International Journal of Agroforestry and Silviculture ISSN 2375-1096 Vol. 7 (9), pp. 001-005, September, 2019.
Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Effect of storage temperature and packaging materials on seed germination and seed-borne fungi of sorghum (*Sorghum bicolor* (L.) *Moench*.) in South West Nigeria

Owolade O. F.[1], Olasoji J. O.[1]* and Afolabi C. G.[2]

[1]Institute of Agricultural Research and Training, Obafemi Awolowo University, Ibadan, Nigeria.
[2]Department of Crop Protection, University of Agriculture, Abeokuta, Nigeria.

Accepted 21 April, 2019

A laboratory experiment was conducted at Ibadan, Nigeria to determine the effect of storage temperature and packaging materials on the germination and associated seed-borne fungi of two accessions of sorghum seed (NG/SA/07/0194 and NGB/08/0270). The seeds were stored at three different storage temperature (gene bank temperature -5°C), freezing temperature (-20 ± 2°C) and ambient temperature (25 ± 3°C), while the packaging materials were in an aluminum can, plastic container and polyethylene bag. The result showed that sorghum seeds stored inside gene bank and freezer irrespective of the packaging materials and type of accession retain their viability to the tune of 90.67 to 100%. Whereas seeds stored at ambient temperature had low germination percentage (10.67 to 28.00%) except those stored in aluminum can (41.33%). A total of six seed-borne fungi species were isolated from the two accessions of sorghum seeds irrespective of storage temperature and packaging materials. These included *Fusarium, Drechslera, Alternaria, Curvularia, Aspergillus and Penicillium*. The incidence of seed-borne fungi were more on seeds stored at ambient temperature (12.00 to 66.33%) irrespective of the storage materials. The results also recorded that the higher the infections by seed-borne fungi, the lower the germination.

Key words: Sorghum, fungi, storage condition, packaging material.

INTRODUCTION

Sorghum or Guinea corn (*Sorghum bicolor*) is a tropical crop and in the grass family, poacea, order poales. Sorghum is the fifth major cereal crop in the world after wheat (*Triticum* sp. L.), rice (*Oryza sativa* L.), maize (*Zea mays* L.), and barley (*Hordeum vulgare* L.). Sorghum grain is used for flours, porridges, malted and distilled beverages, beers and special foods such as popped grain (Crop Plant Resources, 2006). Seed are usually stored for varying lengths of time after harvest. Viability at the end of any storage period is the result of the initial viability at harvest, as determined by factors of production, methods of handling and rate at which deterioration takes place. This rate of physiological change varies with the kind of seed and the environmental condition of storage primarily temperature and humidity (Harmatann and Kester, 1993). During storage, seed quality is determined by several factors like environmental conditions during seed production, pests, diseases, seed oil content, seed moisture content, mechanical damages of seed in processing, storage longevity, packaging materials, pesticides, air temperature and relative air humidity in storage and biochemical injury of seed tissue (TeKrony et al., 1987; Reuzeau and Cavalie, 1995; Anfinrud, 1997; Al-Yahya, 2001; Guberac et al., 2003; Heatherly and Elmore, 2004). Longevity of seed in storage is influenced by the stored seed quality as well as stored conditions. Irrespective of initial seed quality, unfavourable storage conditions, particularly air temperature and air relative humidity, contribute to accelerating seed deterioration in storage. Hence, it is difficult to assess the effective storage period because the storability of the seed is a function of initial

*Corresponding author. E-mail: juliusolasoji@yahoo.com.

seed quality and the storage conditions (Anfinrud, 1997; Fabrizius et al., 1999; Heatherly and Elmore, 2004). Intensity of quality decreasing of stored seed is different among plant species and within plant species (genotypic variability), implying considerable influence of genetic (heritable) components on phenotypic expression of traits that determine seed quality (Morenomartinez et al., 1994; Al-Yahya, 1995, 2001; Guberac et al., 2003; Vieira et al., 2001). Sorghum has been found to be associated with seed-borne pathogen viz., *Fusarium moniliforme* which causes seed rot, *Gloecercospora sorgi* which causes zonate leaf spot, *Sphacelotheca* sp. which causes smut, *Ascochyta sorghina* causal agent of rough leaf spot and *Esepohilium turcicium* which causes leaf blight. *Fusarium moniliforme* is reported to be serious in sorghum as in rice and maize. This pathogen reduces sorghum stands causing stalk rot, top rot and moldy ears. It may depreciate yield to a great extent (Osunlaja, 2005). Abdusalaam and Shenge (2011) isolated seven fungal genera growing on unwashed seed samples of stored sorghum viz., *Helminthosporium sp, Aspergillus sp, Fusarium sp, Rhizoctonia* sp., *Penicillium* sp*., Sclerotium* sp. and *Curvularia* sp. In the effort to support the supply of seeds stocks with best quality, continuous and optimal number of seeds stocks, study were taking to determine the effect of packaging materials and storage environment and packaging materials on sorghum seed germination and seed-borne fungi of sorghum.

MATERIALS AND METHODS

The experiment was carried out in the plant pathology laboratory of the Institute of Agricultural Research and Training, Obafemi Awolowo University, Moor Plantation, Ibadan and National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan between June, 2009 and March, 2010. Two sorghum accessions, NG/SA/07/0194 and NGB/08/0270 obtained from farmers were used for this investigation. A total of 1 kg of clean and bold sorghum seeds of each accession were packed in each of packaging materials (plastic containers, aluminum can and polyethylene bag (200 gauge). These were placed in each storage environment. The initial moisture contents and germination percentage were determined and recorded before packaging the seeds according to the prescribed procedures of the International Seed Testing Association (ISTA). The packaging materials containing the seeds were arranged in a complete randomized design (CRD) in each of the storage environment. Electricity was supplied for at least 8 h (during power failure) each day throughout the period of the experiment.

Germination tests were carried out for the two accessions of sorghum at 6 and 9 months after storage using the blotter paper method by placing 50 seeds per petri plate in four replicate. On the other hand, to determine the seed borne fungus/fungi twenty five seeds were randomly sampled from each accession and were sterilized with 5% sodium hypochloride (NaOCl) for five minutes and rinsed in three changes of sterilized water. Sterilized seeds were then placed on acidified potato dextrose agar (APDA) and the plates were incubated in the biochemical incubator (Model 1200) with a temperature ranging from 25 ± 2°C under 12 h alternating cycles of NUV light and darkness for eight days. Slides preparation of various fruiting bodies/structure of fungi were made and observed under a compound microscope. The fungi were identified to species level, using the keys of Chidambaram et al. (1973) and Mathur and Longsdel (2003). The data collected were subjected to analysis of variance using SAS version 8.2 software.

RESULTS AND DISCUSSION

The moisture content of the sorghum seed samples used in the study varied between 10.5 and 12.5% for accession NG/SA/O7/0194, while it ranged between 10.8 and 12.0% for NGB/08/270 before storage. The percentage germination at sampling ranged between 96 and 100% irrespective of variety (Table 1). Irrespective of the treatment, the moisture content increased with storage period. Highly infected seeds showed high moisture content. On an average the mean moisture contents of the seed samples stored in plastic container in ambient environment reached 13.7 to 14.0% on both accession after six months and 14.5 and 18.5% after nine months irrespective of the storage container. However, the sorghum seed stored in the freezer and gene bank irrespective of their storage materials with a minimum of eight hours electricity supply daily maintained an acceptable moisture content that ranged between 12.0 to 13.5% after nine months of storage. The result in Table 1 also showed that there were no significant differences in between the seed germination of the two sorghum accessions stored in gene bank and freezing temperature irrespective of the storage materials and period of storage. However, seeds of both accessions stored at ambient environment recorded significant low germination except those stored in aluminum can. Seed stored in polyethylene bag and plastic container at ambient temperature recorded the lowest germination percentage after 6 and 9 months period irrespective of variety. This present studies are in line with reports of Asiedu et al. (1999). Who reported that seeds stored in humid and warm environments tend to absorb moisture from the surroundings, leading to increased seed moisture content until equilibrium is established. As seed moisture content increases, the rate of deterioration also increases (Roberts, 1972). There were no significant differences ($p \geq 0.05$) in germination among seed samples stored in the gene bank and freezer irrespective of storage materials. However, mean germination of seeds stored in ambient environment was significantly reduced and varied between 10.6 and 41.33%.

Fungi infection after 6 and 9 months storage period (Tables 2 and 3) showed that all the seed samples with different packaging materials and storage environment were all associated with various fungal pathogens. *Fusarium* spp*, Aspergillus* sp*., Penicillium* sp*., Drechslera* sp., *Alternaria* sp*.,* and *Curvularia* sp. were the dominant microflora associated with the seed irrespective of the storage materials, environment, period and variety. This result was in agreement with those of Kamal and Mughal (1968), Khan et al. (1974) as well as Abdulsalaam and

Table 1. Effect of storage condition and packing materials on percentage germination and moisture content.

Environment	package materials	After harvest				6 months after storage				9 months after storage			
		NG/SA/07/0194		NGB/08/270		NG/SA/07/0194		NGB/08/270		NG/SA/07/0194		NGB/08/270	
		IMC	IGERM	IMC	IGERM	MC	%GERM	MC	%GERM	MC	%GERM	MC	%GERM
Gene bank	Polyethylene bag	11.2	100	11.9	97	11.7	100.00^{a}	12.0	96.00^{a}	12.5	100.00^{a}	12.9	90.67^{a}
	Aluminum can	10.5	100	12.0	100	11.0	96.00^{a}	12.5	100.00^{a}	13.2	93.33^{ab}	13.0	100.00^{a}
	Plastic container	11.7	100	11.8	98	11.9	100.00^{a}	12.0	97.33^{a}	13.0	100.00^{a}	12.2	98.67^{a}
Freezer	Polyethylene bag	12.0	100	11.7	100	12.2	100.00^{a}	1.8	100.00^{a}	12.5	100.00^{a}	13.2	90.67^{a}
	Aluminum can	11.0	100	12.0	97	11.5	100.00^{a}	12.4	96.00^{a}	12.1	100.00^{a}	13.2	93.33^{a}
	Plastic container	11.5	100	11.6	98	11.8	100.00^{a}	11.9	97.33^{a}	12.0	100.00^{a}	13.5	94.67^{a}
Ambient	Polyethylene bag	10.5	100	10.8	96	13.5	37.33^{c}	13.9	37.33^{c}	16.5	34.67^{c}	17.5	10.67^{c}
	Aluminum can	11.7	100	10.9	99	13.8	44.37^{c}	13.6	53.33^{ab}	14.5	39.33^{c}	17.6	41.33^{b}
	Plastic container	12.5	100	11.5	98	14.0	42.67^{c}	13.7	41.33^{c}	17.0	30.67^{c}	18.5	28.00^{c}

Mean in the same column followed by the same letters are not significantly different from each others at P ≤ 0.05; IGERM, initial germination; %germ, percentage germination; IMC, initial moisture content; MC, moisture content.

Table 2. Effect of storage condition and packing materials on percentage incidence of seed-borne fungi of two sorghum accessions at 6 months after storage.

Environment	package materials	NG/SA/07/0194						NGB/08/0270					
		Fus sp.	*Drech* sp.	*Asper* sp.	*Curv* sp.	*Peni* sp.	*Alter* sp.	*Fus* sp.	*Drech* sp.	*Asper* sp.	*Curv* sp.	*Peni* sp.	*Alter* sp.
Gene bank	Polyethylene bag	3.63^{c}	0.5^{a}	3.00^{b}	0.5^{b}	2.67^{c}	2.4^{b}	2.67^{b}	1.06^{c}	3.00^{b}	1.5^{b}	2.67^{c}	1.3^{b}
	Aluminum can	8.00^{c}	0.5^{b}	4.67^{b}	0.0^{b}	2.67^{c}	2.5^{b}	3.33^{b}	0.5^{c}	2.67^{b}	1.5^{b}	3.33^{cd}	2.0^{b}
	Plastic container	2.67^{c}	0.0^{b}	4.67^{b}	0.5^{b}	2.00^{c}	2.0^{b}	6.00^{b}	1.0^{c}	2.67^{b}	2.0^{b}	2.33^{d}	2.0^{b}
Freezer	Polyethylene bag	3.67^{c}	0.0^{b}	7.33^{b}	1.0^{b}	2.66^{c}	1.2^{b}	3.00^{b}	1.0^{c}	4.00^{b}	3.0^{b}	2.66^{c}	2.5^{b}
	Aluminum can	4.33^{c}	0.0^{b}	7.33^{b}	0.5^{b}	3.00^{c}	2.4^{b}	5.00^{b}	2.0^{c}	4.67^{b}	2.0^{b}	2.00^{d}	2.6^{b}
	Plastic container	4.00^{c}	0.0^{b}	5.67^{b}	1.0^{b}	3.33^{c}	2.5^{b}	2.67^{b}	1.0^{c}	4.00^{b}	3.0^{b}	2.33^{d}	2.3^{b}
Ambient	Polyethylene bag	29.67^{a}	2.5^{a}	47.67^{a}	8.6^{a}	11.00^{ab}	8.0^{a}	32.67^{a}	5.2^{a}	47.67^{a}	7.5^{a}	10.67^{cb}	8.4^{a}
	Aluminum can	17.33^{b}	3.0^{a}	45.67^{a}	5.0^{a}	12.00^{a}	10.5^{a}	25.67^{a}	4.5^{a}	46.69^{a}	6.0^{a}	12.00^{a}	9.5^{a}
	Plastic container	40.07^{a}	3.5^{a}	46.67^{a}	9.5^{a}	9.00^{b}	9.5^{a}	31.00^{a}	2.6^{b}	41.33^{b}	5.0^{c}	9.33^{b}	10.5^{a}

Means in the same column followed by the same letters are not significantly different from each other at P≤ 0.05; Fus sp.: *Fusarium* sp,. Drech: *Drechslera* sp,–Asper sp.: *Aspergillus* sp., .Curv sp.: *Curvularia* sp., Pen sp.: *Penicullium* sp., Alter sp.: *Alternaria.*

Table 3. Effect of storage condition and packing materials on percentage incidence of seed-borne fungi of two sorghum accessions at 9 months after storage.

Environment	package materials	NG/SA/07/0194						NGB/08/0270					
		Fus sp.	*Drech* sp.	*Asper* sp.	*Curv* sp.	*Peni* sp.	*Alter* sp.	*Fus* sp.	*Drech* sp.	*Asper* sp.	*Curv* sp.	*Peni* sp.	*Alter* sp.
Gene bank	Polyethylene bag	2.00^{c}	1.6^{b}	2.33^{de}	1.0^{b}	5.00^{de}	2.5^{b}	3.33^{b}	2.3^{b}	5.00^{c}	4.5^{b}	6.33^{b}	2.5^{b}
	Aluminum can	3.00^{c}	1.5^{b}	5.33^{c}	1.5^{b}	4.00^{de}	1.5^{c}	3.33^{b}	1.8^{b}	2.33^{c}	5.0^{b}	2.00^{b}	2.0^{b}
	Plastic container	3.00^{c}	$2..0^{b}$	1.33^{be}	1.0^{b}	2.67^{e}	1.6^{c}	3.67^{b}	2.5^{b}	2.00^{c}	3.5^{b}	2.00^{b}	2.0^{b}
Freezer	Polyethylene bag	1.33^{c}	1.3^{b}	5.33^{cd}	0.5^{b}	8.00^{c}	2.3^{b}	4.33^{b}	2.6^{b}	4.33^{c}	4.3^{b}	6.00^{b}	3.5^{b}
	Aluminum can	3.00^{c}	1.2^{b}	8.00^{c}	0.5^{b}	5.00^{de}	4.5^{b}	9.67^{b}	6.5^{a}	8.00^{c}	6.4^{b}	8.33^{b}	2.0^{b}
	Plastic container	2.00^{c}	1.0^{b}	7.00^{c}	0.0^{b}	5.33^{c}	3.5^{b}	2.00^{b}	2.3^{b}	4.67^{c}	3.5^{b}	5.33^{b}	2.3^{b}
Ambient	Polyethylene bag	43.67^{a}	16.5^{a}	55.33^{a}	17.5^{a}	12.67^{a}	15.0^{a}	46.33^{a}	19.5^{a}	66.33^{a}	10.5^{a}	20.33^{a}	16.3^{a}
	Aluminum can	23.33^{b}	16.09^{a}	52.00^{b}	16.0^{a}	14.67^{a}	16.3^{a}	35.00^{a}	16.8^{a}	54.00^{a}	11.2^{a}	22.00^{a}	15.6^{a}
	Plastic container	43.33^{a}	17.5^{a}	57.00^{a}	15.5^{a}	12.00^{b}	12.5^{a}	39.67^{a}	17.5^{a}	62.33^{b}	19.8^{a}	20.67^{a}	18.5^{a}

Means in the same column followed by the same letters are not significantly different from each other at P ≥0.05; Fus sp.: *Fusarium* sp., Drech: *Drechslera* sp, Asper sp.: *Aspergillus* sp., Curv sp: *Curvularia* sp., Pen sp.: *Penicullium* sp., Alter sp.: *Alternaria* sp.

Shenge (2011) who reported the presence of *Alternaria, Helminthosporium, Fusarium, Curvularia, Stemphylium, Rhizopus, Cladosporium, Aspergillus and Penicillium* species in sorghum seeds.

There were no significant differences in incidence of any of the isolated fungi between the gene bank and freezer storage environment. However, all the associated fungi were significantly higher when seeds are stored in the ambient condition irrespective of packaging methods or period of storage. *Aspergillus spp*. was the most predominant field fungi isolated and its incidence was significantly influenced by the storage environment and not by the packaging materials (Tables 2 and 3). This finding collaborates with the data obtained of Khan and Bhutta (1994) and Bhutta and Hussain (1999), who reported the occurrence of *Drechslera sorokiniana* and *Fusarium moniliforme* as major pathogen of sorghum seed. The percentage incidence of *Aspergillus* sp. on seed of variety NG/SA/07/0194 and NGB/08/270 ranged between 1.33 to 57.00 and 2.00t o 66.33% respectively, after 9 months storage. This was followed by *Fusarium* sp. and *Penicillium* sp.

The incidence of other isolated fungi such as *Drechslera, Curvularia* and *Alternaria* species were less significantly influenced by the type of packaging materials and storage environment. High incidence of those fungi were recorded when sorghum seeds are stored in ambient conditions irrespective of the packaging materials. The finding of the study revealed that seeds of sorghum can best be stored under controlled environment for multiplication. Increase in moisture content over a period of time during storage coupled with high infection rates could lead to a substantial loss of sorghum seeds therefore the need to maintain the temperature and relative humidity of the store. The level of moisture content in stored seeds affects both the grade and storability and has been observed to be an opportunity for microbial activity which increases the rate of seed damage (Abdusalam and Shenge, 2011).

Conclusion

The result of this experiment showed that adequate handling of sorghum seeds in gene bank and freezing conditions can retain the viability of the seeds. It was indicated that sorghum seeds can be stored in gene bank and freezer with any of the storage containers (aluminum can, plastic container and polyethylene bag) without loss of viability of the seed in both accessions when electricity was available for at least 8 h each day.

However, seeds stored under the ambient condition (28 to 32°C) with an air tight aluminum can container could be the storage option for

farmers living in the rural areas where there are no modern storage facilities. This investigation also recorded that low temperature condition associated with lower moisture content is very suitable for sorghum seed storage. In turn the warm temperature and concomitant high relative humidity in the store reduced seed viability due to an increased degree of invasion by seed-borne/ storage fungi (Dejene, 2004).

Finally, sorghum seeds meant for storage should be properly dried to safe moisture content before storage in an air-tight aluminum can in any of the storage environment. Hence, there is need to investigate the best type of storage material that could be used for ambient storage which could reduce the growth of fungal infection and maintained germination of sorghum seeds.

REFERENCES

Abdusalaam S, Shenge KS (2011). Seed borne pathogens on farmer-saved sorghum (*Sorghum bicolor* L.) seed. J. Stored Prod. Post Harvest Res., 2(2): 24-28.

Al-Yahya SA (1995). Losses of corn in the storage. Arab Gulf J. Sci. Res., 13: 199-212.

Al-Yahya SA (2001). Effect of storage conditions on germination in Wheat. J. Agron. Crop Sci., 186: 273-279.

Anfinrud MN (1997). Planting hybrid seed production and seed quality evaluation. In:Sunflower Technology and Production ed by A.H. Schneiter. Agronomy N-35, Madison, Wisconsin, USA, pp. 697-708.

Bhutta AR, Hussain SA (1999). Seed-borne pathogens of wheat in Pakistan. Rachis, 18(2): 66-68.

Chidambaram PS, Mathur SB, Neergaard P (1973). Identification of seed-borne Drechslera sp. Friesia 10: 165-207.

Crop Plant Resources (2006). Sorghum *Sorghum bicolor*. http://darwinnmsu edu/molbio/plant/sorghum.htm.

Dejene M (2004). Grain storage methods and their effects on sorghum grain quality in Hararge, Ethopia. PhD thesis Swedish university of Agriculture Sciences, pp. 1-29.

Fabrizius E, Tekrony D, Egli DB, Rucker M (1999). Evaluation of a viability model for predicting soybean seed germination during warehouse storage. Crop Sci., 39: 194-201.

Guberac V, Maric S, Lalic A, Drezner G, Zdunic Z (2003). Hermetically sealed storage of cereal seeds and its influence on vigor and germination. J. Agron. Crop Sci. 189: 54-56.

Hartmann HT, Kesler DE (1993). Principle and practices of plant propagation and storage. Fourth ed. New Jersey, prentice hall press, p. 90.

Heatherly LG, Elmore RW (2004). Managing Inputs for Peak Production. In: Soybeans: Improvement, Production and Uses eds by Boerma H.R., Specht, J.E. 3rd Edition, Agronomy N-16, ASA, CSSA, SSSA, Madison, Wisconsin, USA, pp. 451-536.

Kamal M, Mughal SM (1968). Studies on plant diseases of South West Pakistan Agric Res. Inst. Tandojam, p. 207.

Khan MQ, Bhutta AR (1994). Seed-borne fungi of wheat cultivars in Pakistan. Pak. J. Ind. Res., 9: 397-398.

Khan SA, Jamir MSB, Neergaard P (1974). Survey on new seed organisms of Pakistan. Seed Sci. Technol., 2: 477-479.

Mathur SB, Longsdel O (2003). Common Laboratory Seed Health Testing Methods for Detecting Fungi. Danish Govt Institute of Seed Pathology for Developing Countries. Copenhegen. Denmark. Published by ISTA, Switzerland, p. 425.

Morenomartinez E, Navarretemaya RV, Ramirezgonzales J (1994). Seed viability of different varieties of bean (*Phaseolus vulgaris* L.) stored under low and high relative humidity. Seed Sci. Technol., 22: 195-202.

Osunlaja SO (2005). Effect of organic amendments on the incidence of stalk rot of cereals. Plant and Soil, pp. 237-241.

Reuzeau C, Cavalie G (1995). Activities of free radical processing enzymes in dry Sunflower seeds. New Phytol., 130: 59-66.

Roberts EH (1972). Viability sof Seeds. Chapman and Hall, p. 448.

TeKrony DM, Egli DB, White GM (1987). Seed Production and Technology. In Soybeans: Improvement, Production and Uses ed by Wilcox, J.R. 2nd Edition, Agronomy N-16, ASA, CSSA, SSSA, Madison, Wisconsin, USA, pp. 295-353.

Vieira RD, TeKrony DM, Egli DB, Rucker M (2001). Electrical conductivity of soybean seeds after storage in several environments. Seed Sci. Technol., 29: 599-608.