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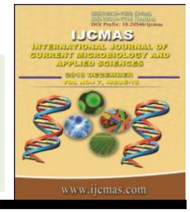

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Effect of Storage on Quality Parameters of Groundnut (*Arachis hypogaea* L.) Seed Lots

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A B S T R A C T

An experiment was conducted to assess the storability of groundnut (*Arachis hypogaea* L.) seed lots based on vigour tests during 2015-16. Nineteen seed lots with varying vigour levels based on different germination percentages were taken and replicated four times. The results indicated that seeds with higher vigour were able to retain the vigour for longer period (at the end of storage period of six months). The vigorous lots recorded higher quality parameters at the end of storage period. The electrical conductivity of seed lots increased with storage period however, the vigorous lots had lower EC values and visa versa for low vigorous lots. The root length, shoot length, seedling dry weight, protein content and oil content in general showed a declining trend. Lipase enzyme activity increased with passage of storage period.

Introduction

Storing seeds after harvest till the next cropping season without impairing the quality is of prime importance for successful seed production. Groundnut being an oil seed crop groundnut seed has short life and looses viability quickly under ambient conditions. Ageing in groundnut seed leads to increased lipid peroxidation, decreased activities of several free radical and peroxide scavenging enzymes (Rao *et al.,* 2006). Groundnut seeds are more sensitive to storage conditions like high temperature; high seed moisture content and light exposure.

The use of vigor tests by seed-producing industries, such as the determination of their physiological quality (Marcos-Filho, 1999) has been increasing. However, tests for vigor can select seed lots with similar germination percentages but different storage capacities (Carvalho and Nakagawa, 2000). The ability to obtain results quickly regarding quality of seeds has many advantages in various sectors of seed production, especially in pre-harvest, reception and processing stages, allowing quick decision making.

As differences in field emergence and storage potential cannot be clearly detected based on germination test, vigour test provides a sensitive index and helps to supplement the germination test to indicate storability. The present study was undertaken to assess the storability and deteriorative changes which result in loss of seed, the present study was undertaken.

Materials and Methods

Nineteen seed lots with different vigour levels based on varied germination percentages formed the nineteen treatments and the same were evaluated for their performance in storage with four replications at Seed Quality Research Laboratory, National Seed Project, University of Agricultural Sciences, Dharwad (2015-16). These seed lots were used to assess their vigour levels through vigour tests and simultaneously utilized for the storage studies to evaluate the performance of these seed lots. The observations on various seed quality parameters were recorded for a period of six months.

The germination test was conducted by employing between the paper method prescribed by ISTA (Anon., 2012) and observations on root and shoot length, seedling dry weight as per the procedure. The seedling vigour index was worked out as per the procedure prescribed by Abdul-Baki and Anderson (1973) and electrical conductivity was assessed as per Parsely, 1958. Oil content and protein content was recorded bi-monthly by Near Infrared (NIR) machine and expressed as percentage by weight basis and lipase activity was estimated by titrimetric method of Malik *et al.*, 2000. The mean data obtained from the experimentation was statistically analysed and subjected to the Analysis of variance by adopting appropriate statistical methods as outlined by Panse and Sukhatme (1985) and Sundararaj *et al.*, (1972). The critical differences were calculated at one percent level of probability wherever 'F' test was significant. The percentage data of germination were transformed into arc sine root transformation before analysis.

Results and Discussion

During storage studies, bi-monthly observations on germination, shoot length, root length, vigour index, electrical conductivity of seed leachates, protein, oil content and lipase activity were recorded. The qualitative loss of seed can be attributed to biochemical changes in oil content, protein and fatty acids (Yadav *et al.*, 2014). The rate of ageing mainly depends on genotype, moisture and temperature. In rapid and slow ageing (natural ageing), the pattern of deterioration preceding the death is the same whether seed survives for few hours or decades. Irrespective of seed lots, seed quality parameters differed significantly due to seed source throughout the six months of storage period. The seed quality parameters showed significant difference due to differences in age of the seed lots. Overall, there was a decline in germination (%), seedling vigour index, protein content (%) and oil content (%). However, an increase in lipase activity and electrical conductivity was found with enhanced period of storage. The results of storage studies are discussed below.

Germination (%) in general declined (Table 1) from initial month of storage till the end of storage period (sixth month). Among all, lot 4 recorded highest germination of 96.5 per cent initially and 53 per cent at the end of storage period followed by lot 16 which recorded 91.5 per cent and 32.75 per cent at the end of 6 months of storage. However, lot 5 which recorded germination of 90.5 per cent initially maintained highest germination of 60.5 per cent at the end of storage period with a reduction of 19.87 per cent at the end of storage period and was more vigorous among all the lots. Meena *et al.,* (2017) found that quality parameters viz., germination percentage, root length, shoot length, seedling vigour index and seedling dry weight decreases with advancement of storage period. Results of this study are in agreement with the findings of El-Keblawy (2003) and Basra *et al*., (2003). Decrease in germination percentage was related to reduction in seed vigour further resulted in the production of abnormal seedlings. The possible reason of this reduction might be the lowering of biochemical activities in seeds. Ageing have damaging effect on enzymes that are necessary to convert complex reserve food in the embryo to simple usable form and ultimately production of normal seedling.

The shoot length, root length and seedling dry weight in general declined from initial month to final month of storage period (Table 1 and 2). The seedling vigour index also declined with the increase in storage period (Table 3). Among all, lot 4 recorded highest seedling vigour index of 2846 initially and 1445 at the end of storage period followed by lot 19 which recorded 2568 initially and 919 at the end of six months of storage. However, lot 5 was able to maintain highest seedling vigour index (2551) at the end of storage period (1661) with a reduction of 17.34 per cent. The lowest initial seedling vigour index of 1012 was recorded by lot 9 which reduced to 40 after six months of storage. Lot 1 with initial seedling vigour index of 1561 recorded the lowest seedling vigour index of 29 among the seed lots at the end of storage period followed by lot 11 with initial and final seedling vigour index value *i.e*. 1676 and 35 respectively. In general, the vigorous lots with high germination (%) had higher seedling vigour index at the end of storage month and vice-versa. The results obtained in this study show that seed aging results in reduced seedling growth and this is a consequence of decline in weight of mobilized seed reserve (seed reserve depletion percentage). Similar results were found by Mohammadi *et al*., (2011) in soybean who reported significant decrease in seedling growth and the fraction of seed reserve mobilization with the advancement of deterioration.

The electrical conductivity of seed leachate indicates membrane integrity and quality of seed and it was negatively correlated with seed quality. The present study, evidently implicated a progressive increase in electrical conductivity of seed leachates during storage period. Among all, lot 9 recorded highest electrical conductivity of 0.358 dSm^{-1} initially and 0.743 dSm^{-1} at the end of storage period followed by lot 6 which recorded 0.188 dSm^{-1} initially and 0.628 dSm^{-1} at the end of six months of storage. Lot 5 recorded lowest electrical conductivity of 0.063 dSm^{-1} initially and 0.338 dSm^{-1} at the end of storage period followed by lot 4 with initial electrical conductivity of 0.065 dSm^{-1} and 0.283 dSm^{-1} at the end of six months of storage which was lowest followed by lot 15 which recorded electrical conductivity of 0.158 dSm^{-1} initially and 0.303 dSm^{-1} at the end of storage period. The average electrical conductivity was 0.148 dSm^{-1} during initial period of storage which enhanced to 0.459 dSm^{-1} at the end of storage period indicating increased permeability of membrane. In general high vigorous seed lots with higher germination (%) have lower electrical conductivity than the low vigorous lots with low germination (%) at the end of storage period (Table 3). Seed ageing results in loss of germination and vigor of old seeds which may be related to accumulation of deleterious effects on membranes due to oxidative damages to fatty acids and protein denaturation as a result of maillard reactions (Narayana Murthy and Sun, 2000). Natural ageing of the seeds, increases membrane permeability and seed borne mycoflora, resulting in increased electrical conductivity of seed leachates (Vasudevan *et al*., 2014).

Table.1 Effect of vigour levels on germination percentage of groundnut during storage of groundnut (GPBD-4) variety

Seed lots	Germination (%)				Shoot length (cm)			
	Initial month	2 Month	4 Month	6 Month	Initial month	2 Month	4 Month	6 Month
L_1	62.00 (51.94)*	29.00 (32.56)	6.50 (14.75)	1.50 (5.12)	10.25	10.51	8.67	3.82
L_2	86.50 (68.45)	83.50 (66.49)	63.00 (52.52)	40.50(39.51)	11.10	10.60	11.83	10.98
L_3	74.00 (59.33)	60.00 (50.76)	30.00 (33.19)	19.50 (26.16)	10.61	11.35	10.55	10.35
L_4	96.50 (79.47)	85.00 (67.24)	66.00 (54.32)	53.00 (46.70)	12.00	11.51	11.68	11.00
L_5	90.50 (72.14)	88.50 (70.27)	84.50 (67.05)	60.50 (51.04)	11.93	11.26	12.82	11.53
L_6	58.50 (49.90)	17.75 (24.88)	10.00 (18.43)	3.00 (9.83)	10.88	10.55	10.57	7.77
L_7	73.50 (59.00)	56.50 (48.73)	28.00 (31.93)	21.50 (27.61)	10.99	10.87	10.79	10.90
L_8	88.50 (70.19)	57.00 (49.01)	38.00 (38.03)	27.50 (31.61)	11.16	11.22	11.40	10.26
L_9	39.50 (38.92)	18.50 (25.43)	7.50 (15.80)	2.00 (7.05)	10.91	9.85	9.38	6.50
L_{10}	73.50 (59.03)	52.00 (46.13)	12.50 (20.65)	5.54 (13.47)	11.69	11.87	11.22	10.78
L_{11}	60.00 (50.76)	33.00 (35.00)	9.50 (17.89)	1.50 (5.12)	11.21	11.59	10.47	5.22
L_{12}	52.50 (46.42)	27.50 (31.61)	13.50 (21.53)	6.5 (14.58)	11.54	10.84	10.44	10.40
L_{13}	65.00 (53.73)	63.00 (52.52)	19.00 (25.82)	10.50 (18.89)	11.68	11.38	11.72	10.86
L_{14}	80.50 (63.81)	73.50 (59.03)	37.00 (37.43)	21.5 (27.61)	10.49	10.51	10.68	10.42
L_{15}	80.00 (63.50)	85.00 (67.24)	54.50 (47.57)	43.00 (40.96)	10.73	10.78	10.44	10.80
L_{16}	91.50 (73.05)	74.50 (59.70)	43.50 (41.24)	32.75 (34.89)	10.03	10.54	10.73	10.45
L_{17}	77.50 (61.69)	62.00 (51.92)	40.00 (39.21)	30.00 (33.18)	11.25	10.98	10.95	10.86
L_{18}	68.00 (55.58)	36.50 (37.15)	24.50 (29.64)	14.50 (22.36)	10.56	11.07	10.27	10.40
L_{19}	88.50 (70.19)	74.50 (59.67)	52.50 (46.42)	34.50 (35.95)	11.59	11.28	12.49	11.03
Mean	**74.03 (60.37)**	**56.83 (49.33)**	**33.68 (34.39)**	**22.59 (25.88)**	**11.08**	**10.98**	**10.90**	**9.70**
SEm±	**1.10**	**1.16**	**0.90**	**1.22**	**0.27**	**0.36**	**0.36**	**1.07**
CD (0.01)	**4.14**	**4.36**	**3.41**	**4.61**	**1.02**	**1.37**	**1.34**	**4.02**

Table.2 Effect of vigour levels on root length and seedling dry weight of groundnut (GPBD-4) variety during storage

Seed lots	Root length (cm)				Seedling dry weight (mg)			
	Initial month	**2 Month**	**4 Month**	**6 Month**	**Initial month**	**2 Month**	**4 Month**	**6 Month**
L_1	14.90	14.50	12.61	5.85	28.56	28.21	19.89	6.61
L_2	16.25	17.07	16.58	15.53	31.62	31.82	32.59	29.60
L_3	16.49	17.58	16.03	14.58	28.68	29.39	28.80	25.88
L_4	17.50	18.11	17.20	16.25	31.85	31.98	30.59	29.50
L_5	16.28	16.02	16.79	15.92	32.38	30.19	33.78	31.38
L_6	16.56	16.17	13.26	9.29	31.90	30.47	22.45	14.58
L_7	14.48	15.35	14.83	14.50	29.69	30.09	30.63	29.78
L_8	15.94	15.53	14.97	14.82	28.05	27.48	27.53	26.28
L_9	14.74	15.22	11.81	8.05	27.17	26.09	15.50	9.29
L_{10}	15.44	15.87	14.95	14.47	29.65	29.03	26.31	15.71
L_{11}	16.69	17.36	13.91	6.69	29.76	28.13	23.87	6.81
L_{12}	16.88	16.46	15.46	12.91	31.76	29.55	21.64	20.71
L_{13}	16.90	17.43	15.92	15.15	32.79	31.46	25.16	25.01
L_{14}	16.46	16.35	16.26	15.74	32.49	30.57	31.07	30.24
L_{15}	16.58	16.36	16.19	15.71	31.38	29.63	32.33	31.29
L_{16}	15.63	14.83	15.53	15.08	29.89	28.61	31.05	29.10
L_{17}	16.71	17.85	16.21	14.76	29.11	30.49	30.08	27.94
L_{18}	16.05	16.11	16.08	15.43	27.89	28.16	27.88	26.08
L_{19}	17.43	16.90	15.81	15.61	28.48	27.39	27.14	25.99
Mean	**16.20**	**16.37**	**15.28**	**13.49**	**30.16**	**29.41**	**27.28**	**23.25**
SEm±	**0.40**	**0.41**	**0.43**	**1.41**	**0.71**	**0.59**	**0.47**	**1.60**
CD (0.01)	**1.51**	**1.53**	**1.62**	**5.31**	**2.66**	**2.21**	**1.77**	**6.02**

Table.3 Effect of vigour levels on seedling vigour index and electrical conductivity of groundnut (GPBD-4) variety during storage

Seed lots	Seedling vigour index				Electrical Conductivity (dSm^{-1})			
	Initial month	2 Month	4 Month	6 Month	Initial month	2 Month	4 Month	6 Month
L_1	1561	727	138	29	0.160	0.213	0.505	0.608
L_2	2364	2310	1790	1072	0.093	0.110	0.220	0.338
L_3	2005	1740	796	486	0.150	0.180	0.260	0.308
L_4	2846	2516	1906	1445	0.065	0.095	0.248	0.283
L_5	2551	2412	2502	1661	0.063	0.078	0.358	0.338
L_6	1603	474	238	51	0.188	0.235	0.568	0.628
L_7	1870	1482	717	547	0.100	0.105	0.388	0.420
L_8	2399	1523	1001	690	0.173	0.243	0.535	0.543
L_9	1012	465	156	40	0.358	0.478	0.708	0.743
L_{10}	1994	1442	328	137	0.115	0.160	0.490	0.523
L_{11}	1676	952	230	35	0.215	0.255	0.450	0.510
L_{12}	1494	752	349	151	0.195	0.265	0.593	0.630
L_{13}	1857	1813	526	273	0.138	0.180	0.410	0.470
L_{14}	2170	1973	993	561	0.170	0.198	0.260	0.323
L_{15}	2183	2306	1453	1139	0.158	0.180	0.218	0.303
L_{16}	2347	1891	1143	836	0.070	0.105	0.283	0.383
L_{17}	2168	1788	1086	768	0.175	0.180	0.383	0.405
L_{18}	1812	993	647	373	0.135	0.255	0.543	0.603
L_{19}	2568	2100	1486	919	0.103	0.193	0.330	0.378
Mean	**2025.40**	**1560.26**	**920.30**	**590.28**	**0.148**	**0.195**	**0.408**	**0.459**
SEm±	**60.12**	**57.72**	**39.55**	**23.27**	**0.004**	**0.004**	**0.008**	**0.012**
CD (0.01)	**226.58**	**217.51**	**149.04**	**87.70**	**0.015**	**0.015**	**0.030**	**0.046**

Table.4 Effect of vigour levels on protein content (%) and oil content (%) of groundnut (GPBD-4) variety during storage

Seed lots	Protein content (%)				Oil content (%)			
	Initial month	2 Month	4 Month	6 Month	Initial month	2 Month	4 Month	6 Month
L_1	34.18	32.02	32.67	32.31	48.00	47.71	47.72	47.40
L_2	32.59	32.36	31.21	31.15	48.91	48.62	48.47	48.82
L_3	32.84	32.12	30.29	30.51	48.84	48.10	47.88	47.67
L_4	32.59	32.36	31.51	30.23	49.31	48.54	48.30	47.97
L_5	32.76	30.72	29.61	29.81	48.18	47.71	47.58	47.37
L_6	32.95	30.09	30.19	29.30	48.76	47.57	46.85	46.72
L_7	32.95	30.40	29.26	29.23	48.59	47.91	47.27	47.19
L_8	32.83	32.41	30.70	30.07	50.75	49.86	48.51	48.29
L_9	32.53	31.06	29.93	30.68	49.84	49.40	49.81	48.17
L_{10}	32.63	31.24	29.71	29.88	48.94	47.82	47.47	47.40
L_{11}	33.35	31.24	30.92	30.82	50.39	50.36	49.71	47.41
L_{12}	34.82	34.67	31.61	31.97	49.03	48.87	45.99	48.52
L_{13}	31.53	31.05	29.84	29.83	48.09	48.86	48.20	47.85
L_{14}	32.54	32.24	31.17	30.92	51.47	49.19	50.72	48.67
L_{15}	31.51	31.21	30.55	29.75	49.78	47.17	46.88	48.08
L_{16}	31.01	30.13	29.66	28.95	47.21	46.80	45.23	46.90
L_{17}	34.53	32.31	31.83	30.26	47.39	46.90	45.61	47.10
L_{18}	32.77	31.24	31.02	31.28	50.11	48.41	49.24	47.29
L_{19}	31.81	31.97	30.71	30.73	49.45	48.85	48.60	47.88
Mean	**32.78**	**31.62**	**30.65**	**30.40**	**49.11**	**48.35**	**47.90**	**47.72**
SEm±	**0.70**	**0.65**	**0.67**	**0.75**	**0.65**	**0.62**	**0.75**	**0.59**
CD (0.01)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

*NS: Non-significant

Table.5 Effect of vigour levels on lipase activity of groundnut (GPBD-4) variety during storage

Seed lots	Lipase activity (µ moles/min)			
	Initial month	2 Month	4 Month	6 Month
L_1	4.31	6.25	6.44	6.31
L_2	4.06	5.25	5.44	5.75
L_3	5.06	6.06	6.25	6.56
L_4	3.63	4.88	5.13	5.31
L_5	4.25	5.75	5.81	6.00
L_6	5.31	6.92	6.06	6.44
L_7	4.25	5.25	5.75	5.88
L_8	3.88	5.38	5.81	6.00
L_9	4.73	5.73	6.38	6.88
L_{10}	4.38	5.13	5.63	5.88
L_{11}	4.13	5.63	5.50	6.50
L_{12}	4.75	5.75	5.48	5.50
L_{13}	4.81	5.31	5.81	5.94
L_{14}	4.69	5.19	5.81	6.13
L_{15}	4.63	5.63	5.50	6.50
L_{16}	4.67	5.88	5.63	6.50
L_{17}	4.88	5.38	5.69	6.00
L_{18}	4.50	5.50	5.94	6.19
L_{19}	4.25	5.25	5.69	6.13
Mean	**4.42**	**5.49**	**5.78**	**6.13**
SEm±	**0.56**	**0.49**	**0.26**	**0.39**
CD (0.01)	**NS**	**NS**	**NS**	**NS**

*NS: Non-significant

The smallest electrical conductivity values, corresponding to the smallest exudates liberation, indicate high physiological potential (larger vigor), which indicates a smaller disorder intensity in the cell membrane systems (Vieira *et al*., 2002).

The protein content (%) reduced with advancement in storage of seed lots (Table 4). There was no significant difference among the seed lots for protein content. However, the mean protein content decreased from 32.78 per cent to 30.40 per cent. The decrease in protein content was observed as ageing advances. The results of the study were in agreement with Narayanamurthy *et al.*, (2002). Protein deterioration was mainly due to condensation, rearrangement, fragmentation, strecker degradation and polymerization. Tatipata (2009) studied the effect of storage period on inner membrane of mitochondria in soybean seeds. Increase in phospholipase activity was observed resulting in hydrolysis of phospholipids thus decreasing the content of phospholipids in the membranes. This event causes disorganization of membrane, so loss of membrane integrity or loss of selective permeability. The loss of phospholipids membrane content may change the shape of proteins embedded in the lipid bilayer of the membrane which might be attributed to reduction in protein content.

The oil content (%) reduced with the advancement in storage of seed lots (Table 4). There was no significant difference among the seed lots for oil content. However, the mean oil content decreased from 49.11 per cent to 47.72 per cent. It is observed that oxidation of lipids and increase in content of free fatty acids during the storage period are the main causes of the fast deterioration of seeds of oil-seed crops, such as the sunflower seeds (Balesevic-Tubic *et al.*, 2007). Decrease of seed quality is connected with bio-chemical changes in seeds of oil crops. These seeds had a quick deterioration due to auto oxidation of lipids and the increase of the content of free fatty acids during storage period.

The lipase activity (µmoles min^{-1}) increased with advancement in storage period of seed lots (Table 5). There was no significant difference among the seed lots for lipase however the mean lipase activity increased from 4.42 µmoles min^{-1} to 6.13 µmoles min^{-1}. Decrease of seed quality was connected with bio-chemical changes in seeds of oil crops. These seeds had a quick deterioration due to auto oxidation of lipids and the increase of the content of free fatty acids during storage period (Kandil, *et al*., 2013). Lipase enzyme which is produced abundantly in oil seeds during storage which breaks down the lipid into free fatty acid. The activity of lipase enzyme increased during storage from 0.231 to 0.236 (meq $min^{-1}g^{-1}$ of sample). It might be due to the secretion of fungal lipase of the storage fungi which increased the rate of lipid degradation (Junaithal Begum *et al*., 2014)

From the results of these investigations, it could be concluded that the seed lots which had higher vigour were able to maintain their storability for longer duration and retain higher quality parameters than low vigour seed lots.

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