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Research Article
Effect of Some Plant Extracts on Seed Viability and Seed Borne Fungi of Sorghum Seed During Storage Periods

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Abstract
The present study was conducted at the Laboratory of Seed Technology Research Unit, Mansoura, Egypt to study the effect of plant extracts neem (*Azadirachta indica*), Moringa (*Moringa oleifera*), basil (*Ocimum basilicum* L.) and datura (*Dataram stramonium*) as seed treatments on storability of of Sorghum seeds. Different concentrations (25, 50, 75 and 100%) of the different plant extracts beside distilled water and storage periods (0, 4 and 8 months) on seed quality of Sorghum cultivar Dorado were used. The obtained results showed that Moringa plant extract at 25% concentration showed the highest results of seed and seedling vigor characters and also reduced infected seed when compared with other seed treatments. Also, the results illustrated that the inhibitory effects of all plant extracts on seed borne fungi was increased as concentration of extracts increased from 0-100%. Finally, it could be concluded that moringa plant extracts at 25% concentration is a good seed treatment for enhancing germination and good control of seed borne fungi on sorghum seed.

Key words: Sorghum, plant extracts, seed viability, seed borne fungi, storage

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Sorghum (*Sorghum vulgare*), a member of the grass family Graminea, is a hardy plant able to grow under a variety of field conditions and which, together with maize, barley, wheat, rice and sugarcane, form part of the world's feed and food production chain for animal and human consumption (Du Plessis, 2008; Jwa *et al*., 2006).

The purpose of proper storage is to reduce biological processes to the highest possible minimum and eliminate unfavorable environmental factors, which limit duration of the safe storage. Azadi and Younesi (2013) demonstrated that increasing storage duration resulted in significantly higher reduction in germination percentage, mean days to germination, germination index, normal seedling percentage beside enzyme activity.

Seed-borne pathogens may cause seed abortion, seed rot, seed necrosis, reduction or elimination of germination capacity as well as seedling damage. Seeds are regarded as highly effective means for transporting plant pathogens over long distances (Halt, 1994). Seed-borne mycoflora of Sorghum were isolated from seed samples of sorghum and those most frequently isolated and identified reported from different parts of the world include *Alternaria alternata*, *Aspergillus flavus*, *A. fumigatus*, *A. niger*, *Cladosporium* spp., *Fusarium moniliforme*, *F. oxysporum*, *F. pallidoroseum*, *Drechslera tetramera*, *Helminthosprium* sp. *Nigrospora* spp., *Phoma* sp., *Mucor* sp., *Penicillium* sp. and *Rhizopus* sp. (Girish *et al*., 2004; Yago *et al*., 2011; Naqvi *et al*., 2013). *Aspergillus flavus* and *Curvularia pallescens* were found to be more pathogenic and cause more deterioration due to production of amylase. Amylase can convert starch into glucose and glucose is easily absorbed by fungi and seeds become more unviable and showing high percentage of germination inhibition (not clear) (Khairnar, 2015). Reduction in germination rate of Sorghum due to *Alternaria alternata*, *Aspergillus* spp., *Rhizopus* spp., *Curvularia lunata* and *Fusarium equiseti*, seed borne fungi could be the main seed borne pathogen affecting Sorghum seed viability. The high frequency of occurrence of mycoflora which affect the seed viability and germination of the above organisms was also observed by Tarp *et al*. (1987).

The extensive use of agrochemicals especially fungicides, which pose more of carcinogenic risk than other pesticides may give rise to undesirable biological effects. One source of potential new pesticides is natural products produced by plants. Plant extracts and essential oils show antifungal activity against a wide range of fungi (Abd-Alla *et al*., 2001).

Antifungal activity of leaf extracts of *Azadirachta indica* (neem) showed maximum activity was observed against the seed-borne pathogenic fungi viz., *Alternaria alternata*, *Aspergillus niger*, *Curvularia lunata*, *Fusarium moniliforme* and *Trichoderma viride*. These plant extracts can possibly be exploited in the management of seed-borne pathogenic fungi to prevent biodeterioration of seeds in an eco-friendly way (Pawar, 2011). Moringa leaf extracts along with some other plant extracts on seeds of cowpea found that Moringa leaf juice use as an antifungal agent inhibited the attack of seed born fungal pathogens more significantly compared with the other plant extracts used as well as the control (Phiri, 2010). Aqueous extracts of the leaves of *Ocimum gratissimum* at 10, 25, 40 and 50% (w/v) concentrations induced the production of phytoalexins in soybean cotyledons and sorghum mesocotyls and induced systemic resistance in cucumber against *Colletotrichum lagenarium as* reflected by reduction in disease incidence and an increase in chitinase production (Colpas *et al*., 2009). Leaf extracts of basil reduced the incidence of seed-borne fungi tested and increased seed germination and seedling emergence of african yam bean compared with the untreated seed (Nwachukwu and Umechuruba, 2001). *Datura stramonium* (Datura) extract is very effective in inhibiting the fungal growth of *Ustilago tritici* and can successfully be used for controlling seed borne fungal pathogens of wheat instead of environment hazardous chemicals for treating seeds of wheat (Seth *et al*., 2014).

The aim of the present study was to evaluate the efficiency of some plant leaf extracts on germination and control of seed borne fungal pathogens of Sorghum during storage.

MATERIALS AND METHODS

Laboratory experiments were conducted at Seed Technology Research unit in Mansura, Dakahalia Governorate, Field Corp Research Institute, Agricultural Research Center, Egypt in 2014 and 2015 planting seasons to study the efficacy of some leaf plant extracts in reducing sorghum seed deterioration under different storage periods (0, 4 and 8 months). Plant aqueous extracts used were *Azadirachta indica* (Neam), *moringa oleifera* (Moringa), *Ocimum basilicum* L. (basil) and *Datura stramonium* (Datura) at concentrations of 25, 50, 75 and 100%, distilled water (0) concentration and dry seed (untreated seed) which the seed are not soaked in water or extract solution.

Source of seed: Sorghum seed (Dorado cultivar) were obtained from the Department of Sorghum Corp Research, Agricultural Research Center, Egypt.

Preparation of leaf plant aqueous extracts: The aqueous extract of each plant material was prepared by soaking 10 g of powdered leaf plant samples in 200 mL of sterile distilled water in 500 mL Erlenmeyer flask at room temperature for 24 h. The supernatant was filtered through double layered muslin cloth and centrifuged at 4000 g for 30 min. It was filtered through Whatman No. 1 filter paper. The extract was preserved aseptically in a brown bottle at 5°C prior to use (Ponnusamy *et al*., 2010).

Seed treatment: Samples of seed were soaked in the different concentrations of plants extracts under study and distilled water, respectively for 2 h. After soaking, the seeds were surface-dried in an incubator with forced air circulation for 48 h on filter paper at a temperature of 25°C to return to their original moisture of 12-14% (on dry weight basis). The seeds of all treatments were stored in cotton bags and kept at ambient conditions in the laboratory for 0, 4 and 8 months.

Eight replicates of 50 seeds from each treatment (400 seeds) were placed in petri dishes (12 cm) containing 3 layers of moistened blotters and incubated in the growth chamber at 25±2°C and the following parameters were evaluated.

Germination percentage (G%): This was calculated by counting only normal seedlings 14 days after planting according to ISTA (1999).

Seed vigor test

Speed Germination Index (SGI): This was calculated according to the Association of Official Seed Analysist (AOSA., 1983) using the following formula:

$$SGI = \frac{\text{No. of germinated seed}}{\text{Days of first count}} + \frac{\text{No. of germinated seed}}{\text{Days of final count}}$$

The seeds were considered germinated when the radicle was at least 2 mm long.

Germination Energy (GE): This was recorded on the 4th day after planting. It is the percentage of germinated seeds 4 days after planting relative to the total number of seeds tested (Ruan *et al*., 2002).

Germination Rate (GR): This calculated according to the following formula of Bartlett (1937):

$$GR = \frac{a+(a+b)+(a+b+c)(a+b+c+m)}{n\,(a+b+c+m)}$$

where, a, b, c are No. of seedlings in the first, second and third count, m is No. of seedlings in final count, n is the number of counts.

Mean Germination Time (MGT): This was calculated based on the following equation of Ellis and Roberts (1981):

$$MGT = \frac{\sum Dn}{\sum n}$$

where, n is the number of seeds, which were germinated on day, D is number of days counted from the beginning of germination.

Electrical Conductivity (EC) tests: The results were recorded as micro mhos/g seed in accordance to Matthews and Alison (1987). The mean of 3 readings was calculated as follows:

$$EC = \frac{\text{Reading of replicate 1}}{\text{Wt. of 50 seeds in replicate 1}} + ... + \frac{\text{Reading of replicate 3}}{\text{Wt. of 50 seeds in replicate 3}} \div 3$$

Seedling characters: Treated and untreated seeds were sown in sterilized sand with the same previous method to determine the germination percentage and seedling characters. Ten normal seedlings from each replicate were randomly taken to measure seedling characters as follows:

- **Shoot and root length (cm):** Measured as mean of ten normal seedlings 14 days after planting
- **Seedling dry weight (g):** Ten normal seedlings were dried in hot-air oven at 85°C for 12 h to obtain the seedling dry weight (g) according to Krishnasamy and Seshu (1990)
- **Seedling Vigor Index (SVI):** Calculated according to the following equation of Abdul-Baki (1980)

Seedling vigor index = dry weight (g) × germination percentage

All data obtained data were subjected to statistical analysis of variance (ANOVA) using the completely randomized design, as described by Gomez and Gomez (1984).

Mycological analysis: The seed health analysis was performed on 200 seeds from each treatment, the other two hundred of untreated seeds served as control (ISTA., 1999). The seeds were plated in petri dishes (9 cm) with eight replicates (25 seeds per petri dish) and incubated at 22±2°C for seven days, under 12 h alternating cycles of NUV light and darkness.

After incubation, the fungi were identified on the basis of their growth and sporulation using a stereomicroscope and when necessary, a compound microscope (Langerak *et al*., 2002; Mathur and Kongsdal, 2003). The total number of infected seeds by fungus in each dish were recorded and the calculated using the following formula:

$$\text{Fungi (\%)} = \frac{N1}{N2} \times 100$$

N1 = Number of seeds with fungal growth
N2 = Number of total seeds

RESULTS

Results of germination percentage, seed vigor and seedling quality attributes of sorghum as affected by storage period, type of plant extract and extracts concentration under study are presented in Table 1 and 2. The results showed that storage period significantly affected germination percentage, seed vigor and seedling quality characters. The highest germination percentage (83.8%) was obtained at zero storage period (0 month) while the lowest value (79.9) was observed at 8 months in storage. Germination percentage was stable and relatively high up to 4 months in storage (83.8-81.8%) but

Table 1: Effect of storage period, plant extracts and concentration on some seed guality attributes of Sorghum

		Seed vigor				
Treatments	G (%)	SGI	GE	GR	MGT (days)	EC
Storage periods						
0 month	83.8	43.6	71.0	0.75	3.8	0.026
4 months	81.8	38.9	69.4	0.73	4.2	0.034
8 months	79.9	38.3	67.6	0.71	4.6	0.037
LSD at 5%	1.0	0.9	2.5	0.02	0.4	0.001
Plant extracts						
Neem	81.3	39.9	68.7	0.73	4.3	0.031
Moringa	83.5	40.1	70.6	0.74	4.1	0.033
Basil	81.7	40.9	69.1	0.72	4.2	0.032
Datura	80.9	40.2	69.1	0.72	4.3	0.035
LSD at 5%	1.3	0.4	1.0	0.01	0.1	0.001
Concentrations						
Dry seed	78.0	35.8	66.0	0.67	4.7	0.035
Distilled water	80.1	39.6	68.0	0.70	4.4	0.034
25%	85.2	42.3	71.7	0.77	4..0	0.030
50%	85.8	42.6	72.8	0.78	3.7	0.030
75%	82.3	41.6	69.9	0.75	4.0	0.031
100%	79.6	39.9	67.8	0.71	4.4	0.035
LSD at 5%	1.4	0.8	1.4	0.01	0.17	0.0001

G (%): Germination percentage, SGI: Speed germination index, GE: Germination energy, GR: Germination rate, MGT: Mean germination time, EC: Electrical conductivity

Table 2: Effect of storage period, plant extracts and concentration on sorghum seedling quality parameters

Treatments	Shoot length (cm)	Root length (cm)	Seedlings dry weight (g)	Seedlings vigor index
Storage periods				
0 month	11.0	12.0	0.505	42.6
4 months	8.8	8.8	0.406	33.5
8 months	7.6	7.3	0.304	24.4
LSD at 5%	0.5	0.3	0.005	0.5
Plant extracts				
Neem	9.2	9.3	0.379	30.9
Moringa	9.3	9.5	0.432	36.6
Basil	9.1	9.2	0.408	33.6
Datura	9.1	9.5	0.401	32.7
LSD at 5%	0.1	0.1	0.006	0.9
Concentrations				
Dry seed	8.1	8.7	0.305	23.8
distilled water	8.2	9.1	0.354	28.5
25%	10.2	9.9	0.481	41.2
50%	10.3	10.3	0.495	42.7
75%	9.5	9.5	0.423	35.1
100%	8.7	8.8	0.371	29.6
LSD at 5%	0.3	0.12	0.008	0.8

thereafter declined drastically with increase in storage time up to 8 months (79.9). Also, there were significant differences among storage periods on seed vigor attribute as expressed by speed germination index, germination energy, germination rate, mean germination time and electrical conductivity (Table 1). The highest values of all seed vigor parameters in this study were produced at 0 month storage while, the lowest values resulted from seed stored for 8 months except mean germination time which had the highest value at 8 months, indicative of lowest seed quality. Seedling vigor parameters (shoot length, root length, seedling dry weight and seedling vigor index) were significantly affected by storage periods (Table 2). The maximum shoot length, root length and seed dry weight and seedling vigor index were obtained in zero storage period (0 month) which were 11.0, 12.0 cm, 0.505 g, 42.6, respectively. Seedling vigor values decreased with advance in storage time, the decrease continued as storage time increased.

The different plant extracts had significant effects on germination percentage, seed and seedling vigor parameters (Table 1 and 2). Moringa extract had superiority in terms of germination percentage and all seed and seedling vigor parameters compared with other treatments evaluated in this study. No significant differences were observed between basil and datura extracts on germination energy, germination rate and shoot length. However, the effect of concentration of plant extracts demonstrated that seeds treated with 50% concentrations gave the highest values of seed and seedling vigor. On the other hand, lowest values of seed germination, seed and seedling vigor were obtained with dry seed treatment.

The interaction between plant extracts and their concentrations significantly affected germination percentage, speed germination index and seedling vigor index (Fig. 1). The highest germination percentage and seedling vigor index were recorded when sorghum seeds were treated with moringa extract at 25% concentration while the lowest was given from dry seeds. Regarding speed germination index, the highest values were obtained on seeds treated with basil extract at 75% concentration.

Effect of plant extracts on percentage of infected seeds with fungi of c.v. Dorado sorghum variety after (0, 4 and 8) months storage are presented in Table 3-6 and Fig. 2. The study gave evidence to the presence of nine principal genera filamentous i.e., Alternaria, Aspergillus, Cladosporium, Curvularia, Helminthosporium, Fusarium, Penicillium, Rhizopus and Trichothecium. The fungal population of sorghum seeds increased with increase in storage period from 0-8 months. Fungal population of distilled water was lower than that of dry seeds.

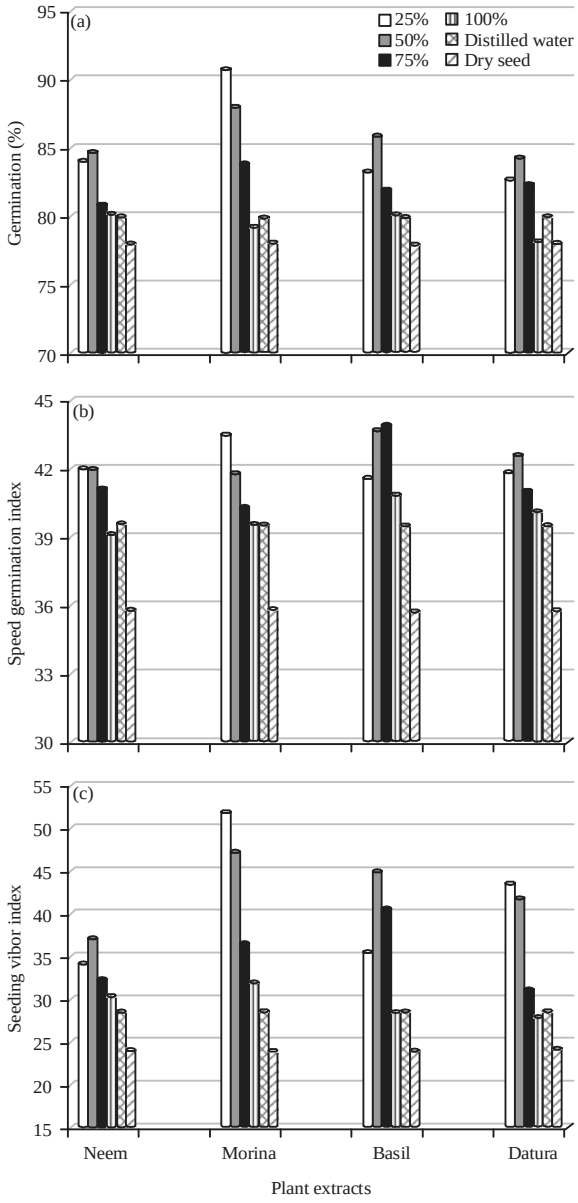

Fig. 1(a-c): Effect of plant extracts with different concentrations on (a) Germination percentage, (b) Speed Germination Index (SGI) and (c) Seedling vigor index of sorghum seed

Generally, *Helminthosporium* sp. recorded the highest frequency percentage followed by *Fusarium moniliforme*, Curvularia *lunata*, *Aspergillus* and *Alternaria*. *A. flavus*, *A. alternata* the highest presence than *A. niger* and *A. tenuis*, respectively throughout the storage periods.

Inhibitory effects of leaf plant extracts' active ingredients on the presence of different fungal genera were observed in all storage periods. These effects increased with increase in the concentrations of different extracts. Moringa extract had the greatest effect on the frequency of most fungi, especially at

Table 3: Effect of plant extracts on percentage of infected seeds with fungi of c.v. Dorado sorghum at post-harvest (0 month storage)

			Neem (%)				Moringa (%)				Basil (%)				Datura (%)			
Fungi	Dry seed	Distilled water	25	50	75	100	25	50	75	100	25	50	75	100	25	50	75	100
Alternaria alternata	18	16	13	12	10	7	11	10	8	6	12	11	8	6	14	12	10	8
Alternaria tenuis	16	14	14	12	6	4	13	10	6	3	14	11	6	4	15	13	10	6
Aspergillus flavus	18	16	14	11	10	8	12	10	8	6	13	11	10	7	14	12	10	8
Aspergillus niger	16	14	12	11	10	9	11	10	8	6	12	11	10	8	13	12	11	10
Cladosporium herbarum	7	6	5	4	2	0	4	2	0	0	4	2	1	0	5	4	4	2
Curvularia lunata	20	18	14	12	11	10	13	12	10	8	14	12	10	8	14	12	10	10
Helminthosporium sp.	22	20	16	15	12	10	15	14	10	8	15	15	10	8	16	14	10	10
Fusarium moniliforme	21	19	15	14	11	8	14	12	10	6	14	14	10	7	16	16	12	10
Penicillium sp.	20	16	13	12	8	4	12	10	4	2	12	10	6	4	15	14	12	10
Rhizopus nigricans	8	6	6	5	2	1	5	4	1	0	6	4	1	1	6	4	2	1
Trichothecium roseum	11	10	10	8	6	3	8	6	4	0	9	8	6	2	10	10	8	3

Test was carried out using blotter technique, two hundred seeds were tested, incubation was carried at 22±2 for 7 days (ISTA., 1999)

Table 4: Effect of plant extracts on percentage of infected seeds with fungi of c.v. Dorado sorghum at four month's storage

			Neem (%)				Moringa (%)				Basil (%)				Datura (%)			
Fungi	Dry seed	Distilled water	25	50	75	100	25	50	75	100	25	50	75	100	25	50	75	100
Alternaria alternata	20	18	11	10	8	5	10	8	6	4	11	10	7	5	12	10	8	5
Alternaria tenuis	19	16	12	11	6	5	11	8	4	2	11	10	4	1	13	11	8	5
Aspergillus flavus	22	20	12	10	8	5	11	8	6	5	11	10	6	6	13	11	9	8
Aspergillus niger	20	18	11	10	8	6	10	8	6	4	10	10	8	5	12	10	9	8
Cladosporium herbarum	8	6	4	2	1	0	3	2	0	0	3	1	0	0	5	4	3	1
Curvularia lunata	22	19	12	11	10	8	11	10	8	6	12	10	8	7	13	11	9	7
Helminthosporium sp.	24	21	14	13	9	8	13	11	8	6	13	12	9	6	15	12	9	9
Fusarium moniliforme	23	20	14	12	10	7	12	11	9	5	13	12	8	6	14	13	10	8
Penicillium sp.	23	20	11	10	6	4	9	8	3	2	10	8	5	4	12	10	9	8
Rhizopus nigricans	12	10	5	3	0	0	4	2	0	0	4	3	0	0	6	3	0	0
Trichothecium roseum	13	11	9	6	3	1	6	4	2	0	7	5	3	0	8	6	4	1

Test was carried out using blotter technique, two hundred seeds were tested, incubation was carried at 22±2 for 7 days (ISTA., 1999)

Table 5: Effect of plant extracts on percentage of infected seeds with fungi of c.v. Dorado sorghum at 8 month's storage

			Neem (%)				Moringa (%)				Basil (%)				Datura (%)			
Fungi	Dry seed	Distilled water	25	50	75	100	25	50	75	100	25	50	75	100	25	50	75	100
Alternaria alternata	24	21	10	9	6	4	9	6	3	1	10	9	5	3	12	8	6	4
Alternaria tenuis	22	20	12	8	6	2	9	7	2	0	10	8	2	0	11	9	8	5
Aspergillus flavus	24	22	12	8	7	4	10	6	4	2	11	8	6	3	14	10	8	6
Aspergillus niger	22	20	10	8	6	5	10	7	4	3	10	8	4	4	11	9	7	6
Cladosporium herbarum	10	9	2	1	0	0	2	0	0	0	2	0	0	0	2	2	0	0
Curvularia lunata	23	21	11	10	8	5	10	8	6	4	10	8	6	5	12	10	8	6
Helminthosporium sp.	26	24	12	10	7	5	11	10	6	4	11	10	7	4	14	11	8	7
Fusarium moniliforme	24	22	13	11	9	5	10	10	7	3	11	11	6	4	12	12	8	6
Penicillium sp.	25	22	9	8	6	3	8	6	2	2	8	6	4	3	10	8	8	6
Rhizopus nigricans	16	15	4	0	0	0	1	0	0	0	2	0	0	0	3	1	0	0
Trichothecium roseum	15	12	5	2	0	0	3	2	0	0	3	3	0	0	4	2	1	0

Test was carried out using blotter technique, two hundred seeds were tested, incubation was carried at 22±2 for 7 days (ISTA., 1999)

100% concentration which reduced the level of fungi observed. The results of the basil, neem and datura extracts on fungal control were similar to moringa extract.

DISCUSSION

Good seed is recognized as an important input in any agricultural production system. Results of this study indicated that seed quality decreased gradually with increase in storage period up to 8 months. Akhter *et al.* (1992) suggested that decreasing in germination percentage was related to chromosomal aberrations that occur under long storage conditions. Decrease of germination percentage in aged seeds may be due to reduction of α-amylase activity and carbohydrate contents (Bailly, 2004). Enzyme activity are significantly decreased by increase in storage time (Azadi and Younesi, 2013). Fungi are one of the major factors that increase seed deterorioration and reduction of seed quality

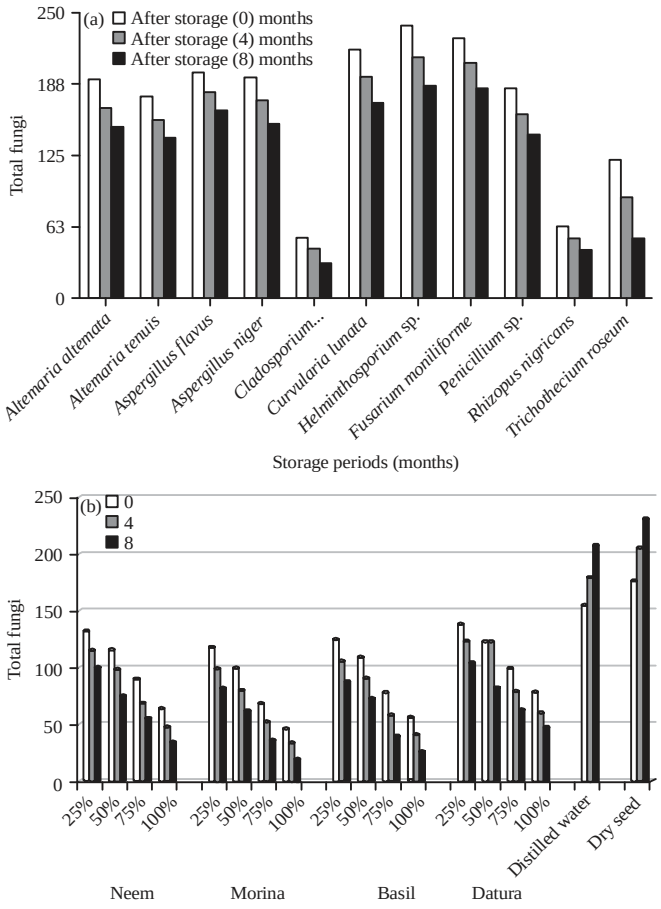

Fig. 2(a-b): (a) Effect of storage period on total percentage fungi of Sorghum seed and (b) Effect of plant extracts, concentration and storage period on percentage total fungi on Sorghum seed

Table 6: Effect of plant extract concentrations on percentage pathogenic infected seeds of sorghum

			Neem (%)				Moringa (%)				Basil (%)				Datura (%)			
Fungi	Dry seed	Distilled water	25	50	75	100	25	50	75	100	25	50	75	100	25	50	75	100
Alternaria alternata	20.7	18.3	11.3	10.3	8.0	5.3	10.0	8.0	5.7	3.7	11.0	10.0	6.7	4.7	12.7	10.0	8.0	5.7
Alternaria tenuis	19.0	16.7	12.7	10.3	6.0	3.7	11.0	8. 3	4.0	1.7	11.7	9.7	4.0	1.7	13.0	11.0	8.7	5.3
Aspergillus flavus	21.3	19.3	12.7	9.7	8. 3	5.7	11.0	8.0	6.0	4.3	11.7	9.7	7. 3	5.3	13.7	11.0	9.0	7.3
Aspergillus niger	19.3	17.3	11.0	9.7	8.0	6.7	10.3	8.3	6.0	4.3	10.7	9.7	7.3	5.7	12.0	10.3	9.0	8.0
Cladosporium herbarum	8.3	7.0	3.7	2.3	1.0	0.0	3.0	1.3	0.0	0.0	3.0	1.0	0.3	0.0	4.0	3.3	2.3	1.0
Curvularia lunata	21.7	19.3	12.3	11.0	9.7	7.7	11.3	10.0	8.0	6.0	12.0	10.0	8.0	6.7	13.0	11.0	9.0	7.7
Helminthosporium sp.	24.0	21.7	14.0	12.7	9.3	7.7	13.0	11.7	8.0	6.0	13.0	12.3	8. 7	6.0	15.0	12.3	9	8.7
Fusarium moniliforme	22.7	20.3	14.0	12.3	10.0	6.7	12.0	11.0	8.7	4.7	12.7	12.3	8.0	5.7	14.0	13.7	10.0	8.0
Penicillium sp.	22.7	19.3	11.0	10.0	6.7	3.7	9.7	8.0	3.0	2.0	10.0	8.0	5.0	3.7	12.3	10.7	9.7	8.0
Rhizopus nigricans	12.0	10.3	5.0	2.7	0.7	0. 3	3.3	2.0	0.3	0.0	4.0	2.3	0.3	0.3	5.0	2.7	0.7	0.3
Trichothecium roseum	13.0	11.0	8.0	5.3	3.0	1.3	5.7	4.0	2.0	0.0	6.3	5.3	3.0	0.7	7.3	6.0	4.3	1.3

including viability in storage. Seed-borne fungal diseases are the most limiting factor. Fungi form a major group of pathogens that can be seed-borne or transmitted through seeds. So, any infectious agent (bacteria, fungi, nematode, etc.) which is associated with seeds have the potential of causing a disease in a seedling or plant, is termed as seed-borne pathogen (Agrawal, 1996). One of the important aspects of good seed, besides high germination and purity, is the absence of seed-borne pathogens. The presence of pathogens with the seed causes the earliest possible infection of its seedling. Yates *et al.* (1997) reported that *F. verticillioides* affects the thickness, height, weight and leaf

length of seedlings developed from infected seeds. This study is the most updated assessment of seed-borne mycoflora on stored Sorghum. The assessment of seed-borne mycoflora revealed that more seed-borne fungi were recovered from stored Sorghum at 8 months compared with at post-harvest. The results of this study show also collaborates those of Bhutta and Hussain (1999), who reported the occurrence of *Drechslera sorokiniana* and *Fusarium moniliforme* as major pathogens of Sorghum seed. Other reports by Singh (1983) also showed that Aspergillus, Drechslera, Penicillium and Fusarium spp., were common associates of stored sorghum seeds. The common occurrence of other pathogens like *Alternaria*, *Curularia*, *Fusarium*, *Aspergillus* and *Penicilium has* been widely reported by Martin *et al*. (1984). Growth promoting activities of leaf extract on wheat seedling vigour was also reported. Interestingly, the inoculums on naturally infected wheat seeds could be reduced with plant extracts as seed dressing biofungicide before sowing (Seth *et al*., 2014). Reducing seed-borne fungi by neem extracts (*Azadirachta indica*) was also observed and further studies will be needed to evaluate the fungicidal effects of the plant extract in controlling seed borne fungi in wheat seed according to Islam *et al*. (2015). Plant extracts had been reported to have effective control of pathogenic fungi on Sorghum. Aqueous extracts of neem has been found to be environmentally safe, it eliminates or reduces the incidence of the economic important pathogens and also increases seed germination (Osman, 2001). The bioactivity of neem extracts has been attributed to various compounds found in seeds and leaves such as nimbin, nimbidin, salannin but the most important of these compounds is azadirachtin (Lale and Abdulrahman, 1999). The *M. oleifera* oil and seed extract had different degrees of inhibition against growth rate and spore germination of all tested pathogens. Reduction of growth and spore germination increased by increasing the amount of oil and seed extract (El-Mohamedy and Abdallah, 2014). The positive impact of moringa is due to the presence of zeatin in Moringa, which is a natural plant hormone and belongs to the cytokinine group, involved in enhancing germination percentage (Makkar and Becker, 1996). Our results in this study indicated that the role of moringa, neem and basil in enhancing and promoting the germination percentage by activation of seed vigor and control of fungal growth of Sorghum seed. Hence, it could be concluded that Sorghum seeds treated with moringa and basil extracts both at 25% concentration were good treatments in reducing deterioration of seed vigor during storage and the control of seed-borne diseases.

REFERENCES

AOSA., 1983. Seed Vigor Testing Handbook: Contribution No.32 to the Handbook on Seed Testing. Association of Officinal Seed Analysis, Boise, Idaho, Pages: 93.

Abd-Alla, M.S., K.M. Atalla and M.A.M. El-Sawi, 2001. Effect of some plant waste extracts on growth and aflatoxin production by *Aspergillus flavus*. Ann. Agric. Sci., 46: 579-592.

Abdul-Baki, A.A., 1980. Biochemical aspects of seed vigor. Hortscience, 15: 765-771.

Agrawal, R.L., 1996. Seed Technology. 2nd Edn., Oxford and IBH Pub. Co., New Delhi, India.

Akhter, F.N., G. Kabir, M.A. Mannan and N.N. Shaheen, 1992. Aging effect of wheat and barley seeds upon germination mitotic index and chromosomal damage. J. Islam Acad. Sci., 5: 44-48.

Azadi, M.S. and E. Younesi, 2013. The effects of storage on germination characteristics and enzyme activity of sorghum seeds. J. Stress Physiol. Biochem., 9: 289-298.

Bailly, C., 2004. Active oxygen species and antioxidants in seed biology. Seed Sci. Res., 14: 93-107.

Bartlett, M.S., 1937. Some examples of statistical methods of research in agriculture and applied biology. Suppl. J. R. Stat. Soc., 4: 137-183.

Bhutta, A.R. and S.A. Hussain, 1999. Seed-borne pathogens of wheat in Pakistan. Rachis, 18: 66-68.

Colpas, F.T., K.R.F. Schwan-Estrada, J.R. Stangarlin, M.L. Ferrarese, C.A. Scapim and S.M. Bonaldo, 2009. Induction of plant defense responses by *Ocimum gratissimum* L. (Lamiaceae) leaf extracts. Summa Phytopathologica, 35: 191-195.

Du Plessis, J., 2008. Sorghum production. ARC Grain Crops Institute, Department of Argiculture. Republic of South Africa.

El-Mohamedy, R.S.R. and A.M. Abdallah, 2014. Antifungal activity of *Moringa oleifera* oil and seed extract against some plant pathogenic fungi. Middle East J. Agric. Res., 3: 242-249.

Ellis, R.H. and E.H. Roberts, 1981. The quantification of ageing and survival in orthodox seeds. Seed Sci. Technol., 9: 373-409.

Girish, A.G., V.P. Rao and R.P. Thakur, 2004. Diversity of grain mold fungi on selected sorghum genotypes. Indian Phytopathol., 57: 84-87.

Gomez, K.A. and A.A. Gomez, 1984. Statistical Producer for Agricultural Research. 2nd Edn., John Wiley and Sons, New York.

Halt, M., 1994. *Aspergillus flavus* and aflatoxin B_1 in flour production. Eur. J. Epidermiol., 10: 555-558.

ISTA., 1999. International rules for seed testing. Seed Sci. Technol., 31: 1-152.

Islam, M.S., M.A. Ali and M.N.I. Sarker, 2015. Efficacy of medicinal plants against seed borne fungi of wheat seeds. Int. J. Natl. Soc. Sci., 2: 48-52.

Jwa, N.S., G.K. Agrawal, S. Tamogami, M. Yonekura, O. Han, H. Iwahashi and R. Rakwal, 2006. Role of defense/stress-related marker genes, proteins and secondary metabolites in defining rice self-defense mechanisms. Plant Physiol. Biochem., 44: 261-273.

Khairnar, D.N., 2015. Studies on seed-borne fungi, Bio deterioration of seeds and control. Int. Res. J. Sci. Eng., 3: 60-62.

Krishnasamy, V. and D.V. Seshu, 1990. Phosphine fumigation influence on rice seed germination and vigor. Crop Sci., 30: 28-85.

Lale, N.E.S. and H.T. Abdulrahman, 1999. Evaluation of neem (*Azadirachta indica* A. Juss) seed oil obtained by different methods and neem powder for the management of *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) in stored cowpea. J. Stored Prod. Res., 35: 135-143.

Langerak, J.C. and D.S. Jaccoud-Filho, 2002. Seed-Borne Fungi: A Contribution to Routine Seed Health Analysis. International Seed Testing Association, Basserdorf, Switzerland, ISBN-13: 9783906549378, Pages: 138.

Makkar, H.P.S. and K. Becker, 1996. Nutrional value and antinutritional components of whole and ethanol extracted *Moringa oleifera* leaves. Anim. Feed Sci. Technol., 63: 221-228.

Martin, J.W., W.L. Seaman and T.G. Atkinson, 1984. Diseases of Field Crops in Canada. Canadian Phytopathological Society, Ottawa, Canada, Pages: 160.

Mathur, S.B. and O. Kongsdal, 2003. Common Laboratory Seed Health Testing Methods for Detecting Fungi. 1st Edn., International Seed Testing Association, Bassersdorf, Switzerland, ISBN-13: 9783906549354, Pages: 425.

Matthews, S. and A.P. Alison, 1987. Electrical Conductivity Test Methods. 2nd Edn., ISTA, Tallinn, Estonia, pp: 37-43.

Naqvi, S.D.Y., T. Shiden, W. Merhawi and S. Mehret, 2013. Identification of seed borne fungi on farmer saved sorghum (*Sorghum bicolour* L.), pearl millet (*Pennisetum glaucum* L.) and groundnut (*Arachis hypogaea* L.) seeds. Agric. Sci. Res. J., 3: 107-114.

Nwachukwu, E.O. and C.I. Umechuruba, 2001. Antifungal activities of some leaf extracts on seed-borne fungi of African yam bean seeds, seed germination and seedling emergence. J. Appl. Sci. Environ. Management, 5: 29-32.

Osman, I.M.A., 2001. Bioactivity of Neem {*Azadirachta indica*) callus extract. Biosciences, Advanced Technology and Environment Council, Sudan Academy of Science, (SAS), Khartoum, Sudan.

Pawar, B.T., 2011. Antifungal activity of some leaf extracts against seed-borne pathogenic fungi. Int. Multidiscipl. Res. J., 4: 11-13.

Phiri, C., 2010. Influence of *Moringa oleifera* leaf extracts on germination and early seedling development of major cereals. Agric. Biol. J. North Am., 1: 774-777.

Ponnusamy, K., C. Petchiammal, R. Mohankumar and W. Hopper, 2010. *In vitro* antifungal activity of indirubin isolated from a South Indian ethnomedicinal plant *Wrightia tinctoria* R. Br. Br. J. Ethopharmacol., 132: 349-354.

Ruan, S., Q. Xue and K. Tylkowska, 2002. The influence of priming on germination of rice (*Oryza sativa* L.) seeds and seedling emergence and performance in flooded soil. Seed Sci. Technol., 30: 61-67.

Seth, R.K., S. Alam and D.N. Shukala, 2014. Efficacy of plant extracts on the germination of wheat seeds. IOSR J. Agric. Vet. Sci., 7: 72-76.

Singh, D.V., 1983. Fungi associated with wheat seeds and their significance. Seed Res., 11: 103-105.

Tarp, G., L. Lange and O. Kongsdal, 1987. Seed-borne pathogens of major food crops is Mozambique. Seed Sci. Technol., 15: 793-810.

Yago, J.I., J.H. Roh, S. Bae, Y.N. Yoon, H.J. Kim and M.H. Nam, 2011. The effect of seed-borne mycoflora from sorghum and foxtail millet seeds on germination and disease transmission. Mycobiology, 39: 206-218.

Yates, I.E., C.W. Bacon and D.M. Hinton, 1997. Effects of endophytic infection by *Fusarium moniliforme* on corn growth and cellular morphology. Plant Dis., 81: 723-728.