum genotypes are more susceptible to grain mold than the late maturing ones, which usually escape the wet weather conditions. This was confirmed with high level of resistance exhibited by the late maturing genotypes IS 23599, IS 14332, IS 14384 and C 43

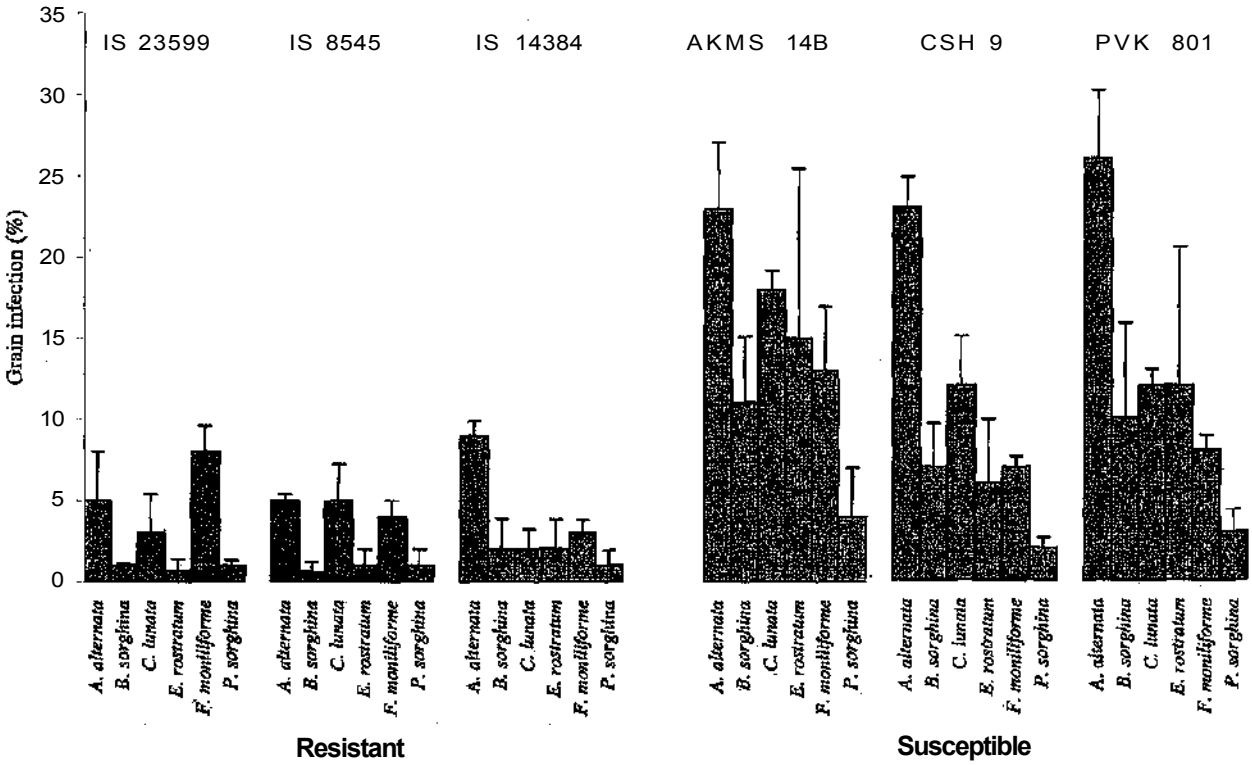

Fig. 1. Mean grain infection on selected resistant and. susceptible sorghum genotypes to various mold fungi

Table 2. Grain mold infection and diversity in mold fungi on 14 sorghum genotypes

Genotypes	Grain infection (%)[a] by mold fungi						
	Overall mold inf (%)[a]	Alternaria alternate	Curvularia lunata	Fusarium monififorme	Phoma sorghina	Bipolaris sorghina	Exserohilum rostratum
IS 23599	20	10	3	5	5	1	6
IS 8545	27	6	3	6	22	3	9
IS 14332	23	10	1	8	1	1	6
IS 14384	30	17	4	5	1	3	4
C 43	24	14	0	7	1	<1	6
Sepon/ 79-26	95	22	9	12	20	24	20
AKMS 14 B	95	45	30	26	13	21	35
Sepon/78-1/SPV 350	92	33	15	13	12	39	28
PVK 801	93	46	13	11	20	17	32
IS 18758C-618-2	89	35	14	21	5	15	35
Swarna	97	21	13	12	1	27	29
CSH 9	84	36	15	14	5	13	22
Bulk Y	92	44	15	15	3	18	34
SPV 104	86	26	2	15	10	4	7
Mean	66	17	13	7	1	5	6
LSD (P<0.05)	15.4	17.8	10.4	15.1	10.5	11.1	16
No. of genotypes with >10% infection	0	11	7	9	5	8	8

[a]Mean of 2 methods, 2 replications/method, 100 seeds/replication.

under favorable weather conditions in the field test, and also in the plating tests. However, there were exceptions. For example, IS 8545 an early maturing genotype was resistant and several late maturing genotypes susceptible. Mold fungi infected the sorghum genotypes differentially. All the six fungi were detected on most susceptible genotypes in the laboratory tests but the same was not true for the field tests. Our findings indicate that both field and plating tests are needed for detecting diversity in the grain mold fungi and identifying sorghum genotypes with stable resistance.

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