Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www. jpp.journals.ekb.eg

Impact of Accelerated Ageing Process on Viability of Egyptian Cotton Seeds

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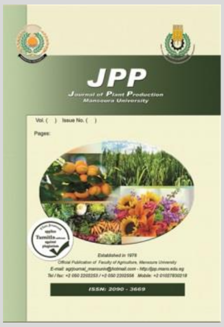

ABSTRACT

Genetic analysis was employed to investigate the influence of aging treatments on cottonseed viability. The seeds of 36 genotypes were artificially aged at 40 °C and 95–100 % relative humidity for control (T_0) and accelerated ageing treatments, T_1= 24 hours, T_2 =48 hours and T_3 =72 hours). Genotypes mean squares were significant for most traits under control and accelerated aging, except electrolyte leakage and seed imbibing % at accelerated aging conditions. The electrolyte leakage and seed imbibing % were increased with the increasing of aging stress. Increased electrolyte leakage with aging confirmed the inferior quality of aged seeds. However, germination % from T_2 to T_3, root fresh weight and shoot fresh weight from T_1 to T_3 were decreased with the increasing of aging stress. The decreases in seedling growth traits by accelerated aging may be a result of progressive loss of seed viability and vigor. Seed index had positively correlated with electrolyte leakage at second treatment and germination %. This indicate that higher seed index may improve electrolyte leakage and seed imbibing % (reduce the ability to both leakage into solution and absorb humidity) under severity storage condition, this relation help to understand the ability of cottonseed storage. Seed imbibing % exhibited negative and significant association with seed germination at second ageing. The genotypic correlations of seed index with other seed quality changed from control (+) to accelerated aging (-), indicating the high effect of aging treatment on the relation between these traits except for germination %.

Keywords: Cotton, accelerated ageing, seed quality, deterioration, correlation

INTRODUCTION

One aim of cotton breeder is to produce cultivar with high yielding potential and enhanced water use efficiency in addition to acceptable fiber quality. However, seed quality maintenance is considered one of the methods to keep genetic purity in cotton for long time, which have major impact on yield potential by increasing the propagation index in subsequent generation to decline period during variety handling and avoiding variety deterioration (EL-Lawendey *et al.*, 2013). Cottonseed is one of the most sensitive agronomic, seeds where significant deterioration occurs often just one year of storage. Cotton Seeds like other oil seeds is more prone to deterioration due to high oil contents (Maqsood *et al.*, 2002). Seed deterioration can be defined as deteriorative alterations occurring with time that increase the seeds exposure to the external challenges and decrease the ability of the seed to survive. Seed aging is one of the major issues in the storage of seeds and storage condition of seeds influence the germination characteristics and vigor potential of the seeds. Firstly, the physiology of seed deterioration is a separate event from seed development and / or germination. Thirdly, seed deterioration is cumulative, as seed aging, increase, seed performance is increasingly compromised. There were two important environments factors influencing the rate of deteriorative processes in seed ageing are the relatively humidity of the air, which controls seed moisture content and the temperature. The sensitivity of seeds to accelerated ageing is dependent on temperature and on their moisture content as a constant temperature losses of seed viability are faster with increasing moister content, seed moisture and storing temperature a kay role in seed longevity (Iqbal *et al.*, 2002). The storage environment where the seeds are stored greatly influences the time period of the survival of the seeds. Seeds deterioration leads to the reduction in the germination capacity and quality, viability and vigor either due to ageing or role of the diverse environmental conditions (Jyoti and Malik, 2013). Decrease in seed vigor may be due to decrease in germination indices, and it can increase the susceptibility of seeds to environmental stress (Walters *et al.* 2010).

Therefore, the present study aimed to investigate the cotton seed quality characters in different artificially accelerated aging time (different seed quality levels), and the genetic relationship among seed quality parameters with seed index.

MATERIALS AND METHODS

The present investigation was carried out at Sakha Experimental Farm, Sakha Agricultural Research Station, ARC, Egypt, during 2016 and 2017 growing seasons. The genetic materials used in this study included eight cotton genotypes; belonging to Egyptian cotton (*Gossypium barbadense* L.), representing a wide range of variability for yield and fiber characters, namely; Giza 69, Giza 86, Giza

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DOI: 10.21608/jpp.2020.79108

93, Giza 96 (as Egyptian genotypes), CB58, Pima S6, Australy and Suvin (as foreign introduced genotypes).

The eight parents were crossed in a half diallel fashion during crop season of 2016 to produce twenty-eight F_1 hybrid seeds. The 28 F_1 hybrids and their parents were grown in a randomized complete block design (RCBD) with three replicates during 2017 season. Each experimental plot consisted of one row, measuring five meters in length and 0.70 m in width, with plants spaced 0.30 m within row. Two plants were left per hill at thinning time. Recommended cultural practices were followed for all the entries.

The seeds of 36 genotypes were artificially aged using the accelerated ageing procedure suggested by Sung (1996) with minor modifications. The seeds were spread in a single layer on plastic trays in a plant growth chamber. The seeds were aged at 40 °C and 95 – 100% relative humidity for control (T_0) and accelerated ageing treatments, T_1=24 hours, T_2 =48 hours and T_3 = 72 hours. Following each ageing treatment, the seeds were allowed to air dray at room temperature until their original weight was restored and sealed in polythene bags in a refrigerator until used to study the following seed quality characters:

1-**Electrolyte leakage**. ***To determine the electrical conductivity (EC) in the seed – leachates 0.5 g of seeds of each genotype were rinsed for a few seconds with distilled water and soaked in 25 ml distilled water. The EC of solute leakage was determined as the total dissolved salts g/L (TDS) by a digital conductivity meter after 120 minutes of soaking according to Nik et al. (2011).***

2-**Seed imbibing (%)** was calculated as the percentage of difference between the weight of 50 seeds after soaking in water for two hours and the initial weight before soaking.

3-**Germination % .** Seeds of each replicate were used to carry out germination % in filter paper at 25 °C. To record data, the sheets were unrolled today after sowing, and the seeds that had produced normal seedlings were counted and recorded.

4-**Roots and shoots fresh weight (g):** Five seedlings of the germinated seeds were randomly collected after 10 days, then separated into roots and shoots and weighted each of them.

Statistical and genetically analysis:

Data were subjected to analysis of variance using standard technique as described by Steel *et al.* (1997) to obtain level of significance among the genotypes. Means of genotypes under different treatments were compared using LSD at 5% and 1% levels of probability.

The genotypic (rg) correlations for each pair of traits could be calculated according to the procedure outlined by Singh and Chaudhary (1977) as the following equations:

$$\textbf{Genotypic correlation (rg)} = \frac{\text{Cov. } g_1 g_2}{\sqrt{\sigma^2 g_1 . \sigma^2 g_2}}$$

Where: Cov. $g_1 g_2$: is the genotypic covariance between a pair of traits.

$\sigma^2 g_1$ and $\sigma^2 g_2$: are the genotypic variances of the first and second traits, respectively.

The significance of the genotypic (r_g) correlation was tested by using "t" test at 0.05 and 0.01 levels of probability as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Genotypes mean squares were significant for most studied seed quality traits under control and accelerated aging (Table1) except for electrolyte leakage at second and third treatments, seed imbibing % at the first accelerated aging condition. In the same trend root and shoot fresh weight at first and second treatment of accelerated aging. These results indicating the presence of the required genotypic variability necessary for further genetic analysis.

Table 1. Mean square of the studied seed quality traits as affected by accelerated aging treatments.

S.O.V	DF	Electrolyte leakage				Seed imbibing %				Germination %			
		T_0	T_1	T_2	T_3	T_0	T_1	T_2	T_3	T_0	T_1	T_2	T_3
Replicates	2	0.0496	0.0144	0.0102	0.0621	801.520	#######	916.800	776.400	41.930	200.900	3541.9	10.8
Genotype	35	0.0167**	0.0088**	0.0144	0.0190	91.826	428.656	548.514*	265.986*	79.20**	554.79**	719.13**	579.44
Error	70	0.006	0.007	0.016	0.015	74.7	348.09	297	143.71	22.9	205.85	382.08	366.93

T_0= control, T_1=24 hr, T_2=48 hr and T_3= 72 hr

Table 1. continued

S.O.V	DF	Roots weight			Shoots weight		
		T_1	T_2	T_3	T_1	T_2	T_3
Replicates	2	1.05743	0.234	0.386	0.253	0.192	1.157
Genotype	35	0.02878	0.022	0.071**	0.243	0.201	0.872**
Error	70	0.063	0.02	0.03	0.19	0.2	0.24

T_0= control, T_1=24 hr, T_2=48 hr and T_3= 72 hr

The deterioration effects of stress treatments on seed quality traits showed that, the electrolyte leakage and seed imbibing % were increased with the increasing of aging stress. Increased electrolyte leakage with aging confirmed the inferior quality of aged seeds. Hence, the increased seed leakage (electrolyte leakage) is may be due to the associated with aging induced changes in cellular membranes of imbibed seeds. Also, Nik *et al.* (2011) reported that increased electrolyte leakage with aging confirmed the inferior quality of the aged seeds. However, germination % from T_3 to T_4, root and shoot weights, seedling fresh weight and seedling dry weight from T_1 to T_3 were decreased with the increasing of aging stress. The decreases in seedling growth traits by accelerated aging may be a result of progressive loss of seed viability and vigor, which is evident through the results of the present studies. The same conclusion was detected by Jain *et al.* (2006); Ashraf and Habib (2011) and El-Lawendey *et al.* (2013). On the other hand, the effects of seed ageing from T_1 to T_2 on germination % increased slightly compared with non-stressed seeds. The possible reason of this increase might be the higher of biochemical activities in cottonseed under slightly stress. Another interpretation, the exposure of seeds to saturated humidity resulted in slow moisture uptake by the seeds. This controlled hydration had shown to improve the performance of a number of seeds (Khan *et al*., 1995). Similar results were reported by Basra *et al*. (2000) and Iqbal *et al*. (2002).

The data illustrated in Tables 2 and 3 showed that the lower values were desirable for electrolyte leakage and seed imbibing %; however, higher values were desirable for the other traits. Electrolyte leakage provides a rapid indicating of seeds deterioration progresses. The cell membranes become less rigid and become more water permeable. It allows the cell contents to leakage into solution with the water and increasing electrical conductivity under accelerated aging progress.

The foreign genotype Austerely 13 showed the highest electrolyte leakage values towards all ageing treatment. The Egyptian variety Giza 86 recorded highest seed imbibing %, exhibited significant increase for electrolyte leakage overall means at most accelerated aging treatments.

Tables 2. The mean performances for seed quality traits as affected by accelerated aging treatments

Parents	Electrolyte leakage				Seed imbibing %			
	T0	T1	T2	T3	T0	T1	T2	T3
Giza 93	0.28	0.32	0.36	0.46	38.30	84.60	85.50	87.00
Giza 69	0.26	0.35	0.40	0.44	30.67	92.93	86.40	91.80
C.B.58	0.33	0.39	0.37	0.40	31.80	115.20	87.60	72.33
Pima S6	0.34	0.43	0.41	0.48	33.43	123.20	104.97	95.83
Australy	0.38	0.40	0.60	0.47	30.80	98.73	95.43	88.27
Giza 86	0.30	0.47	0.48	0.46	33.70	137.90	117.67	109.87
Giza 96	0.34	0.32	0.42	0.36	24.47	106.60	106.37	90.03
Suvin	0.43	0.35	0.42	0.39	31.10	94.13	90.17	90.60
LSD 0.05	0.13	0.14	0.21	0.20	14.04	30.31	28.00	19.48
LSD 0.01	0.17	0.18	0.27	0.27	18.70	40.37	37.29	25.94

T_0= control, T_1=24 hr, T_2=48 hr and T_3= 72 hr

Table 2. Continued

Parents	Germination %				Root weight (g)			Shoot weight (g)		
	T0	T1	T2	T3	T1	T2	T3	T1	T2	T3
Giza 93	80.67	86.67	35.33	9.33	0.85	0.60	0.56	3.03	2.60	1.93
Giza 69	80.00	84.00	38.67	32.00	0.81	0.53	0.51	2.90	2.40	2.07
C.B.58	73.00	86.67	65.33	11.00	0.83	0.53	0.66	3.03	2.43	2.40
Pima S6	85.00	74.67	36.33	14.67	0.95	0.44	0.53	2.60	2.77	2.37
Australy	79.00	80.33	41.33	16.00	0.89	0.33	0.63	2.60	2.37	2.33
Giza 86	91.67	84.33	35.33	14.33	0.95	0.44	0.49	2.67	3.13	2.07
Giza 96	81.67	74.33	60.00	30.67	0.60	0.62	0.50	2.57	2.87	2.27
Suvin	84.67	82.67	39.33	32.00	0.69	0.63	0.50	2.93	2.80	2.17
LSD 0.05	7.78	23.31	31.76	31.12	0.41	0.23	0.28	0.71	0.73	0.80
LSD 0.01	10.35	31.04	42.29	41.45	0.54	0.31	0.37	0.94	0.97	1.06

T_0= control, T_1=24 hr, T_2=48 hr and T_3= 72 hr

Table 3. The mean performances for seed quality traits at four accelerated aging treatments among 28 F_1 cross combinations.

F1 Crosses	Electrolyte leakage				Seed imbibing %				Germination %			
	T0	T1	T2	T3	T0	T1	T2	T3	T0	T1	T2	T3
G.93 X G.69	0.37	0.48	0.53	0.49	52.73	85.97	94.37	85.43	93.33	23.33	2.67	1.33
G.93 X CB58	0.34	0.51	0.48	0.60	29.57	111.23	103.03	93.97	86.00	63.33	12.67	4.67
G.93 X Pima S6	0.28	0.45	0.55	0.58	32.40	93.83	76.47	96.63	88.67	78.00	27.33	10.67
G.93 X Australy	0.26	0.41	0.40	0.54	26.70	101.20	99.40	89.10	90.33	83.33	32.00	8.67
G.93 X G.86	0.40	0.41	0.46	0.49	30.17	96.50	82.27	82.57	88.33	87.33	48.67	24.00
G.93 X G.96	0.30	0.42	0.40	0.44	25.70	100.13	92.60	84.93	88.00	75.33	42.67	10.67
G.93 X Suvin	0.27	0.45	0.44	0.42	30.90	85.47	94.90	79.10	94.00	71.33	21.33	16.00
G.69 X CB58	0.43	0.47	0.45	0.58	25.80	103.80	78.10	84.90	92.67	73.33	29.33	6.67
G.69 X Pima S6	0.28	0.47	0.58	0.50	37.23	103.70	104.03	102.80	93.67	79.33	54.67	10.00
G.69 X Australy	0.33	0.42	0.49	0.39	30.77	110.37	97.43	105.63	86.33	89.33	40.00	3.33
G.69 X G.86	0.40	0.48	0.55	0.47	44.03	106.17	110.40	91.70	84.67	80.00	35.33	6.00
G.69 X G.96	0.34	0.47	0.43	0.44	32.53	114.70	89.60	88.60	83.67	87.33	58.00	18.00
G.69 X Suvin	0.35	0.52	0.52	0.47	26.43	91.93	99.90	107.30	89.33	86.00	48.00	16.00
CB58 X Pima S6	0.33	0.46	0.42	0.49	34.27	93.43	75.90	82.50	81.00	81.33	26.00	8.67
CB58 X Australy	0.27	0.47	0.42	0.42	28.30	92.20	124.47	101.10	88.33	84.00	54.00	40.67
CB58 X G.86	0.34	0.42	0.48	0.36	35.73	96.50	104.60	92.90	87.33	91.00	44.67	46.67
CB58 X G.96	0.35	0.52	0.48	0.38	40.40	113.37	128.17	101.70	84.67	90.00	66.00	30.67
CB58 X Suvin	0.31	0.35	0.41	0.41	34.60	90.67	100.73	95.10	81.00	85.67	55.33	17.33
Pima S6 X Australy	0.31	0.32	0.42	0.42	33.73	99.43	115.23	106.27	89.67	90.00	73.33	32.67
Pima S6 X G.86	0.25	0.41	0.39	0.41	37.87	120.30	106.27	90.00	86.00	84.33	61.33	46.67
Pima S6 X G.96	0.33	0.38	0.39	0.44	34.20	97.60	91.50	92.43	76.67	88.67	50.00	33.33
Pima S6 X Suvin	0.37	0.37	0.51	0.44	37.93	98.80	82.70	90.13	84.00	88.00	54.67	38.67
Australy X G.86	0.39	0.41	0.47	0.60	30.87	101.50	109.50	100.00	92.33	89.33	49.33	9.33
Australy X G.96	0.24	0.40	0.38	0.40	33.23	92.00	79.20	90.43	87.00	82.67	54.67	50.00
Australy X Suvin	0.30	0.38	0.44	0.53	35.53	79.83	73.93	108.47	87.00	88.00	36.00	17.33
G.86 X G.96	0.31	0.38	0.45	0.41	33.90	111.97	102.53	73.57	76.00	88.67	40.67	8.67
G.86 X Suvin	0.31	0.33	0.47	0.47	40.97	95.77	94.63	106.67	82.67	82.67	57.33	30.00
Giza 96 X Suvin	0.29	0.35	0.35	0.41	34.57	100.00	84.63	93.43	86.33	83.33	61.33	32.67
LSD 0.05	0.13	0.14	0.21	0.20	14.04	30.31	28.00	19.48	7.78	23.31	31.76	31.12
LSD 0.01	0.17	0.18	0.27	0.27	18.70	40.37	37.29	25.94	10.35	31.04	42.29	41.45

T_0= control, T_1=24 hr, T_2=48 hr and T_3= 72 hr

However, G.93and and G.96 recorded the lowest values for aging treatment. By increasing humidity flowing ageing treatments, the seed emergency would be decreased for all parental genotypes. The decrease in these traits by accelerated aging may be result of progressive loss of seed viability and vigor (El-Lawendey *et al.*, 2013). With regard to F_1 combinations the crosses showed some sort of resistance across aging treatment due heterogeneity. The cross combination Aust. X Giza 96 recorded the best mean values for seed quality across aging treatments followed by the combination Pima x Giza 86, which showed low values for seed electrolyte leakage, seed imbibing% and high germination percentages, however Giza 93 x Giza showed undesirable values for seed characters across treatment and found to be more influenced by aging treatment. Elbadaly (2018) found that F_1 crosses showed significant increased values for susceptibility index across aging treatments.

Genotypic correlation coefficients for seed index with seed quality traits under different aging treatments are presented in Table (4). The results showed that the genotypic correlations were significance for most cases, which indicate the presence of strong inherent association for seed index with each of cottonseed quality traits. These findings are in harmony with those obtained by El-Lawendey *et al.* (2013).

Table 4. Genotypic correlation coefficients among all the studied characters of 36 cotton genotypes

Characters	SI	EC 1	EC 2	EC 3	EC 4	Imb 1 %	Imb 2 %	Imb 3 %	Imb 4 %	Emerg 1	Emerg 2	Emerg 3
EC 1	0.08											
EC 2	0.38**	0.17										
EC 3	0.05	0.38**	0.48**									
EC 4	0.21	0.18	0.34*	0.33								
Imb 1 %	-0.17	0.04	0.06	0.26	-0.08							
Imb 2 %	-0.13	0.07	0.25	0.02	-0.09	-0.09						
Imb 3 %	0.08	-0.02	0.26	0.17	-0.25	0.08	0.46**					
Imb 4 %	-0.04	-0.11	0.10	0.27	0.12	0.06	0.06	0.38**				
Emerg 1	0.33*	-0.01	0.44**	0.30	0.39**	-0.004	-0.09	0.16	0.37**			
Emerg 2	0.18	-0.14	-0.31*	-0.24	-0.27	-0.36**	0.15	0.07	0.22	-0.34*		
Emerg 3	0.002	-0.14	-0.39**	-0.28	-0.53**	-0.12	0.21	0.27	0.21	-0.29	0.65**	
Emerg 4	0.01	-0.25	-0.35**	-0.33*	-0.57**	-0.003	-0.09	0.11	0.14	-0.12	0.37**	0.59**

SI= seed index, EC= electric conductivity, Imb= seed imbibing% and Emerg= emergence %

Seed index had positively correlated with electrolyte leakage at second treatment and germination %.This indicated that higher seed index may tolerate severity storage condition from germination point of view than the normal condition, also higher seed index may improve electrolyte leakage and seed imbibing % (reduce the ability to both leakage into solution and absorb humidity) under severity storage condition, this relation help to understand the ability of cottonseed storage. These findings are in conformity with those obtained by Pahlavani *et al.* (2008). On the other hand, genotypic correlation for seed index with both seedling lengths differed from treatment ageing to other under this investigation. Consequently, Ye *et al.* (2003) indicated that the estimation of unconditional and conditional correlation coefficients varied considerably of the seed quality traits with themselves at different stages, suggesting that the genetic effects of early stages not always in the same way as that of the later stages.

Electrolyte leakage at second and fourth treatments showed positive associations with both seed germination in control, but it had negative association at second, third and fourth aging treatment. Imbibing % exhibited negative and significant association with seed germination at second ageing.

The genotypic correlations seed index with other seed quality changed from control (+) to accelerated aging (-), indicating the high effect of aging treatment on the relation between these traits except for germination %. These results indicate that seeds with higher seed index may be able to tolerate severity storage condition from germination and vigor point of view. These results may explain that, the elevation of seed weight may be due to the high content of some necessary materials for normal seedling growth. On the other hand, El-Lawendey *et al.* (2013) suggested that higher seed index negatively affected germination % and seedling vigor index with more aging severity.

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تأثير التدهور المستحث على حيوية بذور القطن

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أجري التحليل الوراثي لدراسة تأثير عمليات التدهور المستحث على حيوية بذور القطن ودراسة السلوك الوراثي لصفات جوده البذور (معامل البذرة – التوصيل الكهربي – النسبة المئوية للتشرب –نسبه الانبات – الوزن الطازج للجذير والريشة تحت مستويات مختلفة من الاجهاد المستحث، حيث تم تعريض بذور ٣٦ تركيب وراثي لمعاملات الاجهاد المستحث (درجه حرارة ٤٠درجه مئوية ونسبه رطوبة ٩٥ - ١٠٠ %) تحت فترات زمنيه ٢٤ ساعة , ٤٨ ساعة , ٧٢ ساعة وأظهرت النتائج ما يلي: أظهر تحليل التباين اختلافات وراثيه بين التراكيب الوراثية لمعظم الصفات المدروسة تحت ظروف معاملات التدهور المستحث. أظهرت النتائج أن مظاهر التدهور الناتج عن المعاملات المؤثرة على صفات جوده البذرة تتمثل في زيادة قيمه التوصيل الكهربي في المحلول وزيادة التشرب وانخفاض نسبه الانبات الحيوية وزيادة معامل التوصيل الكهربي في المحلول مع زيادة معاملات التدهور المستحث، وهذا يؤكد التأثير الضار على صفات جوده البذور. كما أظهرت النتائج ان نسبه الانبات قد انخفضت نتيجة زيادة معاملات التدهور المستحث من ٢ يوم - ٣ يوم وايضا انخفاض قيمة كلا من الوزن الطازج لكل من الجذير والريشة مع زيادة معاملات التدهور. ويرجع انخفاض نمو الريشة والجذير نتيجة عمليات التدهور إلى انخفاض حيوية وقوة الانبات. أظهرت النتائج وجود ارتباط معنوي موجب بين كلا من وزن البذرة ومعامل التوصيل الكهربي لمرتجع الراشح ونسبة التشرب تحت ظروف التخزين السيئة، كما اظهرت نسبة التشرب للبذرة علاقة سالبة ومعنوية مع نسبة الانبات تحت ظروف الاجهاد وعند المعاملة الثانية. أوضحت النتائج ان الارتباط الوراثي بين معامل البذرة مع صفات جودة البذرة الأخرى قد تتغير من (+) تحت الظروف العادية الي علامة (-) تحت ظروف الاجهاد ومما يدل على تأثير معاملات الاجهاد على تغيير العلاقة بين صفات جودة البذرة.