Effect of Mold Severity on Seed Traits Governing Potential Performance of Sorghum

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Abstract

In shelter protection (SP) the seeds at harvest are protected from grain mold and had better germinability. However, the mist and the high humidity from flowering to physiological maturity (MF-PM) and from physiological maturity to post physiological maturity (MPM-PPM) enabled infection of seed with grain mold causing loss in seed germinability and seedling growth affecting potential performance of seeds in the field.. The grain hardness was lowest in the treatment MPM-PPM (5.02 kg/cm^2) followed by NC (6.53 kg/cm^2), MF-PM (6.65 kg/cm^2) and SP (6.91 kg/cm^2). The water absorption was lowest in treatment MPM-PPM (0.17%) followed by NC (0.21%), MF-PM (0.219) and SP (0.23%). The seed germination in cold test was lowest in the treatment MPM-PPM (40.7%). The electrical conductivity was lowest in the treatment MPM-PM (143.81 µmhos/cm) followed by NC (148.95 µmhos/cm), MF-PM (150.30) and SP (152.67 µmhos/cm). The mold score was lowest in SP (2.6) followed by MF-PM (4.7); NC (6.1) MPM-PPM (6.1). The floury endosperm percentage was highest in the treatment MPM-PPM(72%). The corneous endosperm percentage was lowest in the treatments MF-PM and MPM-PPM (26%) followed by NC (27%), SP (28%). The dehydrogenase activity was lowest in the treatment MPM-PPM (0.37) followed by NC (0.42), MF-PM (0.425) and SP (0.88). Mold severity, irrespective of genotypes, was maximum in MPM-PPM followed by NC, MF-PM and mold severity was lowest in SP hence the seed quality was highest in SP.

Keywords: Sorghum, grain mold, seed quality

Introduction

Grain mold is a major disease of sorghum [*Sorghum bicolor* (L.) Moench] caused by a complex of several fungal species. Molds develop in the sorghum inflorescence at any stage from the young inflorescence to mature head and the resultant seed infection reduces germination and seed quality (Tonapi, 2004). The real and potential importance of grain mold has been emphasized for Africa, the Americas and India (Forbes *et al.*, 1989). Although more than 49 fungal species have been reported to be associated with the mold complex, species of *Alternaria*, *Aspergillus*, *Curvularia*, *Drechslera*, *Fusarium*, *Penicillium,* and *Phoma* are quite wide spread (Navi *et al.*, 1999). The use of mold resistant cultivars is the most convenient method of control of this disease. The field screening technique (Bandyopadhyay and Mughogho, 1988), and an *in vitro* screening technique (Singh and Navi, 1996) have been standardized to identify resistant sources. Since the information on seed quality in relation to mold severity in seed systems is very little, investigations were undertaken to study the effect of humidity at three different crop growth periods in 49 sorghum genotypes to identify the tolerance to grain mold infection through assessment of resultant seed quality.

Materials and methods

The experiments were conducted at Seed Science and Technology Department, Acharya N.G. Ranga Agricultural University, and at Seed Technology unit of National Research Centre for Sorghum, Rajendranagar, Hyderabad, during 2003-2004. The mist created humidity regimes across three crop growth periods were imposed at ICRISAT in the Rain out shelter experiments. Sorghum seeds having undergone the imposed treatments were subjected to evaluation of seed and seedling traits in relation to induced mold severity and infection.

Genotypes and growing environments

A total of 49 genotypes encompassing hybrids, varieties,

parental lines and lines belonging to indigenous and exotic germplasm (BulkY, Swarna, IS 18522(Sc108-3), IS 18467(GPR148), CSV 4(CS3541), Sepon /79-2, Sepon/79-26, Sepon /78-1/SPV350, SPV 351/ICSV1, SPV 386/ICSV 108, SPV 472/S35/ICSV 111, SPV 745/ICSV 112, SPV 819/ ICSV 210, SPV 876/ICSV 233, ICSV 239/BSR-1, ICSV 88002, ICSV91008, ICSV 89102, ICSV 95001(Red), ICSV 01(White), PSV 16, SPV 881, CSV 15, IS 14384, IS 30469C-140, IS 25017, CSH 9, IS 14332, IS 3443, IS 9478, IS 18758(E 35-1), IS 8545, SPV 104, IS 18758C-618-2(102), CSH 15R, CSH 16, Sureno, PKV 801, KR 194, PMS 7B, SPV 1403, B 58586, IS 23599, C 43, RS 29, 296 B, KR 188, AKMS 14B, SERENE) encompassed following treatments:

NC: Crop grown under natural conditions

SP: Crop shelter protected (no rain) throughout (control)

MF-PM: Seeds exposed to mist from flowering to physiological maturity

MPM-PPM: Seeds exposed to mist from physiological maturity to post-physiological maturity

Observations

The seeds thus obtained were analyzed in a Factorial Completely randomized block design in four replications (@ 100 seeds per replication) to assess the effect of mold severity on seed germinability and seedling traits in sorghum.

The germination test was conducted adopting the roll towel method under controlled conditions of temperature and relative humidity (25°±3° C and 90±3 % RH) (ISTA, 1996). The root length and shoot length of ten randomly selected seven-day old normal seedlings from each replication of standard germination test was measured and expressed in cm. These selected seedlings after shade drying, were dried in a hot air oven (85° C for 24 h) and dry weight (mg) of seedlings was recorded. Vigor index was computed by multiplying seed germination with root length of seedling and expressed as absolute value (Abdul Baki and Anderson, 1973). Field emergence potential of seeds was assessed by sowing 400 seeds in four rows in raised seed beds of red sandy loam soil and the emergence of the plumule from fourth day to tenth day was recorded and expressed as field emergence count in percentage (ISTA, 1996). The seed germination in cold test was computed by planting 100 seeds in four replicates in a rolled paper towel kept at 10°C for seven days and then transferring the same to 25°C for a further four days. The results of cold test are expressed as the percentage of normal seedlings produced (Fiala, 1981).

The components of rate of germination were estimated by taking daily counts in germination test using paper towel pleats under controlled conditions of temperature and relative humidity (25° ± 3°C and 90 ± 3% RH), in four replications of 100 seeds each. In field emergence test, germination is considered to have occurred when radicle has appeared. The rate of germination was assessed by calculating mean daily germination (Edwards, 1934), germination value (Czebator, 1962), peak value (Edwards, 1934), mean germination time, mean germination rate (Krishnaswamy and Seshu, 1989) and coefficient of velocity of germination (Kotoswski, 1926).

The seed hardness of 50 seeds was measured with KIYA grain hardness tester and expressed in Kg/cm^2. The endosperm character in terms of floury and corneous characters was recorded in each genotype and treatment on 10 seeds each and the emerging character was reported in percentage as endosperm character. The relative proportion of the corneous area within a sorghum kernel is often referred to as endosperm texture. Texture was determined by visual examination of longitudinal half kernel. The ratings range from 1 to 5, where 1 means very little floury endosperm (<20%) almost completely corneous and 5 indicates essentially all floury (>80%) endosperm (Munck, 1981). The electrical conductivity of seed leachate was determined with an electrical conductivity bridge and the specific resistance in micromhos/cm calculated by multiplying the measured conductance by the cell constant (Powell, 1986). Dehydrogenase activity (Kittock and Law, 1968) was estimated to assess the effect of mold severity on seed quality.

Results and discussion

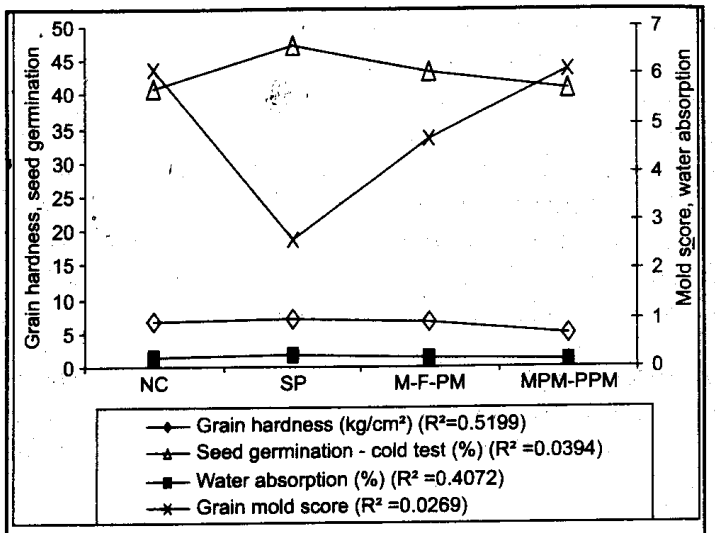
Grain hardness and rate of water absorption

The grain hardness (Fig.1) was lowest in the treatment MPM-PPM (5.02 kg/cm^2) followed by NC (6.53 kg/cm^2), MF-PM (6.65 kg/cm^2) and SP (6.91 kg/cm^2). Among the genotypes SWARNA (4.27 kg/cm^2) recorded lowest grain hardness (Table 1) followed by BULKY (4.87 kg/cm^2). The genotype IS25017 (7.69 kg/cm^2) recorded highest grain hardness followed by RS29 (7.49 kg/cm^2) and IS23599 (7.28 kg/cm^2).

The water absorption (Fig.1) was lowest in treatment MPM-PPM (0.17%) followed by NC (0.21%), MF-PM (0.219) and SP (0.23%). Among the genotypes, the genotype SPV 1403 recorded lowest water absorption (0.04%) (Table 1) followed by IS 14384 (0.06%). The genotype IS3443 recorded highest water absorption (0.40%) followed by SEPON/78-1/SPV350 (0.37%).

Seed germination in cold test and Electrical conductivity of seed leachate

The seed germination in cold test (Fig.1) was lowest in the treatment MPM-PPM (40.7%) followed by NC (40.9%); MF-PM (43.33%) and SP (47.12%). Among the genotypes



NC: Crop grown under natural conditions; **SP:** Crop shelter protected (no rain) throughout (control)
MF-PM: Seeds exposed to mist from flowering to physiological maturity
MPM-PPM: Seeds exposed to mist from physiological maturity to post-physiological maturity

Figure 1. Seed quality traits as influenced by mold infection in sorghum

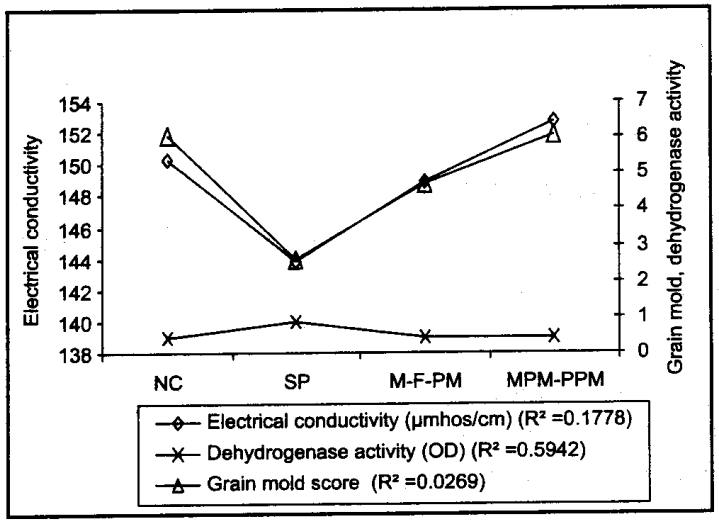


Figure 2. Seed quality traits as influenced by mold infection in sorghum

AKMS 14B recorded lowest germination (16.3%) followed by 296B (17.0%). The genotype ICSV88002 recorded highest germination (77.8%) followed by SPV386/ICSV108 (64.7%), ICSV91008 (61.8%) and IS 18552 (SC108-3) (61.0%).

The electrical conductivity (Fig.2) was lowest in the treatment SP (143.81 µmhos/cm) followed by MF-PM (148.95 µmhos/cm), NC (150.30) and MPM-PPM (152.67 µmhos/cm). Among the genotypes IS14332 (83.5 µmhos/cm) recorded the lowest electrical conductivity (Fig. 2) followed by IS 14384 (96 µmhos/cm). The genotype IS23599 (220.50 µmhos/cm) recorded the highest electrical conductivity followed by RS29 (217.3 µmhos/cm) and 296 B (215.3 µmhos/cm).

Mold severity and endosperm character

Over all grain mold scores as influenced by environment in which they were grown indicated that the mold score (Fig 1.) was lowest in SP (2.6) followed by MF-PM (4.7); NC (6.1) MPM-PPM (6.1). Among the genotypes IS 14384, IS 9478 and RS29 recorded the lowest mold score (2.0) (Table 2) followed by IS14332 and IS 8545(2.1). The genotype BULK-Y recorded the highest mold score (7.7) followed by IS18467 (GPR148) (7.2).

The floury endosperm percentage was lowest in the treatment SP (72%) followed by MF-PM (73%), PM-PPM (74%) and NC (74%). Among the genotypes, the genotypes IS14384 recorded lowest floury endosperm percentage (51%) followed by SPV 386/ICSV108 (53%). The genotype CSV4 (CS3541) recoded highest floury endosperm percentage (93%) followed by PMS7B (90%).

The corneous endosperm percentage was lowest in the treatments MF-PM and MPM-PPM (26%) followed by NC (27%), SP (28%). Among the genotypes, the genotype CSV4 (CS3541) recorded lowest corneous endosperm percentage (8%) followed by PMS7B (10%). The genotype ICSV 88002 recorded highest corny endosperm percentage (56%) followed by IS18758 (E35-1) (55%).

Dehydrogenase activity in seeds

The dehydrogenase activity (Fig.2) was lowest in the treatment MPM-PPM (0.37) followed by MF-PM (0.43), NC (0.42) and SP (0.88). Among the genotypes ICSV88002 and ICSV91008 recorded lowest dehydrogenase activity (0.30) (Table 1) followed by IS3443 (0.31). The genotype 296B recorded highest dehydrogenase activity (1.20) followed by C43 (1.01).

Vigour index and germination indices

The vigour index (Fig. 4) was lowest in treatment MPM-PPM (162) followed by NC(205), MF-PM (211) and SP(242). Among the genotypes BULK-Y (87) recorded the lowest vigour index followed by ICSV89102 (99). The genotype IS14384 (446) recorded the highest vigour index followed by IS9478 (414). The peak value in field was lowest in the treatment MPM-PPM (4.13) followed by MF-PM (6.45), NC (7.96) and SP (7.97). The mean germination time was lowest in the treatment NC and SP (4.17), followed by SP (0.19), MF-PM (5.09) and MPM-PPM (5.87). The germination value was highest in SP (42.0) followed by NC (30.0), MF-PM (22.5) and MPM-PPM (17.4) (Fig. 3).

Table 1. Effect of environment induced mold infection on seed quality in sorghum

Genotype	Loss in seed germinability (%)	Grain hardness (kg cm^{-2})	Water absorption(%)	Seed germination in cold test	Electrical conductivity of seed leachate	Dehydrogenase activity
BULK-Y	65.2	4.87	0.16	42.7	199.8	0.82
SWARNA	63.4	4.27	0.16	39.6	156.0	0.87
IS 18552 (SC 108-3)	49.8	4.99	0.19	61.0	134.8	0.47
IS 18467 (GPR 148)	47.5	5.56	0.19	35.0	113.8	0.68
CSV 4 (CS 3541)	57.5	5.28	0.14	53.3	126.8	0.67
SEPON/79-2	46.5	6.35	0.12	53.9	136.3	0.60
SEPON 79-26	53.7	5.61	0.12	47.1	131.0	0.39
SEPON/78-1/SPV 350	49.2	6.71	0.37	60.8	138.3	0.60
SPV 351	54.8	6.39	0.35	55.9	131.8	0.34
SPV 386/ICSV 108	37.4	6.59	0.26	64.6	131.3	0.35
SPV 472/S35/ICSV 111	41.5	7.30	0.25	33.6	140.8	0.44
SPV 745/ICSV 112	53.0	7.47	0.17	56.3	130.8	0.38
SPV 819/ICSV 210	43.9	7.46	0.25	30.0	142.8	0.48
SPV 876/ICSV 233	52.7	6.57	0.29	29.5	123.3	0.40
ICSV 239/BSR-1	46.7	7.13	0.22	59.0	141.0	0.42
ICSV 88002	49.0	6.34	0.17	77.8	147.8	0.30
ICSV 91008	59.2	5.84	0.09	61.8	193.8	0.30
ICSV 89102	72.0	5.98	0.12	43.0	155.0	0.38
ICSV 95001 (RED)	47.7	6.26	0.16	44.5	167.8	0.41
ICSV 96101 (WHITE)	59.7	6.76	0.12	47.4	133.3	0.37
PSV 16	49.8	6.66	0.10	25.4	167.5	0.35
SPV 881	63.4	6.04	0.12	39.0	141.8	0.42
CSV 15	64.3	6.00	0.34	50.4	157.8	0.38
IS 14384	17.8	6.89	0.06	42.7	96.0	0.45
IS 30469C-140	50.2	6.61	0.27	48.4	117.3	0.39
IS 25017	63.2	7.69	0.28	23.3	136.5	0.38
CSH 9	46.5	7.12	0.13	50.6	118.8	0.56
IS 14332	13.2	6.35	0.36	29.4	83.5	0.40
IS 3443	60.5	6.64	0.41	17.9	138.3	0.31
IS 9478	16.7	6.56	0.35	52.2	114.5	0.57
IS 18758 (E 35-1)	33.3	7.22	0.36	61.7	153.3	0.60
IS 8545	32.8	5.99	0.21	34.5	142.5	0.34
SPV 104	66.9	5.20	0.23	33.3	138.8	0.91
IS 18758C-618-2 (102)	45.2	5.41	0.18	38.4	115.0	0.66
CSH 15R	51.9	4.97	0.20	61.3	165.3	0.48
CSH 16	48.5	6.04	0.22	43.0	145.0	0.46
SURENO	59.7	6.49	0.17	32.7	142.3	0.52
PKV 801	62.0	6.91	0.18	42.5	175.8	0.69
KR 194	52.5	6.62	0.17	36.3	150.5	0.60
PMS 7B	55.3	5.91	0.19	30.9	179.3	0.72
SPV 1403	52.6	5.72	0.04	28.5	156.3	0.54
B 58586	44.4	6.01	0.15	48.7	124.0	0.37
IS 23599	54.0	7.28	0.28	44.5	220.5	0.50
C 43	57.5	7.22	0.23	41.5	204.5	1.01
RS 29	59.9	7.49	0.17	34.5	217.3	0.37
296 B	64.0	5.54	0.16	17.0	215.3	1.20
KR 188	51.0	5.04	0.24	52.3	191.5	0.53
AKMS 14B	58.5	5.16	0.25	16.3	176.3	0.42
SERENE	42.2	7.17	0.26	33.5	138.3	0.63
Mean	50.8	6.27	0.21	43.1	148.9	0.52
CD (P=0.01)	5.7	1.93	0.026	5.1	14.414	0.073

From the results it is evident that the endosperm character in various genotypes varied as different proportions of floury and corneous types between true corneous and floury types. Earlier reports indicate that hard sorghum grains are more resistant to fungal infection during development showing fewer incidences of grain molds than do soft grains. Hard grains also deposit a greater number of protein bodies and larger amount of prolamin than soft grains.. As in other cereals, the starchy endosperm cells become disorganized and die during the later stages of grain maturation while the embryo and aleurone layers remain alive. This must be taken into account when designing strategies to provide resistance to pathogenic fungi, which infect during grain maturation. Thus, there exist gaps in understanding mechanism of infection process of mold at various grain developmental stages in relation to grain hardness and the resultant loss in seed quality.

Endosperm hardness is related with grain mold resistance. Sorghums vary in the proportion of outer vitreous, translucent area and the inner soft, opaque, floury area. Sorghums exhibiting mold resistance had significantly harder endosperms than did susceptible sorghums in environments that were conducive to grain molds. However, in dry environments that are not conducive to grain molding, susceptible sorghums had much harder endosperms that were not statistically different from resistant sorghums (Audilakshmi *et al.*, 1999). This suggests that ability to retain grain hardness under mold-conducive wet conditions is crucial for expression of mold resistance. Glueck and Rooney (1980) opined that corneous endosperm texture and more epicuticular wax contributed to increased weathering resistance. In white sorghum, grain hardness contributes positively to mold resistance (Bandyopadhyay, 1988; Stenhouse *et al.*, 1990).

Glueck and Rooney (1980) reported that cultivars with rapid rate of water uptake exhibited less resistance to weathering. Composition of leachates from these cultivars was richer in nutrients. A thicker mesocarp and softer endosperm texture usually corresponded to increased water absorption and richer leachates. Grain mold severity, caused by *F. moniliforme* was positively correlated with electrolyte leachates (Forbes *et al.*, 1989). Matthews and Bradnock (1967), while evaluating relative vigour of seed lots found that lower the vigour the greater the amount of leaching. Thus, the seeds infected with mold will have higher electrical conductivity and lower dehydrogenase activity. Negative correlations were observed with standard germination, shoot length, dry matter production. Hence, the degree of resistance in a genotype is dependent on the grain mold pressure it can withstand. The breakdown point beyond which mold resistance of a genotype is overcome is a good indicator of

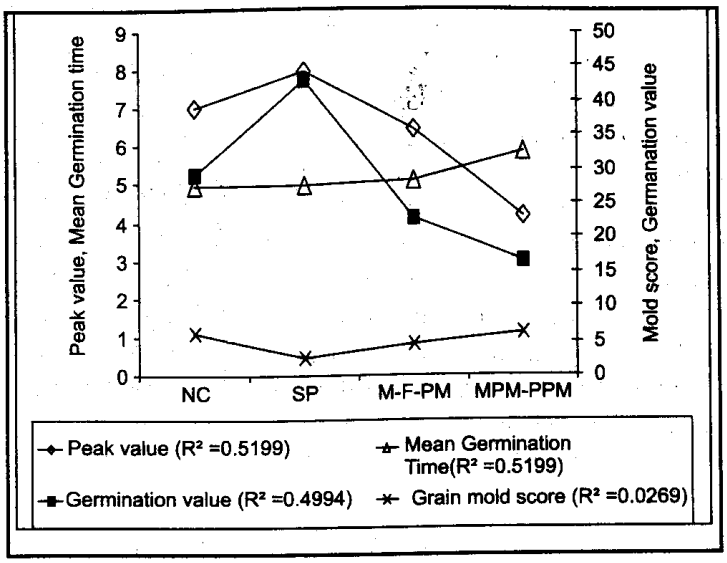


Figure 3. Seed quality traits as influenced by mold infection in sorghum

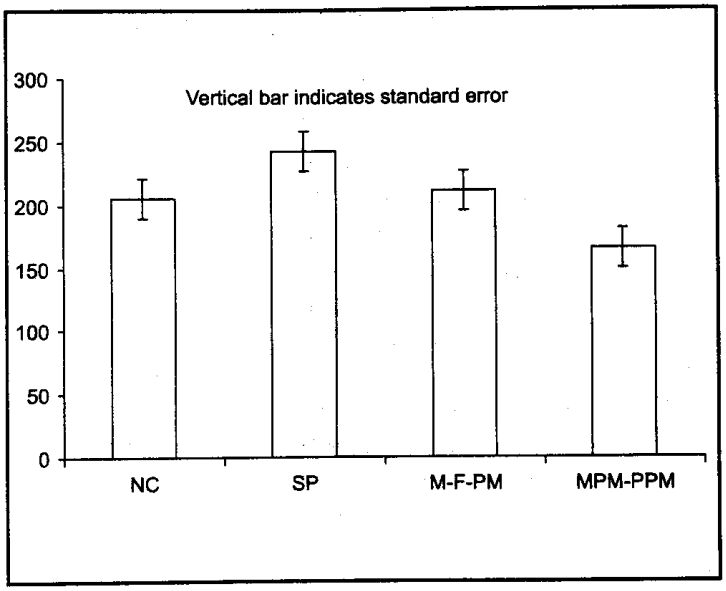


Figure 4. Vigour index as influenced by mold infection in sorghum

the level of mold pressure that the line can withstand.

The correlations worked out among seed traits indicated highly significant positive correlations between grain hardness, field emergence, laboratory germination and endosperm character (Table 3). Grain hardness, electrical conductivity, mold infection and dehydrogenase activity were negatively correlated. The endosperm character and mold infection were negatively correlated, but electrical conductivity had positive correlation with mold infection.

Thus, it can be inferred that the genotypes undergo deleterious changes in terms of seed quality due to mold infection. The grain hardness and corneous endosperm provide resistance to grain molds. Based on over all results

Table 2. Mold severity at different growing environments

Genotypes	NC	SP	MF-PM	MPM-PPM	Mean
BULK-Y	8.9	4.1	8.7	9.0	7.7
SWARNA	8.7	3.4	7.5	8.7	7.1
IS 18552 (SC 108-3)	6.3	3.6	5.3	6.5	5.4
IS 18467 (GPR 148)	8.9	3.8	7.6	8.5	7.2
CSV 4 (CS 3541)	7.9	3.0	7.1	7.4	6.3
SEPON/79-2	5.8	2.4	5.3	6.4	4.9
SEPON 79-26	4.0	2.5	3.8	5.4	3.9
SEPON/78-1/SPV 350	5.1	2.1	3.7	5.5	4.1
SPV 351	6.4	2.4	5.6	6.4	5.2
SPV 386/ICSV 108	6.7	2.5	3.7	7.1	5.0
SPV 472/S35/ICSV 111	7.6	2.6	4.2	6.0	5.1
SPV 745/ICSV 112	7.4	2.5	4.7	6.0	5.1
SPV 819/ICSV 210	6.2	2.0	3.1	6.5	4.4
SPV 876/ICSV 233	5.7	3.0	4.7	5.3	4.7
ICSV 239/BSR-1	6.8	2.2	3.8	7.2	5.0
ICSV 88002	8.6	2.7	5.0	6.7	5.7
ICSV 91008	7.0	2.7	4.0	5.8	4.9
ICSV 89102	5.8	2.2	3.1	5.7	4.2
ICSV 95001 (RED)	8.4	3.5	6.4	6.0	6.1
ICSV 96101 (WHITE)	4.5	2.6	6.2	6.2	4.9
PSV 16	6.3	2.0	2.8	6.4	4.4
SPV 881	8.1	2.3	3.6	6.4	5.1
CSV 15	4.4	2.4	3.1	5.5	3.8
IS 14384	2.0	2.0	2.0	2.0	2.0
IS 30469C-140	8.1	3.3	6.8	8.0	6.5
IS 25017	3.4	2.0	3.1	4.3	3.2
CSH 9	8.5	2.6	7.5	7.3	6.5
IS 14332	2.2	2.0	2.0	2.1	2.1
IS 3443	4.0	2.0	3.7	4.5	3.5
IS 9478	2.0	2.0	2.0	2.1	2.0
IS 18758 (E 35-1)	3.2	2.1	3.6	5.7	3.6
IS 8545	2.0	2.0	2.0	2.4	2.1
SPV 104	9.0	2.4	7.8	9.0	7.0
IS 18758C-618-2 (102)	6.6	2.0	3.9	5.9	4.6
CSH 15R	8.8	3.9	6.2	8.4	6.8
CSH 16	7.4	3.2	4.5	6.9	5.5
SURENO	4.0	2.2	5.1	5.6	4.2
PKV 801	7.0	2.7	4.0	5.8	4.9
KR 194	5.8	2.2	3.1	5.7	4.2
PMS 7B	8.4	3.5	6.4	6.0	6.1
SPV 1403	4.5	2.6	6.2	6.2	4.9
B 58586	6.3	2.0	2.8	6.4	4.4
IS 23599	8.1	2.3	3.6	6.4	5.1
C 43	4.4	2.4	3.1	5.5	3.9
RS 29	2.0	2.0	2.0	2.0	2.0
296 B	8.1	3.3	6.8	8.0	6.5
KR 188	3.4	2.0	3.1	4.3	3.2
AKMS 14B	8.5	2.6	7.5	7.3	6.4
SERENE	4.0	2.0	3.7	4.5	3.5
Mean	6.1	2.6	4.7	6.1	4.8
SE	0.13	0.16	0.03	1.00	0.04
cv%	2.1	6.3	0.7	16.1	0.9

NC: Crop grown under natural conditions ; SP: Crop shelter protected (no rain) throughout (control)

MF-PM: Seeds exposed to mist from flowering to physiological maturity

MPM-PPM: Seeds exposed to mist from physiological maturity to post-physiological maturity

Table 3. Correlations among seed traits in relation to environment induced mold infection in sorghum

Seed trait	Grain hardness	Field emergence	Lab germination	Dehydrogenase activity	Electrical conductivity	Endosperm character	Mold score
Grain hardness	1.000	0.2511**	0.1153	-0.2361**	-0.0646	0.0663	-0.2801**
Field emergence		1.000	0.5273**	-0.2125**	-0.2487**	0.2132**	-0.3730**
Lab germination			1.000	-0.1231	-0.2179**	0.0536	-0.1573*
Dehydrogenase activity				1.000	-0.1052	-0.0672	-0.2873**
Electrical conductivity					1.000	0.0180	0.0477
Endosperm character						1.000	-0.1685*
Mold score							1.000

* Significant at 5%; ** Significant at 1% level

and the inferences drawn, the genotypes used in the present study can be classified into following three categories based on their innate ability for mold tolerance and seed quality under humid conditions:

Tolerent: IS 8545, IS 3443, IS 18758C-618-2, SPV 819, IS 25017, IS 14384, IS 9478, IS 30469C-140, SPV 472

Moderate: SPV 386, SPV 876, SURENO, ICSV 96101, SEPON 78-1, IS18758, CSV 15, PSV 16, CSV 4, ICSV , 95001, SEPON 79-26, CSH 16, ICSV 239, ICSV 91008, IS 18522, SWARNA, PKV 801, C 43, RS 29, KR 188, SERENE

Susceptible: SPV 351, IS 14332, SEPON 79-2, ICSV 8802, SPV 745, IS 18467, CSH 15R, ICSV 89102, CSH 9, SPV 104, CSH 15R, SPV 876, KR 194, PMS 7B, SPV 1403, B 58586, IS 23599, 296 B, AKMS 14B, BULK Y

It is evident that the seed undergo deterioration under natural conditions (NC) and at elevated relative humidity (MF-MPM and MPM-PPM) experiencing the vagaries of climate, and the impact of incidental rain at harvest to induce seed with mold infection and the resultant loss in seed quality. With higher relative humidity at flowering, physiological maturity and post physiological maturity the seed germinability, field emergence, germination loss, rate of germination indices and biochemical traits in seeds get deteriorated due to fungal infection and such seeds will not have acceptable seed quality and marketability. Hence seed systems should avoid such areas for seed production or must standardize suitable planting windows so that harvested seeds will have better innate seed quality components for profitable seed production.

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