Plant Archives Vol. 15 No. 2, 2015 pp. 1167-1173 *ISSN 0972-5210*

ASSESSMENT OF COTTON SEED DETERIORATION DURING ACCELERATED AGEING: CHANGES IN PHYSIOLOGICAL ASPECTS

Nishtha Yadav* and R. S. Brar

Department of Botany, S. G. N. (P.G.) Khalsa College, Sriganganagar - 335 001 (Rajasthan), India.

Abstract

Seed storage in ambient conditions in humid tropical regions is a serious problem. In the present study, we examined whether the loss of germination capacity and viability of cotton seeds during storage under relative humidity levels (45%, 60%, 75% and 90%) in three different storage containers for 60 days associated with accelerated ageing. The germination percentage and vigour index decreased with accelerated ageing. At 45% and 60% RH though polythene bags and aluminium bags retained better vigour content but at 75% and 90% RH, all the containers failed to retain the viability and vigour of seeds.

Key words : Cotton seed, vigour, germination capacity, storage containers.

Introduction

Seed possesses the highest vigour at the time of its physiological maturity and gradually decreases with storage period. Storage environment influences seed longevity greatly. The physiological changes in seed that lead to loss of viability are termed deterioration. Deterioration of seed has been defined as an irreversible degenerative change in the quality of seed after it has reached its maximum quality level. It is an inexorable, irreversible process that progressively impairs the capabilities and performance of the seed and culminates in its death or in loss of the germination capacity. The principal environmental factors influencing seed deterioration and so seed survival are temperature, moisture content and oxygen partial pressure (Roberts, 1972). Harrington (1972) suggested that within normal ranges of moisture and temperature for stored seeds, each 1% reduction in seed moisture or 5°C reduction in temperature doubles the storage life of the seeds. The rate of seed deterioration varies among plant species, cultivars and storage conditions (Dhakal and Pandey, 2001). The exact cause of seed viability loss are still unknown, but the viability is affected by pre-harvest climatic conditions, seed type, seed structure, seed health, temperature, relative humidity and seed moisture content (Abba and Lovato, 1999).

In much of agriculture, open storage is used whereby the seed environment equilibrates with ambient relative humidity and temperature while oxygen is freely available at atmospheric concentration. The climatic conditions of humid tropical regions accelerate the seed viability loss during prolonged storage.

Autoxidation is posited as a major cause of deterioration in air-dry seeds (Solomon, 1951). Moreover, Smith (1992) has pointed out that controlling seed moisture content using hermetic containers or using desiccators and saturated salt solutions or desiccants provides different environment for research. In hermetic storage, the volume of air is small and seed (and associated micro-flora) respiration alter gaseous composition (Roberts and Abdalla, 1968). In desiccators, seeds are in contact with a much larger volume of air. Moreover, if the lid is removed and then replaced (*e.g.* when taking a sample) then both gaseous composition and humidity will revert temporarily towards ambient.

To study the physiological and biochemical changes in seeds during ageing, accelerated ageing has been widely used. In accelerated ageing, the seeds are self-aged by subjecting them to high relative humidity (>90%) and temperature (≥40°C). The seeds aged in this way are compared for morphological, physiological, biochemical and genetic changes with controls.

Seeds of cotton rapidly deteriorate because of higher linoleic acid content. However, reports on biochemical basis of seed deterioration in cotton are very few. The

***Author for correspondence:** E-mail: nishthamtech@gmail.com

Table 1 : Effect of container, storage time period and relative humidity on seeds of variety RG-8 on germination percentage.

Container	Time Period	Control	Relative Humidity				Mean
			45%	60%	75%	90%	
Aluminium bag	**15**	**99.80**	99.80	99.80	99.70	99.70	**99.75**
	30	**96.30**	95.90	95.30	93.30	92.40	**94.23**
	45	**88.60**	87.50	87.10	85.40	83.20	**85.80**
	60	**82.20**	81.40	81.10	74.70	67.50	**76.18**
	Mean	**91.73**	**91.15**	**90.83**	**88.28**	**85.70**	**88.99**
Polythene bag	**15**	**100.00**	99.90	99.80	99.70	99.60	**99.75**
	30	**98.30**	97.50	96.50	94.70	93.80	**95.63**
	45	**91.20**	88.60	87.90	86.50	84.40	**86.85**
	60	**86.70**	86.10	84.30	78.60	68.50	**79.38**
	Mean	**94.05**	**93.03**	**92.13**	**89.88**	**86.58**	**90.40**
Craftpaper bag	**15**	**99.10**	99.10	99.10	99.10	99.10	**99.10**
	30	**96.00**	95.20	94.40	93.10	92.50	**93.80**
	45	**83.30**	83.20	81.50	76.30	74.20	**78.80**
	60	**80.10**	78.40	76.40	72.50	66.50	**73.45**
	Mean	**89.62**	**88.98**	**87.85**	**85.25**	**83.08**	**86.29**
Grand Mean		**91.80**	**91.05**	**90.27**	**87.80**	**85.12**	**88.56**
CD-.05	**C- 3.5**	**C*T-5.7**	**C*T*Tr-21.2**			**C**	**Container**
	T-7.3	**C*Tr-9.8**				**T**	**Time (Days)**
	Tr-4.2	**T*Tr-12.5**				**Tr**	**Humidity**

present studies were conducted to investigate the effect of varying relative humidity conditions and storage containers on the viability and germinability of seeds of four cotton varieties.

Materials and Methods

Cotton (*Gossypium hirsutum* L.) seeds varieties RG-8, RG-18, RS-810 and RS-2013 were obtained from Agricultural Research Station, Sriganganagar, Rajasthan, were surface sterilized with 0.01% $HgCl_2$ solution for 5 minutes and then washed thoroughly and repeatedly with distilled water before drying. The seeds were then kept in three different containers *viz.*, aluminium bag, polythene bag and craft paper bag, further under humid conditions of 45%, 60%, 75% and 90%. The varying levels of relative humidity was maintained with potassium hydroxide (Smith, 1992).

Germination

Seed germination test was conducted by BP method as per rules of International Seed Testing Association (ISTA, 1993) in a germination laboratory. Four replicates of 100 seeds for each treatment were placed on moistened two-layered germination paper. The papers were watered whenever required and placed vertically in seed germination at 26±1°C temperature. The germination count were observed after 7th day of sowing and normal seedlings produced were expressed as germination percentage.

Vigour index

Seed vigour was computed adopting the method of (Abdul-Baki and Anderson, 1973) using the formula:

Vigour Index = Seedling Length × Germination %.

These parameters of each variety have been studied for the effect of storage container, storage time period and relative humidity in 3 way ANOVA (factproa; CRD). For determining significant differences between treatments, Critical Difference (C.D) was used. All statistical analysis were done following (Chandel, 2004).

Results and Discussion

Increased accelerated ageing significantly decreased the germination viability of cottonseeds. The maximum germination was recorded for untreated seeds and was observed after 15 days of storage and it decreased gradually as the storage period prolonged in all varieties. Similar trends were seen in case of seed vigour. The decrease in both germination and seed vigour by accelerated ageing may be a result of progressive loss of

Table 2 : Effect of container, storage time period and relative humidity on seeds of variety RG-18 on germination percentage.

Container	Time Period	Control	Relative Humidity				Mean
			45%	60%	75%	90%	
Aluminium bag	**15**	**100.00**	100.00	100.00	99.70	98.40	**99.53**
	30	**99.40**	99.40	97.40	96.80	96.30	**97.48**
	45	**96.30**	95.60	93.50	91.40	87.60	**92.03**
	60	**84.50**	84.00	82.70	76.20	69.40	**78.08**
	Mean	**95.05**	**94.75**	**93.40**	**91.03**	**87.93**	**91.78**
Polythene bag	**15**	**100.00**	100.00	100.00	99.80	98.60	**99.60**
	30	**99.80**	99.30	97.60	96.60	96.40	**97.48**
	45	**96.60**	95.80	92.30	90.20	87.40	**91.43**
	60	**85.20**	84.50	83.70	77.50	69.40	**78.78**
	Mean	**95.40**	**94.90**	**93.40**	**91.03**	**87.95**	**91.82**
Craftpaper bag	**15**	**100.00**	100.00	99.80	99.50	98.20	**99.38**
	30	**99.20**	98.00	96.20	95.90	95.40	**96.38**
	45	**91.40**	89.20	87.50	83.20	81.50	**85.35**
	60	**76.40**	73.50	71.10	65.30	63.70	**68.40**
	Mean	**91.75**	**90.18**	**88.65**	**85.98**	**84.70**	**87.38**
Grand Mean		**94.07**	**93.28**	**91.82**	**89.34**	**86.86**	**90.32**
CD-.05	**C- 11.2**	**C*T-28.5**	**C*T*Tr-100.5**			**C**	**Container**
	T-25.3	**C*Tr-45.7**				**T**	**Time (Days)**
	Tr-4.2	**T*Tr-59.1**				**Tr**	**Humidity**

Table 3 : Effect of container, storage time period and relative humidity on seeds of variety RG-810 on germination percentage.

Container	Time Period	Control	Relative Humidity				Mean
			45%	60%	75%	90%	
Aluminium bag	**15**	**100.00**	100.00	99.30	99.10	98.30	**99.18**
	30	**97.40**	97.00	96.10	96.00	94.80	**95.98**
	45	**95.00**	94.10	93.90	92.80	91.40	**93.05**
	60	**82.90**	81.80	80.40	69.90	66.30	**74.60**
	Mean	**93.83**	**93.23**	**92.43**	**89.45**	**87.70**	**90.70**
Polythene bag	**15**	**100.00**	100.00	99.70	99.30	98.60	**99.40**
	30	**98.30**	97.90	96.50	96.70	95.30	**96.60**
	45	**95.40**	94.20	93.40	91.20	89.40	**92.05**
	60	**83.70**	82.50	82.10	70.50	68.70	**75.95**
	Mean	**94.35**	**93.65**	**92.93**	**89.43**	**88.00**	**91.00**
Craftpaper bag	**15**	**100.00**	100.00	99.10	98.80	97.90	**98.95**
	30	**96.30**	96.00	95.70	95.30	94.60	**95.40**
	45	**94.30**	93.90	93.20	90.10	88.60	**91.45**
	60	**80.60**	79.40	78.30	68.50	66.10	**73.08**
	Mean	**92.80**	**92.33**	**91.58**	**88.18**	**86.80**	**89.72**
Grand Mean		**93.66**	**93.07**	**92.31**	**89.02**	**87.50**	**91.04**
CD-.05	**C- 14.5**	**C*T-7.1**	**C*T*Tr-21.7**			**C**	**Container**
	T-17.9	**C*Tr-12.7**				**T**	**Time (Days)**
	Tr-15.7	**T*Tr-14.2**				**Tr**	**Humidity**

Table 4 : Effect of container, storage time period and relative humidity on seeds of variety RG-2013 on germination percentage.

Container	Time Period	Control	Relative Humidity				Mean
			45%	60%	75%	90%	
Aluminium bag	**15**	**99.80**	99.80	99.80	99.80	99.80	**99.80**
	30	**96.30**	96.10	95.90	95.80	95.30	**95.78**
	45	**89.30**	88.90	88.60	86.30	84.20	**87.00**
	60	**82.40**	82.00	81.70	73.20	71.50	**77.10**
	Mean	**91.95**	**91.70**	**91.50**	**88.78**	**87.70**	**89.92**
Polythene bag	**15**	**99.80**	99.80	99.80	99.80	99.80	**99.80**
	30	**97.30**	97.00	96.50	96.20	96.00	**96.43**
	45	**89.80**	89.50	88.10	86.20	86.10	**87.48**
	60	**84.30**	83.40	82.70	74.50	74.00	**78.65**
	Mean	**92.80**	**92.43**	**91.78**	**89.18**	**88.98**	**90.59**
Craftpaper bag	**15**	**99.80**	99.80	99.80	99.80	99.80	**99.80**
	30	**96.10**	95.30	95.00	94.90	94.30	**94.88**
	45	**88.50**	87.60	87.30	85.30	83.20	**85.85**
	60	**81.30**	81.00	79.40	72.40	71.20	**76.00**
	Mean	**91.43**	**90.93**	**90.38**	**88.10**	**87.13**	**89.13**
Grand Mean		**92.06**	**91.68**	**91.22**	**88.68**	**87.93**	**89.88**
CD-.05	**C- 12.3**	**C*T-16.1**	**C*T*Tr-32.7**			**C**	**Container**
	T-25.1	**C*Tr-29.4**				**T**	**Time (Days)**
	Tr-13.7	**T*Tr-14.7**				**Tr**	**Humidity**

Table 5: Effect of Container, Storage Time Period and Relative Humidity on seeds of variety RG-8 on Vigour Index

Container	Time Period	Control	Relative Humidity				Mean
			45%	60%	75%	90%	
Aluminium bag	**15**	**1996**	1986	1945	1910	1885	**1931.50**
	30	**1033**	1064	960	840	825	**922.25**
	45	**783**	684	568	465	418	**533.75**
	60	**190**	178	162	151	125	**154.00**
	Mean	**1000.5**	**978**	**908.75**	**841.5**	**813.25**	**885.38**
Polythene bag	**15**	**2136**	2055	2000	1996	1983	**2008.50**
	30	**1256**	1241	1180	1042	1007	**1117.50**
	45	**821**	795	748	691	650	**721.00**
	60	**363**	289	262	237	225	**253.25**
	Mean	**1144**	**1095**	**1047.5**	**991.5**	**966.25**	**1025.06**
Craftpaper bag	**15**	**1910**	1890	1860	1820	1790	**1840.00**
	30	**1005**	990	945	918	865	**929.50**
	45	**428**	411	380	290	248	**332.25**
	60	**181**	163	148	120	112	**135.75**
	Mean	**881**	**863.5**	**833.25**	**787**	**753.75**	**809.38**
Grand Mean		**1008.5**	**978.83**	**929.83**	**873.33**	**844.42**	**906.60**
CD-.05	**C- 3.5**	**C*T-5.7**	**C*T*Tr-21.2**			**C**	**Container**
	T-7.3	**C*Tr-9.8**				**T**	**Time (Days)**
	Tr-4.2	**T*Tr-12.5**				**Tr**	**Humidity**

Table 6: Effect of container, storage time period and relative humidity on seeds of variety RG-18 on vigour index.

Container	Time Period	Control	Relative Humidity				Mean
			45%	60%	75%	90%	
Aluminium bag	**15**	**1891**	1845	1820	1810	1792	**1816.75**
	30	**1240**	1201	1194	1172	1095	**1165.50**
	45	**624**	631	620	595	560	**601.50**
	60	**162**	131	129	113	103	**119.00**
	Mean	**979.25**	**952**	**940.75**	**922.5**	**887.5**	**925.69**
Polythene bag	**15**	**2010**	1972	1964	1878	1790	**1901.00**
	30	**1367**	1232	1201	1182	1145	**1190.00**
	45	**803**	801	778	761	682	**755.50**
	60	**240**	225	214	201	185	**206.25**
	Mean	**1105**	**1057.5**	**1039.25**	**1005.5**	**950.5**	**1013.19**
Craft Paper bag	**15**	**1759**	1732	1725	1679	1625	**1690.25**
	30	**1192**	1175	1150	1102	1078	**1126.25**
	45	**520**	512	490	452	392	**461.50**
	60	**135**	123	106	94	74	**99.25**
	Mean	**901.5**	**885.5**	**867.75**	**831.75**	**792.25**	**844.31**
Grand Mean		**995.25**	**965.00**	**949.25**	**919.92**	**876.75**	**927.73**
CD-.05	**C- 11.2**	**C*T-28.5**	**C*T*Tr-100.5**			**C**	**Container**
	T-25.3	**C*Tr-45.7**				**T**	**Time (Days)**
	Tr-16.5	**T*Tr-59.1**				**Tr**	**Humidity**

Table 7: Effect of container, storage time period and relative humidity on seeds of variety RG-810 on vigour index.

Container	Time Period	Control	Relative Humidity				Mean
			45%	60%	75%	90%	
Aluminium bag	**15**	**2476**	2434	2412	2410	2381	**2409.25**
	30	**1347**	1265	1178	1091	1045	**1144.75**
	45	**1042**	1021	1015	972	891	**974.75**
	60	**545**	512	414	395	372	**423.25**
	Mean	**1352.5**	**1308**	**1254.75**	**1217**	**1172.25**	**1238.00**
Polythene bag	**15**	**2551**	2494	2474	2450	2420	**2459.50**
	30	**1532**	1447	1281	1263	1212	**1300.75**
	45	**1171**	1099	1084	1072	1035	**1072.50**
	60	**576**	553	512	419	407	**472.75**
	Mean	**1457.5**	**1398.25**	**1337.75**	**1301**	**1268.5**	**1326.38**
Craftpaper bag	**15**	**2164**	2145	2136	2136	2014	**2107.75**
	30	**1330**	1257	1169	1053	1021	**1125.00**
	45	**995**	992	891	854	841	**894.50**
	60	**532**	510	409	372	363	**413.50**
	Mean	**1255.25**	**1226**	**1151.25**	**1103.75**	**1059.75**	**1135.19**
Grand Mean		**1355.08**	**1310.75**	**1247.92**	**1207.25**	**1166.83**	**1259.00**
CD-.05	**C- 14.5**	**C*T-7.1**	**C*T*Tr-21.7**			**C**	**Container**
	T-17.9	**C*Tr-12.7**				**T**	**Time (Days)**
	Tr-15.7	**T*Tr-14.2**				**Tr**	**Humidity**

Table 8: Effect of container, storage time period and relative humidity on seeds of variety RG-2013 on vigour index

Container	Time Period	Control	Relative Humidity				Mean
			45%	60%	75%	90%	
Aluminium bag	**15**	**2097**	2074	1989	1925	1872	**1965.00**
	30	**1245**	1184	1165	1082	995	**1106.50**
	45	**748**	678	637	563	472	**587.50**
	60	**115**	105	100	94	83	**95.50**
	Mean	**1051.25**	**1010.25**	**972.75**	**916**	**855.5**	**938.63**
Polythene bag	**15**	**2123**	2095	1981	1965	1890	**1982.75**
	30	**1359**	1313	1290	1242	1171	**1254.00**
	45	**994**	981	892	774	729	**844.00**
	60	**164**	134	112	105	98	**112.25**
	Mean	**1160**	**1130.75**	**1068.75**	**1021.5**	**972**	**1048.25**
Craftpaper bag	**15**	**1956**	1945	1922	1905	1862	**1908.50**
	30	**1130**	1112	1083	992	974	**1040.25**
	45	**580**	547	525	486	428	**496.50**
	60	**175**	168	154	128	104	**138.50**
	Mean	**960.25**	**943**	**921**	**877.75**	**842**	**895.94**
Grand Mean		**1057.17**	**1028.00**	**987.50**	**938.42**	**889.83**	**960.94**
CD-.05	**C- 12.3**	**C*T-16.1**	**C*T*Tr-32.7**			**C**	**Container**
	T-25.1	**C*Tr-29.4**				**T**	**Time (Days)**
	Tr-13.7	**T*Tr-14.7**				**Tr**	**Humidity**

seed viability and vigour which is evident through the result of the present study (Jain *et al*., 2006). These observations showing declinations in seed vigour are in accordance with earlier works on Artiplex cardobensis (Aiazzi *et al*., 1996) and soybean (Filho *et al*., 2001). In cotton, germination and vigour decreased in all four varieties with increase in levels of relative humidity during accelerated ageing in all three containers, which is similar to the results obtained in seeds of six forest tree species by Agboola and Etejere (1991), when he compared the effect of ten relative humidity regimes ranging from 4-100% during storage. Maximum germination and vigour was observed at 45% RH. Varieties RG-8 and RG-18 responded better to all four relative humidity levels compared to varieties RS-810 and RS-2013. Variety RS-810 showed maximum vigour at 45% RH as compared to varieties RG-8, RG-18 and RS-2013. Maximum vigour index (553) was observed in seeds of variety RS-810 after 60 days of storage, decreased by 4% with respect to control under the effect of 45% RH.

Effect of storage time period was much more pronounced than the effect of relative humidity. After 60 days of storage, seeds of variety RG-8 showed least decrease 20.37% in germination as compared to control 13%. Maximum decrease 36% in germination was observed in seeds stored in craft paper bags after 60 days of storage in seeds of variety RG-18, which decreased to 35% with highest relative humidity. After 60 days of storage, seeds of variety RS-810 showed minimum decrease 80.39% in vigour index as compared to control 75%. Variety RS-810 was better over varieties RG-8, RG-18 and RS-2013 after 60 days of storage. Dhawan and Brar (2007) found significant reduction in seed vigour of gram seeds with advancement in time.

Effect of containers was significant on germination and vigour in all four varieties of cotton. Polythene bags with 90.5% germination were the best storer, followed by aluminium bags and craft paper bags. Aluminium bags and polythene bags behaved at par for the seeds treated with 45% and 60% RH. Minimum decrease 14% in germination was observed in seeds stored in polythene bags after 60 days of storage in variety RG-8, which increased to 31% with 90% RH. Maximum vigour index 1326 was shown by the seeds of variety RS-810 stored in polythene bags. At 45% and 60% RH though polythene bags and aluminium bags retained better vigour content but at 75% and 90% RH, all the containers failed to retain the viability and vigour of seeds.

References

Abba J. and A. Lovato (1999). Effect of seed storage temperature and relative humidity on maize (*Zea mays* L.) seed viability

and vigour. *Seed Sci. & Technol*., **27** : 101-114.

Agboola, D. A. and E. O. Etejere (1991). Effect of relative humidity during seed storage on longevity of seeds of six forest tree species. *Nigerian Journal of Botany*, **4** : 23-32.

Aiazzi, M. T., J. A. Arguell, A. Perezo and C. A. Guzman (1996). Deferioration in *Artiplex cardobensis* (Gandoger et Suckert) seed : Natural and accelerated ageing. *Seed Sci. & Technol*., **25** : 147-155.

Abdul-Baki, A. A. and J. D. Anderson (1973). Vigour determination in soybean seed by multiple criteria. *Crop Sci*., **13** : 630-633.

Chandel, S. R. S. (2004). *A handbook of agricultural stastistics*. pp: B68-B97.

Dhakal, M. R. and A. K. Pandey (2001). Storage potential of niger (*Guizotia abyssinica* Cass.) seeds under ambient conditions. *Seed Sci. & Technol*., **29** : 205-213.

Dhawan, S. and R. S. Brar (2007). Effect of sulphurdioxide on vigour of gram varieties stored in different containers under various conditions of humidity. *Seed Res*., **35(2)** : 259-264.

Filho, J. M., A. D. C. November and H. M. C. P. Chamma (2001). Accelerated ageing and controlled deterioration seed vigour tests for soybean. *Sci. Agric*., **58** : 421-426.

Harrington, J. F. (1972). Seed Storage and Longevity. In: *Seed Biology (Physiological Ecology)* Kozlowskii, T.T.(ed). Academic Press Inc. N.Y. pp. 209-240.

ISTA (1993). International rules for Seed Testing. *Seed Sci. & Technol*. (suppl.), **21**: 1-288.

Jain, N., R. Koopar and S. Saxena (2006). Effect of accelerated ageing on seeds of radish (*Raphanus sativa* L.). *Asian Journal of Plant Sciences*, **5(3)** : 461-464.

Roberts, E. H. (1972). Storage environment and the control of viability. In : *Viability of seeds* (Ed: Roberts, E.H.) Chapman and Hall, London. pp. 14-58.

Roberts, E. H. and F. H. Abdalla (1968). The influence of temperature moisture and oxygen on period of seed viability in barley, broad beans and peas. *Annals of Botany*, **32** : 97-117.

Smith, R. D. (1992). Seed storage, temperature and relative humidity. *Seed Science Research*, **2** : 113-116.

Solomon, M. E. (1951). Control of humidity with Potassium hydroxide, Sulphuric Acid or other solutions. *Bulletin of Entomological Res*., **42** : 543-554.

Villiers, T. A. (1973). Aging and the longevity of seeds in field conditions. In: W. Heydecker, ed, *Seed Ecology*. Butterworths, London, pp 265-288.