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SEED STORAGE CAPACITY OF DIFFERENT GRAIN SORGHUM (SORGHUM BICOLOR (L.) MOENCH) CULTIVARS

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Sorghum is assuming importance as a major feed grain and fodder crop in the arid region of Northeast Brazil. Seed of high planting value is required to ensure adequate stand in the ever-changing and unpredictable field conditions. Viability losses occur mainly through preharvest deterioration, and rapid ageing by exposure of the poorly stored seed to occasional spells of high humidity. Sorghum cultivars introduced into this region were found to possess varying capacities of inherent germination (AKIL et al(1)). At this stage of ongoing selection and improvement program, due consideration should be given to inherent seed quality of the sorghum cultivars.

Seed deterioration processes which start right at physiological maturity and continue until appropriate storage, may amount to as much as 30% loss in germination (MONDRAGON and POTTS (5)). Proper drying of the sorghum seed is necessary before storage. BASS et el(2) demonstrated that seed moisture above 10% and temperatures exceeding 70° F resulted in poor storage. Four to seven percent moisture was superior for preservation of seed quality. Reduction of both preharvest and post-harvest seed deterioration could be of great economic importance.

Prediction of storability is important to avoid losses of storing a degrading seed mass. Seed of high germination normally would store better and tests like Accelerated Ageing Test, are used to judge storability (DELOUCHE et al (3), TIPPAYARUK(8)). Different causes of deterioration have been mentioned by STREETER(7) to be chromosomal aberrations, fat rancidity, food depletion, enzyme inactivation and impairment of some repair mechanisms.

In the present study, germination and vigor of grain sorghum cultivars were determined after subjecting the seed to various humidity levels. Storability was related to Accelerated Ageing Test and imbibition rate was observed in the seed.

MATERIALS AND METHODS

Cultivars of grain sorghum *(Sorghum bicolor* (L) Moench) used in this study were planted in four replications at Fazenda Saco Verde of the Federal University of Ceará, Fortaleza, Brazil on March 15, 1977 under dryland conditions. Harvest from replication three was used in these studies except that from replication four for results of Table 1. Seeds were harvested on July 7, 1977 and stored in a cold room (75% relative humidity and 12° C) until used.

Germination and Speed Index: Two hundred seeds were placed in a 15 cm

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petri dish over a single filter paper moistened with 8 ml of water. Two replications were used and seeds were incubated at 25° C in the dark. First, second and last germination counts were taken after 48, 72 and 120 hours of incubation, respectively. Seedlings with a minimum of 0.5 cm long healthy radicles were considered normal. Speed indices of 3, 2 and 1 were assigned, respectively, to individual seeds germinating at first, second and last counts. Average of two replications was reported.

Accelerated Ageing Test: Two hundred seeds were incubated in an accelerated ageing chamber maintained at 42° C and 100% relative humidity for a period of seven days according to method of DELOUCHE et al(3). Seeds were then taken out and germinated as mentioned earlier. Final count was taken at 96 hours.

Storage at Different Humidity Levels: Different humidy levels were created in large glass bottles with sealed caps according to VILLIERS and EDGCUMBE(9). Sulfuric acid dilutions giving specific gravities of 1.14, 1.29 and 1.425 were used to maintain relative humidity levels of 90%, 60% and 30%, respectively. Seeds were placed in the bottles without touching acid solution, and assuring aeration. After storage for 15, 30 or 45 days, the seeds were taken out and germinated as mentioned earlier.

Water Imbibition Rate: Seed weighing eight grams or more was placed in excess of water. After a lapse of one hour or more, it was taken out, blotted between filter papers and weighed. Gain in weight as a result of imbibition was plotted as a function of time.

RESULTS AND DISCUSSION

Seed of 14 sorghum cultivars was harvested in July, 1977, stored in a cold room and germination was estimated on three different dates (Table 1). Initial variation in germination (41.5 — 88.0%) and speed of germination (Index 111 - 245) among these cultivars was high. There appeared to be no loss of viability during 10 months of experimental storage. Speed of germination, however, decreased in almost all cases indicating a process of deterioration in the form of loss of vigor. In some instances, germination actually increased as if some type of dormancy was present at the time of initial testing. Similar increase in germination was visible in some cultivars, when seed harvested from replication three was tested on two different dates (Table 2). In a separate study (AKIL et al(1)), germination of these cultivars was found to be substancially high right after harvest. It appears, therefore, that these cultivars may be passing into dormancy sometimes 6 to 8 months after harvest. This is contrary to the finding of GRITTON and ATKINS(4) where dormancy in sorghum seed did not persist beyond 90 days after harvest Further work is needed to understand the phenomenon of increase in germination, many a time without accompanying increase in speed of germination.

Accelerated Ageing Test: Seeds from replication three were subjected to accelerated ageing and the resulting germination is shown in Table 2. DELOUCHE et al(3) have used this test successfully to estimate comparative storability of a seed lot. This test has also been used to determine seedling vigor. Accordingly cultivars EA-955, EA-91, EA-206, EA-201, and EA-145 gave high rating for storability and vigor.

Storage at 90% Humidity: Storing the seed at 90% relative humidity and 32° C was equivalent to subjecting the seed to Accelerated Ageing Test or even worse because this treatment lasted for month and a half (Table 2). Low quality seed of 'cultivars EA-86, EA-180, EA-121 and EA-171 lost germination almost completely. Other cultivars resisted germination loss effectively, at least upto 30 days of storage. In Ceará where rainy season extends over several months, high humidity and

Table 1 Variation in the germination of grain sorghum cultivars during experimental storage in the cold room* Fortaleza Ceara, Brazil.

Cultivar	January, 1978		July, 1978		October, 1978	
	Germ. %	Speed index	Germ. %	Speed index	Germ. %	Speed index
EA- 86	41.5	111	32.0	69	36.0	87
EA- 180	55.3	143	48.0	91	58.0	138
EA- 121	69.5	190	53.5	128	67.0	157
EA- 171	62.3	140	45.0	77	63.0	129
EA- 7	82.0	227	89.5	206	87.5	222
EA-1154	80.8	213	82.0	170	82.5	183
EA-1183	73.0	161	59.0	96	75.5	154
EA- 3	80.3	234	86.5	213	87.5	246
EA- 955	88.0	245	91.0	211	88.5	204
EA- 91	82.0	225	83.0	185	80.5	206
EA- 206	84.8	240	83.0	190	76.5	185
EA- 40	88.0	234	87.0	200	89.5	226
EA- 201	81.5	209	76.0	151	88.0	204
EA- 145	87.0	234	86.0	219	90.5	227

* Cold room temperature was about 12°C and humidity about 75 %. Seed material used in this study was from replication IV from Iraucuba harvest of 1977.

high temperature conditions could be a real problem for seed storage without monitoring the environment. Loss in speed of germination was even more drastic. Accelerated Ageing Test was reliable for predicting storability but rate of germination loss at 90% humidity would give a better insight into storage quality.

Storage at 60% humidity: At 60% humidity (and 32° C), there was steady decline in germination for the cultivars having low vigor seed (Table 3). Oth cultivars resisted any storage loss a in some situations there was even slig increase in germination during the e perimental period of 45 days. Both pr cesses of dormancy breakage and se deterioration were probably going at this humidity and temperature lev This storage situation may be desirab for a shorter term of a few months b over a longer period, considerable d terioration in seed quality is expect even in vigorous seed samples.

Table 2 Germination and vigor of grain sorghum cultivars as affected by storage at 75 % and 90 % humidities. Fortaleza, Ce. Br.

Cultivar	Stored at 75% humidity & 12 C, Tested January, 1978 Germ. %	Speed index	Feb, 1978 Aging Test vigor %	October, 1978 Germ. %	Speed index	Stored at 90% humidity and 32 C for period of 15-days Germ. %	Speed index	30-days Germ. %	Speed index	45-days Germ. %	Speed index
EA- 86	56.0	137*	30**	59.0	154	14.5	29	7.0	12	5.5	8
EA- 180	52.5	146	21	50.5	125	16.0	32	6.5	13	5.0	6
EA- 121	66.0	185	18	76.0	183	24.0	56	5.5	10	0	0
EA- 171	67.2	175	26	66.0	134	13.6	25	0.5	1	0	0
EA- 7	57.5	126	38	87.0	205	43.1	93	35.4	68	27.6	48
EA-1154	76.5	211	34	85.0	203	54.5	119	36.5	71	32.0	58
EA-1183	81.8	214	14	77.0	156	39.0	81	21.0	38	19.0	27
EA- 3	67.5	184	25	73.0	195	54.0	108	30.0	54	31.0	43
EA- 955	86.5	253	48	89.5	208	49.5	108	39.7	76	36.5	52
EA- 91	79.0	198	42	86.0	224	45.5	95	35.5	64	43.0	73
EA- 206	85.5	243	45	88.0	220	60.0	143	43.0	83	44.0	78
EA- 40	81.0	189	32	84.0	203	44.2	97	39.3	74	24.2	43
EA- 201	89.3	245	46	87.5	195	52.0	105	38.5	75	35.0	56
EA- 145	91.0	269	76	94.0	240	55.8	127	26.1	48	8.5	12

* Speed index was calculated by assigning increasing values to seeds germinating faster.

** Percent vigor was estimated after subjecting the seeds to Accelerated Ageing Test.

Table 3 Seed storability of grain sorghum cultivars at 60 % and 30 % humidities. Fortaleza, Ce. Br.**

Cultivar	Stored at 60% humidity, 32 C for 15-days Germ. %	15-days Speed IN DEX	30-days Germ. %	30-days Speed IN DEX	45-days Germ. %	45-days Speed IN DEX	Stored at 30% humidity, 32 C for 15-days Germ. %	15-days Speed IN DEX	30-days Germ. %	30-days Speed IN DEX	45-days Germ. %	45-days Speed IN DEX
EA- 86	32.5	63	16.5	29	20.0	34	24.5	47	23.0	41	30.5	37
EA- 180	43.7	83	38.0	73	38.0	63	33.0	64	23.5	30	32.0	36
EA- 121	61.8	136	49.7	93	46.0	76	55.8	123	44.0	66	52.0	76
EA- 171	44.5	86	36.5	58	44.6	70	28.8	52	27.0	29	29.0	34
EA- 7	86.9	177	70.5	137	77.3	151	73.0	144	85.5	148	64.2	103
EA-1154	88.0	199	71.1	138	69.0	136	83.3	191	75.5	170	60.5	99
EA-1183	63.5	135	38.5	70	51.5	81	48.2	102	28.5	36	24.5	35
EA- 3	74.0	155	67.5	130	75.5	146	76.5	159	69.0	133	73.5	138
EA- 955	87.5	205	76.0	157	72.0	157	77.0	197	73.0	132	67.0	119
EA- 91	77.9	163	68.0	134	81.0	159	75.0	151	80.5	123	75.5	110
EA- 206	78.0	173	71.0	144	70.0	142	76.5	181	67.5	117	65.0	100
EA- 40	89.3	191	77.4	149	81.5	164	73.5	154	70.4	127	75.4	119
EA- 201	78.8	161	62.0	114	59.5	105	60.0	131	40.5	65	39.5	50
EA- 145	86.5	185	67.5	129	64.0	115	84.5	199	63.0	111	58.5	98

* Speed index was calculated by assigning higher values to seeds germinating faster.

** Seed of these cultivars was harvested during July, 1977 and stored under controlled conditions on July 12, 1978.

Storage at 30% Humidity: This environment was expected to give best results as far as preservation of seed quality was concerned. But here germination as well as speed of germination were considerably lowered in all the cultivars (Table 3). In high vigor cultivars, this decline was even more prominent. It is not likely that 30% humidity is detrimental to the seed quality. As further studies now show more clearly, seeds pass into a dormant state. Low humidity and high temperature are conducive to secondary dormancy in these seed samples. This environment may be very suitable for prolonged storage. Just before planting, seeds could be placed in a humid atmosphere to get rid of this dormancy. NAKAMURA(6) worked with a variety of seeds and concluded that storage environment of 25 - 30% humidity would result in minimum quality deterioration. However, VILLIERS and EDGCUMBE(9) observed loss of viability in lettuce seed at too low humidity levels. Probable reason for this was considered to be accumulating damage to macromolecules because of inability of repair and turnover systems to operate in tissues with low water content.

Imbibition Rate: Water imbibition rate over a period of 24 hours was determined for the seeds of seven cultivars (Fig. 1). In general higher the via-

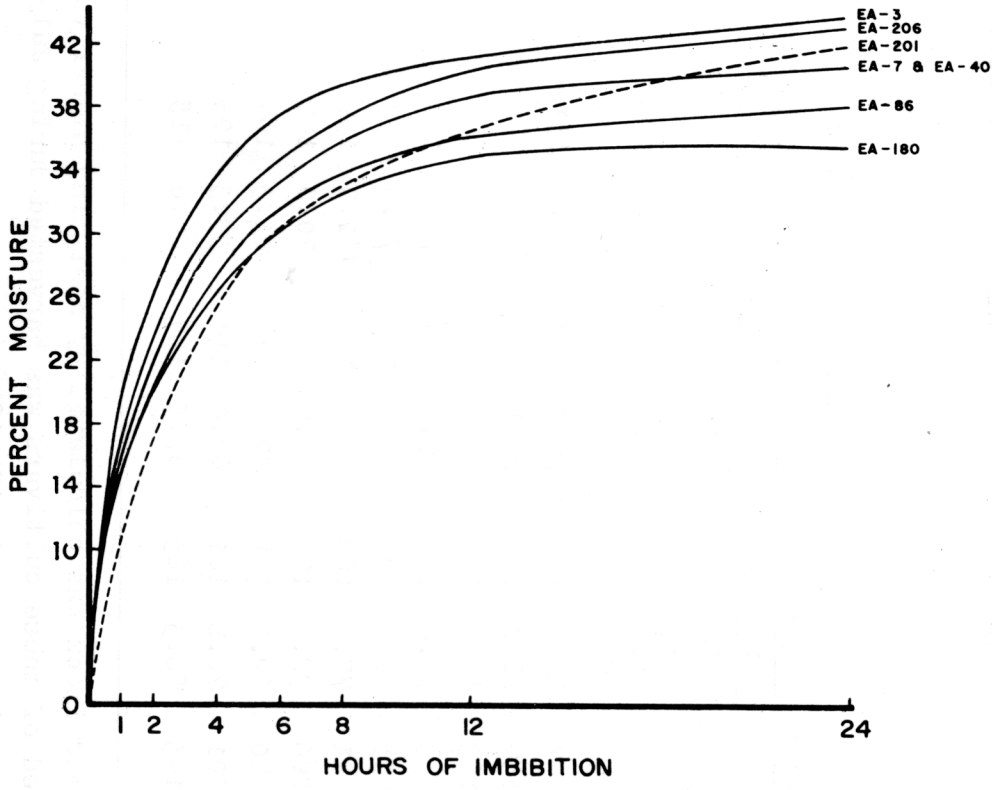

Figure 1. Imbibition rate of different grain sorghum cultivars. Fortaleza, Ceará, Brazil.

bility rating, greater was the imbibition rate of the cultivar. One reason, therefore, for better germination performance in some cultivars was greater seed-coat permeability and probably earlier onset of hydrolytic activities in the germinating seeds. The effect of secondary dormancy on imbibition rate needs to be explored yet. According to GRITTON and ATKINS(4), seed dormancy in sorghum was due to dormant embryo or seed-coat restrictions unrelated to permeability. Cultivars like EA-86 had consistently low viability not because of dormancy as treatments like chilling and exposure to high humidity did not alter that situation.

It can be concluded that grain sorghum cultivars varied a lot in the inherent quality of the seed they produced. Not only plant genetics was playing a role but also field conditions, especially microenvironment during preharvest period could modify seed viability and vigor. The cultivars in which secondary dormancy could be induced easily, might be of special importance for storage and preservation of seed quality. This situation of dormancy and seed deterioration needs to be further investigated.

SUMÁRIO

Quatorze cultivares de sorgo granífero (*Sorghum bicolor* (L) Moench) foram testadas em termos de viabilidade de sementes, vigor, capacidade de armazenamento e taxa de embebição de água. De um modo geral, as cultivares com elevada taxa de germinação e alto vigor, mostraram melhor capacidade de armazenamento. O teste de envelhecimento acelerado apresentou-se relacionado com a capacidade de estocagem. O grau de deterioração das sementes a 90% de umidade foi muito alto, durante um período de 45 dias de armazenamento.

A viabilidade das sementes de baixa qualidade aproximou-se de zero com este tratamento. Condições ambientais de 60 ou 75% de umidade, em um período de 45 dias, não foram prejudiciais à percentagem de germinação das melhores cultivares, embora tenham promovido uma diminuição na velocidade de germinação. Ao contrário do que se esperava, o armazenamento sob condições de 30% de umidade relativa apresentou um acentuado declínio na germinação. Com base nisso, aventou-se ocorrer, sob tal condição, o estabelecimento de dormência secundária, o que seria muito desejável para longos períodos de estocagem. O grau de embebição de sementes de vários cultivares foi diretamente proporcional ao fator viabilidade, indicando ser a permeabilidade uma causa da melhor germinação apresentada por algumas dessas cultivares.

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