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EFFECT OF STORAGE PERIODS, CULTIVARS, ENVIRONMENTS AND PACKAGE MATERIALS ON GERMINATION, VIABILITY AND SEEDLING VIGOR OF WHEAT GRAINS

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ABSTRACT

An experiment was carried out at Sakha Agricultural Research Station during 2010 and 2011 seasons to study the effect of storage periods, cultivars, environments and package materials on germination, viability and seedling vigor of wheat grains.

Three cultivars of wheat (Gemmiza7, Sakha 93 and Giza 168) were used during this study. Grains were packaged in three package materials (Jute, Jute coated plastic, Metal cans) after that grains stored in three types of environments (Dust, Sand and Ash). The stored grains were tested after two different periods for germination, viability (Electrical conductivity and Acidity %) and seedling vigor (radical length, plumule length and seedling dry weight). The obtained results recorded highly significant differences among the tested cultivars for all studied characters. Moreover, increasing storage period after harvest until 18 months decreased significantly all characters except electrical conductivity and acidity percentage which were increased with increasing storage period. Also, highly significant differences were observed among grains quality characters due to the different storage environments. Grains stored in ash had the worst characters as compared with other environments while grains stored in dust and sand gave the best characters. Moreover, grains stored in metal cans produced the best characters while, grains stored in jute bags gave the worst characters. It could be recommended that using metal cans to store wheat grains tell 18 months without using any chemicals is the best method for saving viability and seedling vigor.

INTRODUCTION

The purpose of seed storage is to preserve planting stocks from one season to the next. In some cases, the objective of seed storage is to maintain seed quality for the longest duration possible to be utilizing for nutritional consumption. This approach creates a greater diversity in seed inventory and provides a guarantee to seed supply in years when acceptable seed quality and production is low (Thamaga-Chitja *et al*., 2004). In addition, seed storage enables the maintenance of germplasm over time for improved plant breeding programs (Copeland and McDonald, 1995).

The major determinants of storage risk are moisture, temperature, type of storage bags and time of storage (Hong *et al*., 1994). In some parts of the world, especially in the tropics, conditioned storage is necessary in order to maintain high viability of some seed from harvest to planting (Harrington, 1970).

In recent years, packaging seeds in moisture-barrier containers to prevent loss of viability and resistant or hermitically sealed containers for storage and marketing has explored. The purpose of such containers is to maintain seeds at safe storage moisture levels (Copeland and McDonald, 1995). Seeds in package that are not completely impervious to moisture may gain or lose moisture with time. Seeds in small packages gain or lose moisture faster than seeds in large packages. Therefore, small packages require better moisture-barrier materials than do large ones for equal moisture protection (Bass, 1971).

Despite significant advances in food storage methods, many African and South African communities still rely on traditional storage methods for seed to be used as food and fodder (Olakojo and Akinlosotu,2004 and Thamaga-Chitja *et al*., 2004) because 1- Chemical insecticides have serious drawbacks such as genetic resistance, toxic residues, worker safety, increasing costs of application and decreasing seed viability. 2- Small-scale farmers may not have facilities to store their seed at 4-10°C.

The aim of the present investigation was to study the effect of storage periods, varieties, environments and package materials on germination, viability and seedling vigor of wheat grains.

MATERIALS AND METHODS

This investigation was carried out in the laboratory of Seed Technology at Sakha Agricultural Research Station, Kafr El-Sheikh during the period from May, (2010) to November, (2011) to study the effect of two storage periods [6 months (A1) and 18 months (A2)], three wheat cultivars [Gemmeza 7(B1), Sakha 93(B2) and Giza 168(B3)], three storage environments [Dust (C1), Sand (C2) and Ash (C3)] and three package materials [Jute (D1), Jute coated plastic (D2) and Cans (D3)] on germination, viability and seedling vigor of wheat grains. Factorial design in completely randomized (CRD) was used (Gomez and Gomez, 1984).

Samples of wheat grains were obtained from the season of 2010 after harvesting (15 kg from each cultivar). The samples were sieved and cleaned from dust, husk or any inert materials then divided into three portions. The first portion was kept without storage. The second portion was packaged in [Jute (D1), Jute coated plastic (D2) and metal cans (D3)]. Each package was filled with 500 g of seeds and stored in three different environments [Dust (C1), Sand (C2) and Ash (C3)]. The third portion was the same of the second portion. Random grain samples were taken from each package at two different periods of storage [after 6 months of storage (A1) and after 18 months of storage (A2)].

Data were recorded on standard germination:- Test was carried out under optimum conditions according to international rules testing (ISTA, 2006).

Acidity percentage:- Grain samples were taken at random from each plot and grounded to fine powder to pass through 2 mm mesh to determine acidity percentage according to (AOAC, 1999).

At the beginning of storage germination %, viability and seedling vigor of wheat grains were measured on an original weight basis as follows in table 1

Table 1: Germination, viability and seedling vigor of wheat grains as measured before storing.

Characters studied	Wheat		
	Gemiza7	Sakha.93	Giza168
Germination (%)	100	100	100
Conductivity (µ-mhos/g)	13	13.9	13.4
Acidity (%)	0.20	0.22	0.21
Radical length (cm)	14	14.5	14.2
Plumule length (cm)	15	15.7	15.3
Seedling dry weight (mg)	24	24	24

RESULTS AND DISCUSSION

Increasing storage period significantly decreased germination percentage, radical length, plumule length and seedling dry weight. The decline in these traits was associated with an increase in electrical conductivity values and acidity percentage (Table 2). Similar results were reported by El-Aidy (1988), El-Borai *et al*. (1993), Soad (1997), El-Aidy *et al*. (2001) and El-Sayed *et al*. (2004a).

A highly significant difference among studied cultivars for all traits were obtained. Sakha 93 was significantly lower in germination percentage, radical length and higher in electrical conductivity and acidity percentage(Table 2).

For storage environments highly significant differences were obtained in all tested characters. Grains stored in ash gave the lowest germination percentage, radical length, plumule length and seedling dry weight ,while it gave the highest values in electrical conductivity and acidity percentage. On the other hand grains stored in dust and sand gave higher values in germination percentage, radical length, plumule length and lower values in electrical conductivity and acidity percentage (Table 2).

Data cleared that grains stored in metal cans significantly superior to the other two package materials. Grains stored in cans gave higher values in germination percentage, radical length, plumule length, seedling dry weight and lower values in electrical conductivity and acidity percentage. These results are in harmony with those reported by Soad (1997).

Table 2: Germination, viability and seedling vigor of wheat grains as affected by storage periods, cultivars, environments, package materials and their interactions.

	Germination (%)	Conductivity (μ-mhos/g)	Acidity (%	Radical length (cm)	Plumule length (cm)	Dry weight (mg)
	A = Storage period					
After 6 months	96.20 a	14.125 b	0.284 b	9.260 a	11.070 a	22 a
After 18 months	72.71 b	26.644 a	0.572 a	7.959 b	9.473 b	18 b
F. test	**	**	**	**	**	**
	B = Cultivars					
Gemmiza 7	85.52 a	19.581 c	0.417 b	8.589 b	10.411 a	20
Sakha 93	83.38 c	21.274 a	0.451 a	8.356 c	10.135 b	20
Giza 168	84.48 b	20.298 b	0.416 b	8.885 a	10.269ab	20
F. test	**	**	**	**	**	N.S
	C = Environments					
Dust	85.49 a	19.220 b	0.423 b	8.835 a	10.585 a	20
Sand	85.35 a	19.250 b	0.422 b	8.672 a	10.196 b	20
Ash	82.54 b	22.683 a	0.449 a	8.322 b	10.033 b	20
F. test	**	**	**	**	**	N.S
	D = Package materials					
Jute	63.65 c	32.135 a	0.677 a	7.006 c	8.715 c	18 b
Jute coated plastic	93.29 b	15.024 b	0.317 b	8.872 b	10.506 b	20 ab
Cans	96.43 a	13.994 c	0.290 c	9.952 a	11.594 a	22 a
F. test	**	**	**	**	**	**
	Interactions					
A×B	**	**	**	**	**	*
A×C	**	**	NS	NS	NS	NS
A×D	**	**	**	**	**	**
B×C	NS	NS	NS	**	**	NS
B×D	**	**	**	**	**	NS
C×D	**	**	**	**	**	NS
A×B×C	NS	NS	NS	**	**	NS
A×B×D	**	**	**	**	**	**
A×C×D	**	**	NS	**	**	*
B×C×D	NS	*	NS	**	**	NS
A×B×C×D	NS	NS	NS	**	**	NS

***, **, NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.**

The interaction between storage periods and cultivars indicated highly significant differences in all studied characters (Table 3). Data clear that increasing storage period significantly decreased germination percentage and seedling vigor with all cultivars. On the other hand increasing storage period significantly increased electrical conductivity values and acidity percentage. These results are in harmony with those reported by El-Sayed and Abd El-Aziz (2005) and Govender *et al*. (2007).

Table 3: Germination, viability and seedling vigor of wheat grains as affected by the interaction between storage periods and cultivars.

Periods	Cultivars	Germ.	E.C	Acidity	Radical Length(cm)	Plumule Length(cm)	Seedling dry weight(mg)
A1	B1	96.7 a	13.57 e	0.28 cd	9.33 a	11.37 a	23 a
	B2	95.7 a	14.59 d	0.3 c	9.37 a	11.05 b	23.4 a
	B3	96.2 a	14.20 d	0.272 d	9.09 a	10.79 c	23.2 a
A2	B1	74.3 b	25.59 c	0.554 b	7.85 c	9.46 d	18 b
	B2	65.2 d	27.95 a	0.601 a	7.34 d	9.49 d	17.6 b
	B3	72.7 c	26.39 b	0.561 b	8.68 b	9.47 d	18.6 b
Sig.		**	**	**	**	**	*

***, **, NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.**

The interaction between storage periods and environments indicated significantly affected germination percentage and electrical conductivity values (Table 4). Results clear that grains stored in ash gave the lowest germination percentage and the highest electrical conductivity value. In contrast grains stored in dust and sand gave the highest germination percentage and the lowest electrical conductivity value during the two storage periods. These results are in agreement with those recorded by Soares *et al*. (1993) and Tippes (1995).

Table 4: Germination and electrical conductivity of wheat grains as affected by the interaction between storage periods and environments.

Periods	Environments	Germ.	E.C
A1	C1	96.6 a	14.08 c
	C2	96.5 a	14.07 c
	C3	95.5 a	14.22 c
A2	C1	74.4 b	24.36 b
	C2	74.2 b	24.43 b
	C3	62 c	31.15 a
Sig.		**	**

***, **, NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.**

Highly significant interaction was obtained between storage periods and package materials in all studied characters (Table 5). Results showed that grains stored in metal cans remained higher values in germination percentage, seedling vigor and lower values in electrical conductivity and acidity. On the other hand, grains stored in jute bags gave lower values in germination percentage, seedling vigor and higher values in electrical conductivity and acidity during the two storage periods. Similar results were obtained by El-Aidy *et al*. (2001) and El-Sayed (2004b).

Table 5: Germination, viability and seedling vigor of wheat grains as affected by the interaction between storage periods and package materials.

Periods	Package materials	Germ.	E.C	Acidity	Radical length(cm)	Plumule length(cm)	Seedling dry weight(mg)
A1	D1	93.3 d	14.42 c	0.342 c	8.59 d	9.99 c	21.8 ab
	D2	97.2 b	14.09 cd	0.269 d	8.92 c	11.26 b	23.8 a
	D3	98.2 a	13.86 d	0.24 e	10.27 a	11.96 a	24 a
A2	D1	34 f	49.85 a	1.011 a	5.42 e	7.44 e	14.8 c
	D2	89.4 e	15.96 b	0.366 b	8.83 cd	9.75 d	17.2 bc
	D3	94.7 c	14.13 cd	0.34 c	9.63 b	11.23 b	22 a
Sig.		**	**	**	**	**	**

***, **, NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.**

Data clear that Gemmiza 7 stored in dust gave the highest value in radical and plumule lengths while, Giza 168 had the lowest value of radical and plumule lengths when stored in ash environment (Table 6). Similar results were reported by El-Aidy *et al*. (2001) and El-Sayed *et al*. (2004a).

Table 6: Radical and plumule lengths of wheat grains as affected by the interaction between cultivars and storage environments.

Cultivars	Environments	Radical Length(cm)	Plumule Length(cm)
B1	C1	8.65 bc	10.767 a
	C2	8.461 cd	10.178 bcd
	C3	8.656 bc	10.289 bc
B2	C1	8.583 bc	10.594 ab
	C2	8.472 cd	10.394 abc
	C3	8.011 d	9.817 d
B3	C1	9.272 a	10.394 abc
	C2	9.083 ab	10.017 cd
	C3	8.3 cd	9.994 cd
Sig.		**	**

***, **, NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.**

Highly significant differences were found in all traits except seedling dry weight to the interaction between cultivars and package materials (Table7). Results indicated that grains stored in metal cans gave higher values in germination percentage, radical length, plumule length and lower values in electrical conductivity value and acidity percentage with all cultivars. In contrast grains stored in jute bags gave lower values in germination percentage, radical length, plumule length and higher values in electrical conductivity and acidity percentage with all cultivars. These results are in harmony with those recorded by El-Aidy (1988), El-Aidy *et al*. (2001) and El-Sayed *et al*.(2004b).

Table 7: Germination, viability, radical and plumule lengths of wheat grains as affected by the interaction between cultivars and package materials.

cultivars	Package materials	Germ.	E.C	Acidity	Radical Length(cm)	Plumule Length(cm)
B1	D1	65.8 c	30.43 c	0.667 b	6.83 d	8.5 f
	D2	94 b	14.64 ef	0.308 cd	8.89 b	10.74 c
	D3	96.8 a	13.67 h	0.276 e	10.05 a	11.99 a
B2	D1	61 e	34.16 a	0.718 a	6.18 e	8.53 f
	D2	92.9 b	15.37 d	0.329 c	8.96 b	10.76 c
	D3	96.2 a	14.3 fg	0.305 cd	9.922 a	11.52 b
B3	D1	64.2 d	31.82 b	0.645 b	8.01 c	9.11 e
	D2	93 b	15.06 de	0.314 cd	8.77 b	10.02 d
	D3	96.3 a	14.01 gh	0.289 de	9.883 a	11.28 b
Sig.		**	**	**	**	**

***, **, NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.**

ighly significant differences were found in all traits except seedling dry weight due to the interaction between storage environments and package materials (Table8). Data showed that grains stored in jute bags and ash environment gave lower values in germination percentage, radical length, plumule length and higher values in electrical conductivity and acidity percentage ,while grains stored in metal cans and dust or sand gave higher values in germination percentage, radical length, plumule length and lower values in electrical conductivity value and acidity percentage. Similar results were recorded by El-Sayed *et al*. (2004b).

Table 8: Germination, viability, radical and plumule lengths of wheat grains as affected by the interaction between storage environments and package materials.

Environments	Package materials	Germ.	E.C	Acidity	Radical Length(cm)	Plumule Length(cm)
C1	D1	65.8 d	28.79 b	0.668 b	7.61 d	9.333 d
	D2	93.9 b	14.89 c	0.309 cd	8.92 b	10.81 b
	D3	96.6 a	13.98 d	0.291 d	9.97 a	11.62 a
C2	D1	65.9 d	28.84 b	0.664 b	6.91 e	8.63 e
	D2	93.9 b	14.91 c	0.312 cd	9.19 b	10.43 c
	D3	96.2 a	14 d	0.289 d	9.92 a	11.53 a
C3	D1	59.2 e	38.78 a	0.697 a	6.49 f	8.183 f
	D2	92 c	15.27 c	0.329 c	8.51 c	10.28 c
	D3	96.4 a	14 d	0.289 d	9.97 a	11.64 a
Sig.		**	**	**	**	**

***, **, NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.**

adical and plumule lengths significantly affected by the interaction among storage periods, cultivars and environments (Table 9). Sakha 93 stored in ash environment had the lowest radical and plumule length after 18 months while, grains stored in dust environment gave the highest radical length for Sakha 93 after 6 months but, Gemmiza 7 had the highest value for plumule length when grains stored in dust environment (Table 9). Similar results were reported Soad (1997), El-Aidy *et al*.(2001) and El-Sayed *et al*. (2004b).

Table 9: Radical and plumule lengths of wheat grains as affected by the interaction between storage periods and cultivars.

Periods	Cultivars	Environments	Radical Length(cm)	Plumule Length(cm)
A1	B1	C1	9.24 de	11.58 a
	B1	C2	9.47 bc	11.38 b
	B1	C3	9.27 cd	11.14 cd
	B2	C1	10.03 a	11.26 bc
	B2	C2	9.3 bcd	11.17 cd
	B2	C3	8.77 g	10.72 e
	B3	C1	9.5 b	11.07 d
	B3	C2	9.17 def	10.59 e
	B3	C3	8.6 g	10.73 e
A2	B1	C1	8.06 h	9.96 f
	B1	C2	7.46 i	8.98 j
	B1	C3	8.04 h	9.43 h
	B2	C1	7.13 j	9.93 f
	B2	C2	7.64 i	9.62 g
	B2	C3	7.26 j	8.91 j
	B3	C1	9.04 ef	9.72 g
	B3	C2	9 f	9.44 h
	B3	C3	8 h	9.26 i
Sig.			**	**

***, **, NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.**

The interaction among storage periods, cultivars and package materials indicated highly significant differences in all traits (Table 10). Data showed that grains stored in jute bags gave lower values in germination percentage, seedling vigor and higher values in electrical conductivity and acidity percentage with all cultivars especially sakha 93 while grains stored in metal cans gave higher values in germination percentage, seedling vigor and lower values in electrical conductivity and acidity percentage with all cultivars especially Gemmiza 7. These results are in harmony with those recorded by El-Aidy (1988), El-Aidy *et al*. (2001) and El-Sayed *et al*.(2004a).

Table 10: Germination, viability and seedling vigor of wheat grains as affected by the interaction among storage periods, cultivars and package materials.

Periods	Cultivars	Package materials	Germ.	E.C	Acidity	Radical Length(cm)	Plumule Length(cm)	Seedling dry weight(mg)
A1	B1	D1	93.9 bc	13.86 fgh	0.336 de	8.91 cde	10.34 fg	22 abc
	B1	D2	97.7 a	13.54 gh	0.27 fg	9.07 bcd	11.51 bc	23.8 ab
	B1	D3	98.5 a	13.32 h	0.232 g	10 a	12.24 a	23.4 ab
	B2	D1	92.4 c	14.87 e	0.371 cd	8.53 ef	10.1 g	21.8 abc
	B2	D2	96.8 a	14.54 ef	0.278 f	9.2 bcd	11.27 cd	23.8 ab
	B2	D3	97.8 a	14.38 efg	0.251 fg	10.37 a	11.78 b	24.4 a
	B3	D1	93.5 bc	14.53 ef	0.32 e	8.34 f	9.53 h	21.4 abc
	B3	D2	96 a.9	14.19 e-h	0.258 fg	8.48 ef	11.01 de	24 ab
	B3	D3	98.2 a	13.89 fgh	0.238 fg	10.44 a	11.84 ab	24.2 a
A2	B1	D1	37.7 e	47 c	0.998 b	4.74 h	6.66 j	14.8 bc
	B1	D2	90.3 d	15.74 d	0.346 cde	8.71 def	9.98 g	17.2 abc
	B1	D3	95 b	14.02 e-h	0.319 e	10.1 a	11.73 b	22.2 abc
	B2	D1	29.6 g	53.44 a	1.066 a	3.83 i	6.97 j	13.4 c
	B2	D2	89 d	16.19 d	0.38 c	8.72 def	10.24 g	17.2 abc
	B2	D3	94.7 b	14.22 e-h	0.359 cde	9.48 b	11.26 cd	22.4 abc
	B3	D1	34.9 f	49.11 b	0.97 b	7.67 g	8.69 i	16.4 abc
	B3	D2	89 d	15.93 d	0.371 cd	9.06 bcd	9.02 i	17.6 abc
	B3	D3	94.3 b	14.13 e-h	0.341 cde	9.32 bc	10.71 ef	21.6 abc
Sig.			**	**	**	**	**	**

***, **, NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.**

Data in Table 11 showed highly significant differences in all traits except acidity percentage due to the interaction among storage periods, environments and package materials. Results indicated that grains stored in jute bags and ash environment gave lower values in germination percentage, seedling vigor and higher values in electrical conductivity at the end of storage period. On the other hand grains stored in metal cans and dust or sand gave higher values in germination percentage, seedling vigor and lower values in electrical conductivity at the end of storage period. Similar results were recorded by Soares *et al*. (1993) and Tippes (1995).

Highly significant differences were found in radical and plumule length due to the interaction among cultivars, storage environments and package materials (Table 12). Data showed that grains stored in jute bags and ash environment gave lower values in radical length and plumule length with all cultivars especially Sakha 93, while grains stored in metal cans and dust or sand gave higher values for radical and plumule lengths with all cultivars. These results are in harmony with those reported by Soad (1997) and Govender *et al*. (2007).

The interaction among storage periods, cultivars, environments and package materials indicated highly significant differences in radical and plumule length (Tables 13and 14). Results indicated that grains stored in jute bags and ash environment gave the lowest radical and plumule lengths at the end of storage period with all cultivars especially sakha 93. On the other hand grains stored in metal cans and dust or sand gave the highest radical and plumule lengths with all cultivars at the end of storage period (18 month). Similar results were obtained by El-Borai *et al*. (1993), Soad (1997), El-Aidy *et al*. (2001) and El-Sayed *et al*. (2004b).

Table 11: Germination, electrical conductivity and seedling vigor of wheat grains as affected by the interaction among storage periods, environments and package materials.

Periods	Environments	Package materials	Germ.	E.C	Radical Length(cm)	Plumule Length(cm)	Seedling dry weight(mg)
A1	C1	D1	94 c	14.36 d	9.26 cd	10.31 d	0.11 a-d
	C1	D2	97.5 a	14.02 d	9.19 cd	11.62 ab	0.118 a
	C1	D3	98.3 a	13.87 d	10.33 a	11.97 a	0.121 a
	C2	D1	94 c	14.34 d	8.26 fg	9.93 de	0.108 a-d
	C2	D2	97.5 a	14.02 d	9.53 c	11.28 bc	0.119 a
	C2	D3	98.2 a	13.86 d	10.14 ab	11.92 a	0.119 a
	C3	D1	91.8 d	14.56 d	8.28 fg	9.73 e	0.108 a-d
	C3	D2	96.5 ab	14.23 d	8.02 g	10.89 c	0.121 a
	C3	D3	98.1 a	13.87 d	10.33 a	11.98 a	0.12 a
A2	C1	D1	37.7 f	43.22 b	5.97 h	8.36 f	0.077 cde
	C1	D2	90.4 d	15.76 c	8.66 ef	9.99 de	0.09 a-e
	C1	D3	95 bc	14.1 d	9.61 c	11.27 bc	0.108 a-d
	C2	D1	37.8 f	43.33 b	5.57 h	7.32 g	0.076 de
	C2	D2	90.3 d	15.8 c	8.84 de	9.59 e	0.088 a-e
	C2	D3	94.3 c	14.14 d	9.69 bc	11.13 c	0.111 abc
	C3	D1	26.7 g	63 a	4.71 i	6.63 h	0.071 e
	C3	D2	87.6 e	16.31 c	8.99 de	9.67 e	0.081 b-e
	C3	D3	94.7 bc	14.13 d	9.6 c	11.3 bc	0.112 ab
Sig.			**	**	**	**	*

***, **, NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.**

Table 12: Electrical conductivity, radical and plumule lengths of wheat grains as affected by the interaction among cultivars, storage environments and package materials.

Cultivars	Environments	Package materials	Radical Length(cm)	Plumule Length(cm)
B1	C1	D1	7.4 h	9.4 klm
	C1	D2	8.5 efg	10.92 dg
	C1	D3	10.05 a	11.98 ab
	C2	D1	5.9 k	7.783 p
	C2	D2	9.38 bc	10.73 e-h
	C2	D3	10.1 a	12.02 a
	C3	D1	7.18 hi	8.317 o
	C3	D2	8.78 c-f	10.58 fgh
	C3	D3	10 ab	11.97 ab
B2	C1	D1	6.53 j	9.07 lmn
	C1	D2	9.18 cd	11.17 cde
	C1	D3	10.03 ab	11.55 abc
	C2	D1	6.48 j	9.12 lmn
	C2	D2	9.12 cde	10.62 fgh
	C2	D3	9.82 ab	11.45 bcd
	C3	D1	5.53 k	7.42 p
	C3	D2	8.58 d-g	10.48 gh
	C3	D3	9.92 ab	11.55 abc
B3	C1	D1	8.9 c-f	9.53 jkl
	C1	D2	9.08 cde	10.33 hi
	C1	D3	9.83 ab	11.32 cd
	C2	D1	8.35 fg	8.98 mn
	C2	D2	9.07 cde	9.95 ij
	C2	D3	9.83 ab	11.12 c-f
	C3	D1	6.77 ij	8.82 n
	C3	D2	8.15 g	9.77 jk
	C3	D3	9.98 ab	11.4 cd
Sig.			**	**

***, **, NS indicate P<0.05, P<0.01 and not significant, respectively. Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.**

Table 13: Radical length of wheat seedling as affected by the interaction among storage periods, cultivars, environments and package materials.

Periods	Cultivars	Environments	Package materials		
			Jute	Jute coated plastic	Metal Cans
6 months	Gemmiza 7	Dust	9.27 c-k	8.4 k-o	10.07 a-g
		Sand	8.27 l-o	10.03 a-h	10.1 a-f
		Ash	9.2 d-l	8.7 j-n	9.83 a-i
	Sakha 93	Dust	9.5 b-j	10.07 a-j	10.53 a
		Sand	8.37 k-o	9.4 c-j	10.13 a-e
		Ash	7.73 op	8.13 m-o	10.43 ab
	Giza 168	Dust	9 i-m	9.1 g-m	10.4 ab
		Sand	8.133 m-o	9.17 e-l	10.2 a-c
		Ash	7.9 n-p	7.17 p	10.73 a
18 months	Gemmiza 7	Dust	5.53 q	8.6 j-o	10.03 a-h
		Sand	3.53 s	8.733 j-n	10.1 a-f
		Ash	5.17 qr	8.8 j-n	10.17 a-d
	Sakha 93	Dust	3.57 s	8.3 k-o	9.53 b-j
		Sand	4.6 r	8.83 j-n	9.5 b-j
		Ash	3.33 s	9.03 i-m	9.4 c-j
	Giza 168	Dust	8.8 j-n	9.07 h-m	9.27 c-k
		Sand	8.57 j-o	8.97 i-m	9.47 b-j
		Ash	5.63 q	9.13 f-l	9.23 c-l

Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.

Table 14: Plumule length of wheat seedling as affected by the interaction among storage periods, cultivars, environments and package materials.

Periods	Cultivars	Environments	Package materials		
			Jute	Jute coated plastic	Metal Cans
6 months	Gemmiza 7	Dust	10.63 g-k	11.77 a-e	12.33 a
		Sand	10.23 i-m	11.67 a-e	12.23 ab
		Ash	10.17 j-n	11.1 d-h	12.17 a-c
	Sakha 93	Dust	10.43 h-m	11.63 a-e	11.7 a-e
		Sand	10.23 i-m	11.37 c-g	11.9 a-d
		Ash	9.63 m-p	10.8 f-j	11.73 a-e
	Giza 168	Dust	9.87 k-p	11.47 b-f	11.87 a-d
		Sand	9.33 o-r	10.8 f-j	11.63 a-e
		Ash	9.4 n-q	10.77 f-j	12.03 a-c
18 months	Gemmiza 7	Dust	8.17 r-t	10.07 j-o	11.63 a-e
		Sand	5.33 v	9.8 l-p	11.8 a-e
		Ash	6.47 u	10.07 j-o	11.77 a-e
	Sakha 93	Dust	7.7 t	10.7 f-j	11.4 c-g
		Sand	8 st	9.87 k-p	11 e-i
		Ash	5.2 v	10.17 j-n	11.37 c-g
	Giza 168	Dust	9.2 pq	9.2 pq	10.77 f-j
		Sand	8.63 q-s	9.1 pq	10.6 g-l
		Ash	8.23 r-t	8.77 qr	10.77 f-j

Means designated by the same letter within columns are not significantly different according to Duncan's multiple range test.

CONCLUSION

From the obtained results, it could be recommended to use metal cans to store grains for 18 months without using any chemicals. Grains stored with this method will remain germination percentage, viability and seedling vigor with a little decline.

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تاثير فترة التخزين والاصناف وبيئة التخزين ونوع العبوة المستخدمة على الإنبات والحيوية وقوة البادرة فى حبوب القمح

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**** قسم تكنولوجيا البذور بسخا – مركز البحوث الزراعية**

اجريت تجربة فى محطة البحوث الزراعية بسخا لدراسة تا ثير كل من فترات التخزين وانواع العبوات المستخدمة وكذلك بيئة التخزين على الإنبات والحيوية وقوة البادرة فى حبوب القمح.

اقيمت هذه التجربة فى شهر مايو عام 2010 واستمرت حتى نهاية شهر نوفمبر عام 2011 فكانت فترة التخزين الكلية (18 شهر).

وتم استخدام 3 أصناف من القمح وهى (جميزة 7 ، سخا 93 ، جيزة 168). وتم تخزين التقاوى فى 3 انواع من العبوات وهى(جوت ، جوت مبطن بالبلاستيك ،علب). وتم تخزين التقاوى بعد وضعها فى العبوات المختلفة فى 3 انواع من البيئات وهى (تربة ، رمل ، رماد). وتم سحب العينات على مرحلتين الاولى بعد 6 شهور من بداية التخزين والثانية بعد 18 شهر من بداية التخزين. وذلك لدراسة التغيرات فى الانبات وحيوية الحبوب (التوصيل الكهربى ،الحموضة) وكذلك قوة البادرة (طول الجذير، طول الريشة ، الوزن الجاف للبادرة).

وقد تم دراسة جميع هذه الصفات قبل تخزين التقاوى وذلك للمقارنة ومعرفة الاختلاف. واستخدم التصميم تام العشوائية. وتم تحليل النتائج احصائيا كتجربة عاملية.

ويمكن تلخيص اهم النتائج المتحصل عليها فيما يلى:-

اوضحت النتائج المتحصل عليها وجود اختلافات عالية المعنوية بين الاصناف تحت الدراسة فى جميع الصفات. كما ان زيادة فترة التخزين بعد الحصاد وحتى 18 شهر ادت الى نقصان معنوى فى جميع الصفات المدروسة ما عدا الحموضة والتوصيل الكهربى والتى زادت بزيادة فترة التخزين دليل على تدهور الحبوب.

ايضا وجدت اختلافات عالية المعنوية فى جميع الصفات المدروسة نتيجة لاختلاف البيئات المستخدمة فى التخزين. حيث ان الحبوب التى تم تخزينها فى الرماد كان لها تأثير سالب على الصفات بالمقارنة بالبيئات الاخرى. اضافة الى ذلك فان الحبوب التى تم تخزينها فى العلب اعطت افضل الصفات فى حين ان الحبوب التى تم تخزينها فى عبوات الجوت أعطت تأثير سالب على الصفات.

وتوصى الدراسة باستخدام العلب المعدنية فى تخزين حبوب القمح لمدة 18 شهر بدون استخدام اى كيماويات للحفاظ على الحيوية وقوة البادرة.

قام بتحكيم البحث

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