Journal of the Advances in Agricultural Researches (JAAR) Volume: 27 (3)

Effect of Storage Period and Condition on Cotton Seed Viability and Its Chemical Composition

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DOI: 10.21608/JALEXU.2022.161397.1080

Article Information

Received:September 7th 2022

Revised: October 11th 2022

Accepted: October 13th 2022

Published: September 31st 2022

ABSTRACT: This study was conducted at Seed Technology Research Laboratory, Sakha Agricultural Research Station, ARC, Egypt, during 2020 to 2022 years to elucidate seed germination%, seedling characters, EC, moisture content, seed index, crude protein, oil%, acidity% and free fatty acid of some cotton cultivars (*Gossypium barbadense* L.) due to different storage period and storage conditions. The chemical composition of the seeds with high oil content is related to specific processes occurring in the seeds during storage. In this trial, Giza45, Giza92, Giza94 and Giza96 cotton cultivars were submitted to accelerated aging for three and five days, and natural aging for 6 and 18 months, under controlled and conventional (non-controlled) conditions. Increasing accelerated aging period from 0 to 3 and 5 days caused decreased in germination%, seedling vigor, protein% and oil%. While, increased electrical conductivity, moisture%, acidity and free fatty acid. Generally increasing storage period reduced seed germination%, seedling vigor, oil% and protein%. While, increased electrical conductivity, moisture%, acidity and free fatty acid. Controlled conditions 42%RH gave the highest viability and seedling vigor during storage period up to 18 months compared to other storage conditions. Giza92 and Giza94 cultivars greater resistance to germination loss in artificial and natural aging than the other cultivars and gave the highest seed viability (as a results of the high seed germination%, lowest electrical conductivity, acidity % and free fatty acid). The losses of vigor, poor germination, weak and abnormal seedling are associated with an increase in the free fatty acids that produce deleterious effects on cell.

Keywords: cotton, seed aging, storage, germination%, vigor

INTRODUCTION

Seed deterioration can be defined as the loss of quality, viability and vigor either due to aging or effect of adverse environmental factors during storage. Oil seeds are very sensitive to the harsh environmental conditions. It is hypothesized that their oil content readily oxidize, which deteriorate the seed health in storage (Kausar *et al*., 2009). On Various factors such as weather conditions during seed producing stage, diseases, pests, seed oil, moisture content, mechanical damages, storage period, temperature and relative humidity on air of store can affect vigor of seeds (Cardoso et al., 2012 and Carvalho et al., 2016). Seed characteristics decrease under long storage condition due to aging. It is the reason of declining in germination, emergence and seedling growth (Soltani *et al*., 2008). All organisms undergo aging and it enhances under unfavorable or stress environments. Maximum germination percentage achieves immediately after harvesting and gradually decreases with storage time. Seed aging is one of the major issues in seed storage and seed storage conditions influence the germination characteristics and vigor potential of seeds. There were two important environments factors influencing the rate of deteriorative processes in seed ageing are the relatively humidity of the air, which controls the moisture content of seeds and the temperature. The sensitivity of seeds to accelerated ageing is dependent on temperature and moisture content as a constant temperature loss of seed viability is faster with increasing moister content. Seed moisture and storage temperature are the Kay role of seed longevity (Iqbal *et al*., 2002). A balance of seed moisture content and relative humidity is essential for seed storage. Harington (1972) found out two principles still in use that decrease influence of the moisture and temperature to the seed deterioration. The first stated that each decreased percentage of grain moisture content prolongs life of stored seed twice. The second stated that each decreased 5°C of the seed temperature prolongs life of the stored seed twice. High moisture level during the process of storing is unfavorable due to diminishing preservation ability of seed viability.

In general, the seeds are sensitive to adverse environmental conditions. The natural oil contained inside the seeds will undergo various biochemical changes and this will lead to degradation and spoilage of the seeds, during the storage period (Kausar *et al*., 2009). Seed aging is one of the major issues in seed storage and seed storage condition affects germination properties and vigor potential (Mc Donald, 2004). Seed aging is one of the important and inevitable processes in seed life and is primarily influenced by temperature and moisture content (Ellis and Roberts 1981).

The rate at which seed aging occurs depends on the seed's ability to resist degradation changes by means of protection mechanisms specific to each plant species (Balešević *et al.* 2010). The seeds of different plant species, kept in the same storage conditions, lose their viability to a different degree. For example, onion seeds are difficult to store, while barley seeds maintain good germination under varied storage conditions (Milošević *et al*., 1996). The chemical composition of oilseeds causes specific processes to occur during storage. The fat-rich seeds have a limited life due to their special chemical composition. For example, storing cotton seeds requires special attention due to the high content of oil, otherwise processes may occur that lead to loss of germination capacity and seed viability.
(Kavitha *et al*., 2017) showed that as a conclusion, three days of accelerate ageing was equivalent to ten Months of natural storage at the time maintained the highest germination in sesame seed.

Therefore, the present study aimed to know different seed storage conditions and storage times affected the germinability and chemical composition of cotton seed and to examine the possibility of using the accelerated aging test for the assessment of reduced or preserved seed viability over time. And access to the best cultivar that can withstand storage in high relative humidity conditions while maintaining the vitality of the seeds

MATERIAL AND METHODS

The seed of cotton cultivars (Giza45, Giza92, Giza94 and Giza96) developed at Cotton Res. Institute, Agric. Res. Center, Giza, Egypt was submitted to accelerated and natural aging.

Accelerated aging (artificial aging): The seed was placed in aging chamber in metal dishes, on metal sieves immersed in a water bath at 42°C and relative humidity of 100%. The test lasted three and five days, in four replicates.

Natural aging: Seed was stored in two ways. First part was kept in controlled conditions; at 30±2 ^{o}C and relative air humidity of low 42% and height 72%. The second part was kept under conventional storage conditions (non controlled conditions in a laboratory environment) jut package were used for storing seeds. Seed characteristics were tested after harvest (control) and after six and eighteen month of storage at Seed Technology Laboratory, Sakha Agricultural Research Station, Field Crops Research Institute, ARC, Giza, Egypt during November 2020 to April 2022 years.

Table 1. Monthly means of air temperature and relative humidity (RH %) from November 2020 to April 2022 at Sakha location.

Month	Air temp °C		RH%		Month	Air temp		RH%	
	Max*	Min**	7:30	13:30		Max*	Min**	7:30	13:30
November 2020	**25.0**	**17.5**	**86.7**	**56.8**	**August 2021**	**34.6**	**28.3**	**85.3**	**48.4**
December 2020	**22.9**	**13.7**	**87.7**	**55.7**	**September 2021**	**32.5**	**25.0**	**84.1**	**49.5**
January 2021	**21.0**	**13.5**	**86.7**	**59.5**	**October 2021**	**29.4**	**21.5**	**76.5**	**61.2**
February 2021	**21.5**	**12.5**	**87.5**	**55.9**	**November 2021**	**26.7**	**18.8**	**88.1**	**56.2**
March 2021	**23.8**	**15.4**	**83.8**	**53.7**	**December 2021**	**20.2**	**12.3**	**87.8**	**59.9**
April 2021	**27.6**	**19.4**	**74.3**	**45.8**	**January 2022**	**17.6**	**9.9**	**88.1**	**62.6**
May 2021	**31.9**	**23.8**	**68.9**	**38.4**	**February 2022**	**19.4**	**10.5**	**87.7**	**53.7**
June 2021	**31.1**	**25.5**	**80.1**	**50.2**	**March 2022**	**19.1**	**11.2**	**85.6**	**52.5**
July 2021	**34.9**	**27.9**	**84.9**	**50.5**	**April 2022**	**27.7**	**19.7**	**76.5**	**45.4**

*** Max = maximum temperature, ** Min = minimum temperature**

Germination percentage: Of fresh seed, artificially and naturally aged seed was estimated by the standard laboratory germination test, according to the Rules of International Seed Testing Association (I.S.T.A., 1999). The results of the treated seed were compared with the germinability of fresh seeds (measured at the start of the experiment and used as the control treatment). **Seedling vigor**: Ten normal seedlings from each replicate were taken to measure plumule length (cm), radical length (cm) and seedling dry weight (g) according to (I.S.T.A., 1999). **Viability**: Electrical conductivity (EC) of leached from four replicates of 50 seeds weight and soaked in 250 ml of distilled water for 24h was measured in $\mu S.cm^{-1} g^{-1}$ using conductivity meter, were carried out under optimum conditions according to the international rules (I.S.T.A., 1999). **Seed index**: One hundred seeds were counted and weighted this was carried out according to the (I.S.T.A., 1999)

Regulations. **Crude protein**: Known weight of the fine powdered seeds (ca 0.1g) was digested using a micro kjeldahl apparatus. The crude protein was calculated by multiplying the total nitrogen by 6.25 (A.O.A.C 2000). **Oil percentage:** Oil of the seeds was extracted by Soxhlet`s extractor using Petroleum ether (60-80°C) was preferred for extractions which continued for not less than eight hours (rate of siphoning was 6-7 /hr.) according to the methods of (A.O.A.C. 2000). **Moisture content, Acidity % and free fatty acid (F.F.A):** were determined according to the methods of (A.O.A.C. 2000).

Collected data were analyzed according to the completely randomized design (CRD) and replicated four times. Analysis of variance computed according to Snedecor and Cochran (1982) and treatment means was compared by Duncan Multiple Range Test, (Duncan, 1955). All the treatments were compared at 0.5% level of significance using the critical difference test. All statistical analyses were performed using analysis of variance technique by "MSTAT-C" (1990) computer software package.

RESULTS AND DISCUSSION

Artificial aging of cotton seeds cause a significant deterioration in the seed germination percentage, plumule length and radical length, protein % and oil%. Seed germination percentage, plumule length, radical length, protein% and oil% decreased by increasing accelerated aging for three and five days, while seedling dry weight was insignificant. On the other hand, the electrical conductivity, seed moisture %, seed index, acidity% and free fatty acid% were increased by increasing accelerated aging for three and five days in Tables 2 and 3. The losses of vigor, poor germination and abnormal seedling are associated with an increase in the free fatty acids that produce deleterious effects on cell. **Iqbal *et al*., (2002).** The sensitivity of seeds to accelerated ageing is dependent on temperature and on their moisture content as a constant temperature loss of seed viability is faster with increasing moister content, seed moisture and storage temperature the role in seed longevity.

These results are in agreement with both **Sultan *et al*. (2020)** reported that the electrolyte leakage was increased with the increasing of aging stress. Increased electrolyte leakage with aging confirmed the inferior quality of aged seeds. However, germination % from 48h to 72h, root fresh weight and shoot fresh weight from 24h to 72h were decreased with the increasing of aging stress. Seed germination percentage, seedling characters, protein % and oil % were reduced with increasing seed aged and similar trend was obtained when the same experiment was done in sunflower seed by **Ranganathan and Thiagarajah (2015)** and in maize by **Ranganathan (2015)**. Negative effect of aging was observed in parameters such as seed germination percentage and seedling indices showed negative effect of aging **Siadat *et al*. (2012)**. Differences in seed germination were observed among different temperature and relative humidity levels, although those differences were significant in viability values. Decreasing in the percentage of seed germination might be due to the chromosomal aberrations that take place under long term storage conditions of seeds **Akhtar *et al*. (1992).**

Table 2: Mean values of seed germination %, seedling vigor, electrical conductivity, seed index (g) and moisture% as affected by artificial aging of cotton cultivars.

Treatments	Germination %	Seedling vigor: plumule length (cm)	Seedling vigor: Radical length (cm)	Seedling vigor: Seedling dry weight (g)	Electrical conductivity µS.cm^{-1} g^{-1}	Seed index (g)	Moisture %
Artificial aging							
0 day	93.7 a	13.5 a	16.3 a	0.311	19.6 c	10.5 c	10.7 c
3 days	82.9 b	9.7 b	12.2 b	0.301	23.2 b	11.0 b	11.3 b
5 days	62.7 c	6.3 c	8.8 c	0.296	25.9 a	11.3 a	13.4 a
F-Test	**	**	**	NS	**	**	**
Cultivars							
Giza45	71.1 c	7.2 d	11.8 c	0.301	25.4 a	11.8 a	12.3 a
Giza92	83.9 a	13.8 a	16.5 a	0.321	19.3d	9.6 d	11.1 b
Giza94	85.8 a	10.3 b	13.8 b	0.294	20.0c	10.2 c	11.3 b
Giza96	75.8 b	9.3 c	10.4 c	0.305	23.0 b	11.1 b	12.4 a
F-Test	**	**	**	NS	**	**	*
AXB	NS	NS	NS	NS	NS	NS	**

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

Tables 2 and 3 indicated that the seed germination %, seedling vigor, electrical conductivity, seed index, moisture content%, protein, oil%, acidity% and free fatty acid% of cotton seeds were significantly affected by cultivars except seedling dry weight. Giza92 and Giza94 cultivars gave the longest lifespan according to highest germination percentage. On the other hand were gave the lowest values of electrical conductivity, seed index, moisture content, acidity and free fatty acid. Elevated levels of free fatty acids which are toxic to most cells, are not present in healthy seed tissues. So, it can be concluded that free fat acidity contribute to the degradation of seeds through membranes rupture.

Table 3: Mean values of seed protein %, oil%, acidity% and F.F.A as affected by artificial aging of cotton cultivars.

Treatments	Protein %	Oil %	Acidity %	F.F.A%
		Artificial aging		
0 day	24.0 a	23.4 a	9.7 c	0.256 c
3 day	23.2 b	22.6 b	12.2 b	0.288 b
5 day	21.9 c	21.3 c	15.2 a	0.320 a
F-test	**	**	**	**
		Cultivars		
Giza45	23.5 a	22.2 c	15.7 a	0.284 ab
Giza92	22.8 b	23.5 a	11.2 bc	0.275 b
Giza94	22.6 b	23.0 b	10.8 c	0.279 b
Giza96	23.3 a	21.1 d	11.8 b	0.314 a
F-test	**	**	**	**
AXB	**	**	**	*

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

Data showed in Table 4 the interaction between artificial aging and cultivars was significantly in moisture %, protein%, oil%, acidity% and free fatty acid%. Data showed significant decrease in moisture %, acidity% and free fatty acid% in the zero days (control) and up to 5 days with Giza 92 and Giza94 cultivars. Giza 92 followed by Giza94cultivars retained its high oil content% and the lowest free fatty acid under high deterioration conditions when 5 days of aging compared to another cultivars.

Table 4: Interaction of artificial aging and cultivars on moisture %, protein%, oil %, acidity% and F.F.A% of cotton.

Aging	Cultivars	Moisture %	Protein%	Oil %	Acidity%	F.F.A%
0 days (control)	Giza45	10.8 f	24.4 a	23.0 d	12.1 d	0.256 cde
	Giza92	10.5 f	23.7 b	24.4 a	9.1 g	0.244 e
	Giza94	10.6 f	23.6 b	24.0 ab	7.6 h	0.253 de
	Giza96	11.2 e	24.2 a	22.4 e	9.9 fg	0.272 b-e
3 days	Giza45	11.5 c	23.6 b	22.3 ef	15.5 b	0.288 b-e
	Giza92	10.9 f	23.0 c	23.5 bc	11.0 de	0.271 b-e
	Giza94	11.1 e	22.8 c	23.2 cd	10.3 ef	0.284 b-e
	Giza96	11.5 c	23.5 b	21.4 gh	11.9 d	0.300 bcd
5 days	Giza45	14.4 b	22.4 d	21.2 h	19.4 a	0.311 ab
	Giza92	11.8 d	21.7 e	22.7 de	13.5 c	0.310 ab
	Giza94	12.3 c	21.5 e	21.8 fg	13.6 c	0.308 abc
	Giza96	15.0 a	22.2 d	19.5 i	14.5 bc	0.361 a
F-test		**	**	**	**	*

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

Concerning the duration of storage, reduced seed germination%, plumule length, radical length and seedling dry weight was observed in cotton seed by increasing storage period Table 5. Results revealed that before storage treatments significantly exceeded the other storage periods seed germination % (94.5 %), plumule length (10.9 cm), radical length (13.3 cm) and seedling dry weight (0.287 g) followed by after 6 months. While, after 18 months from storage recorded lowest seed germination % (68.6%), plumule length (8.1 cm), radical length (9.3 cm) and seedling dry weight (0.266 g). In this regard, **Manomani (2002)** reported that the decline in seedling length and seedling dry weight with increase of storage periods might be due to their genetic differences age induced deterioration, inherent differences in seed structure and composition. In addition, **Mohammadi *et al.* (2011)** reported that seed deterioration results in decreased percentage of seed germination % and seedling length. Seedling growth and the fraction of seed reserve mobilization indicated a significant reduced with the advance of deterioration. **El-Sayed *et al.* (2017)** reported that increasing storage period after harvest time until 12 month affected significantly most studied characters such as germination%, seedling vigor, moisture content, seed index, crude protein and oil%. **Ramya *et al.* (2018)** showed that seedling parameters i.e. seed germination %, seedling length and seedling dry weight were decreased with the period of storage. On the other hand, electrical conductivity, seed moisture % and seed index increasing with increased storage period from 0 to 6 month and 18 months. This is a result of the high relative humidity around the seed, which leads to an increase in the absorption of moisture by the seed membrane, which leads to a high weight of seed index, which helps to increase the deterioration of the seed as a result of the increase in the moisture content in it. **Hussein et al. (2012)** showed that electrical conductivity of the seed is a measure of membrane functions the results on individual seed conductivity indicates that membrane function is less damaged when the seeds are aged for a short time and membranes are likely to be responsible for the slower growth and germination in aged seeds.

Decrease of seed quality is connected with bio-chemical changes in seeds of oil crops. The longer seeds storage period increases intensity of seeds aging. Also increasing storage period from zero to 6 and 18 month significantly decreased the mean crude protein 24.0, 23.0 and 22.1 %, oil% 23.3, 22.5 and 21.9 %. While, acidity and free fatty acid increased by increasing storage period from zero to 6 month and 18 months Table 6. Elevated levels of free fatty acids which are toxic to most cells, are not present in healthy seed tissues. So, it can be concluded that free fatty acidity contribute to the degradation of seeds through membranes rupture. These results are in good agreement with those reported by **Meena *et al.* (2017), Kavitha *et al.* (2017) and Alaa and Nagwa (2021).**

Table 5: Mean values of seed germination %, seedling vigor, electrical conductivity, seed index (g), seed index (g) and moisture % as affected by storage period and storage conditions of cotton cultivars.

Treatments	Germination %	Seedling vigor			Electrical conductivity $\mu Sm^{-1}g^{-1}$	Seed index (g)	Moisture %
		Plumule length (cm)	Radical length (cm)	Seedling dry weight (g)			
Storage period							
Zero	94.5 a	10.9 a	13.3 a	0.287 a	15.7 c	10.0 c	10.2 c
6 month	83.1 b	8.9 b	10.3 b	0.273 ab	20.2 b	10.5 b	12.4 b
18 month	68.6 c	8.1 c	9.3 c	0.266 b	25.3 a	10.9 a	13.0 a
F-test	**	**	**	*	**	*	**
Storage conditions							
controlled conditions 42%rh	87.8 a	10.4 a	12.4 a	0.284 a	17.3 c	10.3 c	11.3 c
controlled conditions72%rh	82.9 b	9.0 b	10.6 b	0.275 ab	20.4 b	10.5 b	12.0 b
conventional storage	79.6 c	8.6 c	9.8 c	0.268 b	23.6 a	10.7 a	12.3 a
F-test	**	**	**	*	**	*	**
Cultivars							
Giza45	76.1 c	8.3 d	9.5 c	0.269 b	25.4 a	12.2 a	12.3 a
Giza92	89.4 a	9.8 b	11.6 b	0.288 a	18.6 b	9.3 c	11.4 d
Giza94	88.0 a	10.8 a	12.8 a	0.302 a	13.6 c	8.9 d	11.7 d
Giza96	80.1 b	8.7 c	9.9 c	0.243 c	23.9 a	11.5 b	12.1 b
F-test	**	**	**	**	**	**	**
Interactions							
AXB	**	*	*	N.S	**	N.S	N.S
AXC	**	**	**	N.S	**	N.S	N.S
BXC	*	**	**	N.S	N.S	**	**
AXBXC	N.S	**	**	N.S	N.S	N.S	**

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

Table 6: Mean values of protein%, oil%, acidity% and F.F.A% as affected by storage period and storage conditions of cotton cultivars.

Treatments	Protein%	Oil %	Acidity %	F.F.A %
Storage period				
Zero	24.0 a	23.3 a	9.7 c	0.255 b
6 month	23.0 b	22.5 b	13.0 b	0.350 a
18 month	22.1 c	21.9 c	15.1 a	0.417 a
F-test	**	**	**	**
Storage conditions				
controlled conditions 42%rh	23.3 a	23.1 a	11.6 c	0.300 c
controlled conditions72%rh	23.0 b	22.6 b	12.6 b	0.347 b
conventional storage	22.8 c	22.0 c	13.6 a	0.398 a
F-test	**	*	**	*
Cultivars				
Giza45	23.5 a	22.4 c	15.8 a	0.351 a
Giza92	22.8 c	23.4 a	12.1 c	0.319 b
Giza94	22.5 d	22.9 b	10.2 d	0.309 b
Giza96	23.3 b	21.7 d	12.5 b	0.351 a
F-test	**	**	**	*
Interaction				
AXB	**	**	**	N.S
AXC	**	**	**	*
BXC	**	**	**	N.S
AXBXC	N.S	N.S	N.S	N.S

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

The results showed that a significant effect of storage conditions on the average of seed germination%, plumule length, radical length, seedling dry weight, electrical conductivity, moisture content%, seed index, crud protein%, Oil%, acidity% and free fatty acid% Tables 5 and 6. The results clearly indicated that storage under controlled conditions 42% relative humidity gave the highest in seed germination percentage, plumule and radical length, seedling dry weight and the lowest of values of electrical conductivity, seed moisture content, seed index, acidity% and free fatty acid compared to the controlled conditions 72% RH and conventional storage. The seeds stored under controlled conditions 42% RH showed better seed quality values compared with the other two storage conditions where the crude protein % was (23.3 %) and oil% was (23.1 %). Under the low relative humidity storage conditions even the seed metabolic activities maintained at a lower rate and minimizing the deterioration. The results showed that losses of vigor, poor germination, weak and abnormal seedling are associated with an increase in the free fatty acids that produce deleterious effects on cell. Elevated levels of free fatty acids which are toxic to most cells, are not present in healthy seed tissues. So, it can be concluded that free fat acidity contribute to the degradation of seeds through membranes rupture **Iqbal *et al*. (2002).**

The results were in accordance with **Singh *et al*. (2016)** and **Ramya *et al.* (2018)** reveled that storage under refrigerator conditions at low temperatures had superior quality maintained compared to storage under dry cold room and ambient conditions in all the seedling parameters. Seed aging during storage is inevitable Phenomenon, but the degree and speed of decline in seed quality depends strongly besides the storage conditions, the types of plants stored and the quality of the primary seeds **Balešević-Tubić *et al*. (2005)** as well as on the genetic features of seeds **Malenić *et al.* (2003). Milosevic *et al*. (1996)** also suggested that seed longevity is genetically determined, and that significant differences exist between varieties of same crop in its ability to maintain quality during storage. So they are it was suggested that seed longevity could be improved through appropriate breeding procedures. **Nishtha and Brar (2015)** showed that at 45% and 60% RH retained better viability and vigor content but at 75% and 90% RH all containers failed to maintain the viability and vigor of seeds.

Giza 92 cultivar followed by Giza 94 greater resistance to germination loss in storage that the other cultivars, and gave the highest plumule and radical length, seedling dry weight, oil % and gave the lowest values of electrical conductivity, seed moisture content, seed index, acidity% and free fatty acid%. Several cultivars of the same species that were compared for seed longevity differed significantly. Electrical conductivity of the seed is a measure of membrane functions, the results on individual seed conductivity indicate that membrane function is less damaged when the seeds are aged for a short time and membranes are likely to be responsible for the slower growth and germination in aged seeds **Hussein *et a.l* (2012)**. **El-Sayed *et al*. (2017)** reported that there are differences in the seed germination%, vitality of seeds and chemical composition between the cultivars and these imbalances may be due to genetic differences between the cultivars tolerance storage conditions. **Asseri *et al*. (2021)** reported that the higher seed germination %, root length, shoot length and seedling dry weight were obtained with Giza94 cultivar.

The interaction between storage period and storage conditions according to data collected is presented in Table 7. Data showed that significant decreased in seed germination%, plumule and radical length and protein % and increased in electrical conductivity, acidity% and free fatty acid% up to 18 month. Controlled conditions 42% RH gave the highest seed germination%, plumule and radical length, crud protein% and oil% in 6 month and 18 month and the lowest in electrical conductivity, acidity% and free fatty acid in 6 month and 18 month, respectively. This mean the controlled conditions 42% RH in both storage period produced the highest viability (by increasing seed germination% and decreasing both of electrical conductivity, acidity and free fatty acid) so it is a best treatment.

Table 7: Interaction of storage period and storage conditions on seed germination %, seedling length (cm), electrical conductivity, protein%, oil%, acidity% and F.F.A% of cotton.

Storage period	Storage condition	Germination %	Seedling length		Electrical conductivity $\mu Sm^{-1}g^{-1}$	Protein %	Oil %	Acidity %	F.F.A%
			Plumule length (cm)	Radical length (cm)					
Zero	controlled conditions 42%rh	94.5 a	11.0 a	13.3 a	15.7 e	24.0 a	23.7 a	9.7 g	0.256 e
	controlled conditions72%rh	94.5 a	11.0 a	13.3 a	15.7 e	24.0 a	23.7 a	9.7 g	0.226 e
	conventional storage	94.5 a	11.0 a	13.3 a	15.7 e	24.0 a	23.7 a	9.7 g	0.256 e
6 month	controlled conditions 42%rh	89.8 b	10.3 b	12.4 ab	17.5 de	23.4 b	22.8 b	11.5 f	0.294 de
	controlled conditions72%rh	82.8 c	8.2 c	10.1 c	20.5 cd	23.0 c	22.5 c	13.1 e	0.340 cde
	conventional storage	76.7 d	7.7 d	8.4 d	22.6 bc	22.7 d	22.2 d	14.4 c	0.436 ab
18 month	controlled conditions 42%rh	75.9 d	10.1 b	11.7 b	18.6 de	22.4 e	21.7 e	13.5 d	0.349 bcd
	controlled conditions72%rh	69.4 e	7.7 d	8.5 d	25.0 b	22.1 f	21.6 e	15.1 b	0.384 bc
	conventional storage	63.5 f	7.1 e	7.7 d	28.5 a	21.7 g	21.3 f	16.8 a	0.465 a
F-test		**	**	**	**	**	**	**	**

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

The interaction effect between storage period and cotton cultivars is presented in Table 8. Data showed significant decreased in seed germination %, seedling vigor, protein content% and oil % up to 18 months storage. In general, Giza92 and Giza94 cultivars gave the longest lifespan according to the high percentage of seed germination. While, Giza94 cultivar gave the highest plumule and radical length with control period. Giza92 and Giza94 cultivars surpassed in seed germination%, plumule and radical length and oil%. While were the lowest values of electrical conductivity and acidity with 6 months and the best cultivars when stored up to 18 months.

Table 8: Interaction of storage period and cultivars on seed germination %, seedling length (cm), electrical conductivity, protein%, oil% and acidity% of cotton.

Storage period	Cultivars	Germination %	Seedling length		Electrical conductivity µSm^{-1}g^{-1}	Protein %	Oil %	Acidity %
			Plumule length (cm)	Radical length (cm)				
Zero	Giza45	88.0 bc	9.6 cd	10.7 e	17.5 e-g	24.4 a	22.3 f	12.2 e
	Giza92	99.3 a	10.6 b	14.0 b	14.2 gh	23.7 c	24.2 a	9.2 h
	Giza94	100.0 a	13.5 a	16.3 a	13.2 h	23.6 d	23.4 c	7.6 i
	Giza96	90.7 b	10.1 c	12.1 c	17.8 ef	24.2 b	23.1 d	9.9 g
6 month	Giza45	75.0 e	8.0 fg	9.1 ghi	24.3 c	23.5 d	21.6 h	16.3 b
	Giza92	89.8 bc	8.8 e	10.7 de	19.2 de	22.7 f	23.6 b	12.6 d
	Giza94	87.4 c	9.8 c	11.9 cd	13.4 h	22.5 h	23.1 d	10.4 f
	Giza96	80.1 d	8.4 ef	9.4 fgh	23.8 c	23.4 e	21.7 h	12.7 d
18 month	Giza45	62.2 g	7.2 h	8.6 hi	34.3 a	22.4 h	21.1 i	18.8 a
	Giza92	77.2 d	8.6 e	10.0 efg	22.5 cd	21.5 j	22.8 e	14.5 c
	Giza94	73.4 e	9.3 d	10.3 ef	14.3 f-h	21.8 i	22.0 g	12.5 de
	Giza96	66.6 f	7.8 gh	8.2 i	30.3 b	22.6 g	21.7 h	14.8 c
F-test		**	**	**	**	**	**	**

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

The interaction between storage conditions and cotton cultivars according to data collected is presented in Table 9. Results showed that significant increase in seed germination %, plumule and radical length, protein content % and oil% when seeds stored in controlled conditions 42% relative humidity for the cultivars compared to controlled conditions 72% relative humidity and conventional storage. Giza92 and Giza94 gave the highest seed longevity and oil% and lowest moisture content, seed index and acidity when stored in controlled conditions at 42% and 72% relative humidity and conventional storage compared to other cultivars for period of up to 18 months.

Table 9: Interaction between storage conditions and cultivars on seed germination%, seedling length (cm), seed index (g), moisture content%, protein%, oil% and acidity% of cotton.

Storage conditions	Cultivars	Germination %	Seedling length		Seed index (g)	Moisture content %	Protein %	Oil %	Acidity %
			Plumule length (cm)	Radical length (cm)					
controlled conditions 42%rh	Giza45	80.6 d	8.9 def	9.8 efg	8.7 g	11.8 bcd	23.7 a	22.1 e	14.4 c
	Giza92	92.9 a	10.0 b	12.6 b	9.2 f	11.4 d	22.9 ef	23.9 a	11.0 h
	Giza94	93.3 a	13.5 a	16.3 a	8.9 f	10.2 e	22.9 ef	23.6 b	9.3 j
	Giza96	84.2 c	9.3 cd	11.0 cd	11.4 d	11.8 bcd	23.5 b	22.7 c	11.7 g
controlled conditions72 %rh	Giza45	75.0 ef	8.2 hi	9.5 fg	12.2 a	12.4 ab	23.3 c	21.6 f	15.6 b
	Giza92	89.8 b	9.2 de	11.4 cd	9.4 e	11.6 cd	22.4 h	23.5 b	12.1 f
	Giza94	86.4 c	9.8 bc	11.8 bc	9.5 e	11.9 bcd	22.8 f	22.7 c	10.3 i
	Giza96	80.3 d	8.6 fgh	9.6 efg	11.9 b	12.1 bc	23.3 c	22.1 e	12.5 e
conventional storage	Giza45	72.7 f	7.9 i	9.1 g	12.4 a	12.7 a	23.1 d	21.2 g	17.3 a
	Giza92	85.7 c	8.8 efg	10.8 cde	9.1 f	12.0 bcd	22.2 i	22.6 c	13.2 d
	Giza94	84.1 c	9.2 de	10.4 def	10.9 d	12.0 bcd	22.5 g	22.4 d	10.9 h
	Giza96	75.8 ef	8.3 ghi	9.0 g	11.6 c	12.4 ab	23.1 d	21.6 f	13.2 d
F-test		**	**	**	**	**	**	**	**

*, ** and NS indicated P< 0.01, 0.05 and not significant, respectively.

CONCLUSIONS

Accelerated aging tests on changes in cotton seeds demonstrated that the degree of seed degradation during natural aging and the possibility of seed storage in the laboratory could be predicted. The best method of storage seeds is the one that causes the slightest changes in the biological nature of the seeds, which can be achieved through proper regulation of air humidity and relative temperature. Even the most sensitive seed will retain a high level of viability for several years if stored with low moisture content and at low temperature.

Accelerated and natural aging reduced the cottonseed germination and viability under this study. Seeds aged up to three days showed improved germination percentage. This may be due to slow hydration, as in priming, which is hydro-priming technique that alters germination character and improves germination percentage. Increasing the period of artificial ageing up to five days and 18 months of seed storage produced deleterious effects on seeds and germination ability were reduced significantly. Low germination percentage is related to seed deterioration and poor quality.

The data showed that five days of accelerate ageing was equivalent to eighteen months of natural storage in the extent of deterioration that occurred to the seed and the weakening of the vitality of the seed

Therefore, under conditions at higher relative humidity up to 72% and conventional storage it could be recommended with using the cotton cultivars Giza92 and Giza94 for storage seeds for long periods up to 18 months to gave the highest seed viability by (increasing the seed germination% and lowest electrical conductivity, acidity and free fatty acid), seed survival, oil and protein% content.

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الملخص العربي

تأثير فترة و ظروف التخزين علي حيويه بذور القطن و تركيبها الكيماوي

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أجريت هذة الدراسة بقسم بحوث تكنولوجيا البذور بمحطة البحوث الزراعية بسخا خلال الفترة 2018 إلى 2020 لتوضيح نسبة الانبات وصفات البادرة والتوصيل الكهربائي ومحتوى الرطوبة ووزن 100بذره ونسبة الزيت % ونسبة البروتين % و نسبه الزيت و الحموضه % و الاحماض الدهنيه الحره لبعض أصناف القطن و مدي تأثرها بفترات و ظروف التخزين المختلفة. يرتبط التركيب الكيميائي للبذور التي تحتوي على نسبة عالية من الزيت بعمليات معينه تحدث في البذور أثناء التخزين. في هذه التجربة ، تم إخضاع الصنف جيزة 45 و جيزة 92 و جيزة 94 و جيزة 96 للتدهور الصناعي لمدة ثلاثة وخمسة أيام . أدت زيادة فترة التدهور الصناعي من صفر إلى 3 و 5 أيام إلى انخفاض في نسبة الإنبات وحيوية البادرات ونسبة الزيت و نسبة البروتين. بينما زادت نسبة التوصيل الكهربائي ونسبة الرطوبه والحموضه الكليه و الأحماض الدهنيه الحره. و بشكل عام ، أدت زيادة فترة التخزين إلى انخفاض نسبة الإنبات وحيوية البادرات ونسبة الزيت والبروتين. بينما زادت نسبة التوصيل الكهربائي ونسبة الرطوبة والحموضة الكليه و الأحماض الدهنيه الحره. أعطت الظروف المتحكم فيها 42% رطوبه نسبيه أعلي حيويه و قوة البادرات لفترة تخزين تصل إلي 18 شهر بالمقارنه بالظروف الأخري. أعطي كلا من الصنف جيزة 92 و جيزة 94 مقاومه أكبر لفقد الأنبات و ذلك خلال فترة التدهور الصناعي و الطبيعي عن باقي الأصناف و أعطي أعلي حيوية للبذرة (و ذلك كنتيجه لأرتفاع نسبة الأنبات و إنخفاض كلا من التوصيل الكهربي و الحموضه الكليه و الأحماض الدهنيه الحره). يرتبط كلا من الفقد في الحيويه و ضعف الإنبات و الشتلات الضعيفه و الغير طبيعيه بزيادة نسبة الأحماض الدهنيه الحره التي تنتج آثارًا ضارة على الخلية.