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B Lohitha
Ph.D Scholar, Department of
Seed Science and Technology
Bidhan Chandra Krishi
Viswavidyalaya, Mohanpur,
Nadia, West Bengal, India

A Dutta
Associate Professor,
Department of Seed Science
and Technology
Bidhan Chandra Krishi
Viswavidyalaya, Mohanpur,
Nadia, West Bengal, India

Effect of storage containers and storage period on physio-biochemical changes in wheat (*Triticum aestivum* L.) varieties

B Lohitha and A Dutta

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Abstract

The quality of seed is the most important factor in improving crop yields. Under favourable weather conditions and management practices, seed yield may decrease upto 10% due to use of poor quality seeds. Therefore, seeds should be maintained properly using appropriate storage containers for next season sowing. Hence, an experiment was conducted to study the effect of storage containers and storage period and to determine the pattern of seed deterioration throughout the storage period on wheat genotypes. Seeds of two varieties namely NADI#1 (V1) and DBW 303 (V2) were stored in containers like earthen pots, cloth bags and polythene bags for a storage period of 8 months. The design of experiment was Factorial Completely Randomized Design (FCRD) replicated thrice with three factors, comprising container as first factor, period of storage as second factor and variety as third factor. Seeds stored in polythene bag (C3) recorded highest mean value followed by earthen pot (C1) and cloth bag (C2). During both first and second year, NADI#1 (V1) recorded the higher germination percentage (92.71 and 92.30), seedling length (24.78 and 25.17 cm), vigour index-I (2302.25 and 2327.88), soluble protein content (11.00 and 10.84 mg g⁻¹), α - amylase activity (0.392 and 0.415 μ mol min⁻¹) and peroxidase activity (4.24 and 4.14 μ mol min⁻¹) as compared to DBW 303 (V2). NADI#1 (V1) showed minimum values of electrical conductivity (58.91 and 55.00 μ S cm⁻¹g⁻¹ during first and second year respectively) for seeds that were stored in polythene bag (C3). All the physiological and biochemical parameters showed decreasing pattern throughout the storage period (P1 to P5) except electrical conductivity activity which showed increasing trend in both the varieties in all three containers. The deterioration trend was rapid in cloth bag but slower in polythene bag owing to its moisture impervious nature. Therefore, wheat seeds are best stored under polythene bag with germination value (>85%) even upto P5 compared to cloth bag.

Keywords: Seed quality, wheat genotypes, storage containers, seed deterioration, polythene bags

Introduction

Cereals are the main source of energy for the majority of global population and hold a significant role in human nutrition as agricultural products. Marketing companies and traders maintain cereals for profit, whereas farmers store them mainly as seed for sowing and other purposes. Food grains are often kept by government organizations in order to maintain domestic food safety, market price stability and supply stability, as well as to generate income through exports. Therefore, fundamental elements of economic and policy considerations are the shifting storage dynamics in terms of quality maintenance and losses [1]. The quality of seeds depends upon its storage in appropriate storage structures till the following growing season which determines the amount of agricultural yield. Furthermore, suitable seed storage requires seed drying to a desired moisture content [2], seed packing, protection from rain [3], dust, snow, rodents [4], and insects [5], as well as protection from pathogens are crucial. In general seed deterioration starts from the field or can occur due to damage during harvesting or drying of seed, such that poor quality seed often placed under storage. The quality is further reduced when stored in poor ventilated, damp conditions and in moisture prone structures. Hence the initial quality of the seed is an important parameter to be considered before storing of the seed. Farmers and seed companies in general store seed under conditions of open storage. Based on findings [7], it is important to know how long propagation material could survive while retaining high germination (>85% in case of wheat). Loss of viability is linked with long-term seed storage.

Corresponding Author:
B Lohitha
Ph.D Scholar, Department of
Seed Science and Technology
Bidhan Chandra Krishi
Viswavidyalaya, Mohanpur,
Nadia, West Bengal, India

Proper management of seeds during storage period can maintain seed quality and enhance yield of crop. Due to serious constraints in food production, the issue of food insecurity in emerging nations continues to be a major concern. On the other hand, farmers grow crops either for consumption or commercial purpose, but their lack of knowledge about storage of seed impacts agricultural crop productivity particularly in less developed nations of the world [10].

The problem of seed insecurity has been experienced by rural farmers due to inadequate storage facilities and improper seed storage techniques. Poor germination from improper seed storage might result in a 10% reduction in seed quality [14, 15]. Farmers in India still rely on some conventional storage structures with minor modifications like bamboo structures, mud and earthen structures, gunny bags, structures with polythene lining, wooden and underground structures [22]. Also, farmers of Nepal depend on number of practices for storing wheat seed, including storing them in mud bins, polythene bags, reused fertilizer bags, and domestic metal containers [16]. Further, if farmers frequently monitor and dry their seed periodically during storage, they can preserve the seed quality even under conventional storage structures in high-temperature and low-rainfall areas to some extent [16]. In this regard, it is important to access farmers knowledge of traditional seed storage practices which are reliable, affordable and are suitable for storing seed to some extent until next season. Packing of seed in hermetically sealed or moisture-proof containers is an important condition for safe storage. These containers were meant to keep seeds at a safe moisture level for storage. Storing seed in containers such as cloth bags, mud pots and ordinary paper gives least storage effectiveness. However, a variety of polyethylene and laminate materials performed moderately well in storage. Hence, storing the seed in completely moisture resistant containers hermetically store the seed that allow the seed for long term storage. Other packing materials efficacy was directly correlated with their capacity to withstand moisture [6]. Therefore, this study was established to investigate the effect of storage containers and storage period on wheat seed quality in terms of physiological and biochemical aspects.

Materials and Methods

The present study was conducted in the laboratory of Department of Seed Science and Technology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, West Bengal. Seeds after harvesting before storage were shade dried until the moisture brought upto 12% and stored for 0,2,4,6 and 8 months separately in three different containers such as earthen pot, cloth bag and polythene bag under ambient conditions and periodically data related to physiological and biochemical seed parameters were taken with 3 replications each with 2 months interval. Physiological parameters like germination (%), seedling length (cm), vigour index-I, and biochemical parameters like total soluble protein content (mg g^{-1}), peroxidase activity ($\mu\text{mol min}^{-1}$), α - amylase activity ($\mu\text{mol min}^{-1}$), electrical conductivity ($\mu\text{S cm}^{-1}\text{g}^{-1}$) were recorded. The design of experiment was Completely Randomized Design with three factor analysis comprising storage container as first factor and storage period as second factor while third factor consists of two varieties namely NADI#1 from CIMMYT, Mexico through AICRP on wheat and barley and DBW 303 (Karan Vaishnavi), biofortified variety from N-W

plain zone. Mean value data of different parameters for first and second year were considered for statistical analysis using OPSTAT computer programming [13] developed by CCS HAU, Hisar.

Results and Discussion

Effect of storage containers on wheat varieties

Physiological characters like germination percent, seedling length, and vigour index-I which not only determine the seed longevity throughout the storage period but also estimate the success of their establishment in the field after storage. The effect of storage containers on all parameters significantly differed for all the parameters. The highest mean values for germination percentage (92.71% and 92.30%), seedling length (24.78 cm and 25.17 cm) and vigour index-I (2302.25 and 2327.88) was observed under polythene bag (C3) in both the varieties during both the years. It was followed by earthen pot with germination percentage (90.5% and 89.96%), seedling length (24.36 and 24.65 cm) and vigour index-I (2,201.29 and 2,225.85). Least values were observed for seeds that were stored in cloth bag during both the years.

Biochemical changes starts immediately after harvest. It is accelerated during storage conditions due to unfavourable conditions. Additionally, the biochemical composition differs greatly among wheat cultivars and the predicted physiochemical shifts occur throughout the storage period [17]. The biochemical parameters as shown in table no. 1 and 2, revealed highest values for different biochemical parameters for the seeds that were stored in polythene bag and least values for seeds that were stored in cloth bag and except for electrical conductivity. The soluble protein content may vary according to variety. There was a significant variation due to container for the parameter where total soluble protein content was highest for seeds stored in polythene bag (11.00 and 10.84 mg g^{-1}) and lowest values in cloth bag (8.53 and 9.43 mg g^{-1}) in both years. The parameter α -amylase is an important parameter to predict the process of germination in cereal crops because α -amylase in the aleurone layer responsible for conversion of endosperm starch into sugars, providing energy for root and shoot growth, thus effecting in good plant growth [24]. The mean α -amylase content was found higher for seeds stored in polythene bag (0.392 and 0.415 $\mu\text{mol min}^{-1}$ in first and second year respectively) indicating less seed deterioration as compared to other two containers. There was significant variation between containers during both the years except earthen pot and cloth bag in first year and earthen pot and polythene bag during second year. The activity of all antioxidant enzymes declines owing to the process of seed aging [19, 20]. Seeds stored under polythene bag recorded highest peroxidase activity (4.24 and 4.14 $\mu\text{mol min}^{-1}$ in first and second year respectively) compared to other two containers with a significant deviation between containers, indicating lesser deterioration of seeds stored in polythene bag [21]. A quick test to determine seed quality is by testing the electrical conductivity. Higher the electrical conductivity higher is the seed deterioration. This is because seed deterioration causes the cell membrane to degrade leading to leakage of cell constituents that results in electrolytes losses. Seeds stored in cloth bag showed peak values in E.C (68.68 in first year and 63.88 $\mu\text{S cm}^{-1}\text{g}^{-1}$ in second year) due to its moisture impervious nature which damage the seeds faster whereas seeds stored under polythene bag showed lower values in E.C (58.91 in first year and 55.00 $\mu\text{S cm}^{-1}\text{g}^{-1}$ in

second year). The moisture impervious nature of polythene bag allowed seed to deteriorate lesser than other two containers which are moisture pervious in nature that maintained high moisture content in seeds. Seeds stored in cloth bag showed rapid deterioration due to decreased respiration rate that ultimately reduced the metabolism of seed leading to reduced seed vigour and biochemical activity at the end of storage period.

Effect storage period on wheat varieties

The seed quality parameters recorded in P1 (immediately after harvesting) in both the varieties showed higher values. The rate of deterioration of seed seem to be in an increasing trend and the recordings seem to be in decreasing pattern observed from P1 (0 month) to P5 (eight months) and a notable variation observed between storage periods in both the years for germination percent. From P1 to P5, showed reducing trend in all the physiological parameters like germination percent, seedling length and vigour index-I. Throughout eight months of duration in both the years, V1 (81.50% and 81.19) maintained the minimum standard germination percent until 8th month of storage (D5) while V2 (78.06% and 77.52%) maintained less than the minimum standard germination percent concluding better performance of V1 over V2 in germination percent. The seedling length displayed highest recorded value at the end of D5 for variety V1 (19.68 and 20.23 cm during first and second year respectively). Similarly, Seed vigour showed higher values for V1 (1,655.45 and 1692.60 during both the years) at the end of storage duration (D5).

The soluble protein content, α - amylase values too seem to

reduce throughout the eight months storage period as depicted in table no. 1. The soluble protein content mean values recorded highest during P1 (11.80 and 10.83 mg g⁻¹ during first and second year) and lowest during P5 (7.81 and 8.45 mg g⁻¹ during first and second year) whereas the peroxidase values seem to as shown in table 2, spike up until P2 (4.49 and 4.41 $\mu\text{mol min}^{-1}$) and gradually lowering its values until P5 (3.38 and 3.30 $\mu\text{mol min}^{-1}$) from P3 onwards. Since peroxidase enzymes eradicate H₂O₂ and free radicals, it protects seeds against deterioration during storage duration [12, 18] and hence the activity seem to spike rapidly until P2 and then as seed deterioration increases rapidly, its activity declines until P5 shows lower defense action. The mean of storage periods in case of Electrical conductivity as shown in table 2, recorded an increasing pattern from P1 to P5 (36.33 to 130.79 $\mu\text{S cm}^{-1}\text{g}^{-1}$ in first year and 34.60 to 117.10 $\mu\text{S cm}^{-1}\text{g}^{-1}$ in the second year) indicating higher deterioration rate of seed. With the increase in storage duration, the seed cell membranes and cell organelles undergo damage that ultimately lead to accelerated seed degradation and cell leachates that contribute to higher values of electrical conductivity. Less vigour seeds discharge more leachates, which results in a higher E.C. value [19]. Since vigour and germination are inversely proportional to E.C [23] and thus, the values of E.C were higher at P5 stage, whereas the germination and vigour seem to have reduced values. In case of all the biochemical parameters, the recordings showed higher values in case of V1 compared to V2, making V1 as superior performer over V2 throughout eight months.

Table 1: Effect of containers and storage duration on Physiological parameters of wheat genotypes

	Germination (%)						Seedling Length(cm)						Vigour Index						
	First year			Second year			First year			Second year			First year			Second year			
Container	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	
C1	P1	96.53	93.53	95.03	95.90	93.8	94.85	27.14	26.36	26.75	27.78	26.62	27.20	2,619.20	2,465.35	2,542.28	2664.61	2497.27	2580.94
	P2	94.80	91.83	93.32	95.00	91.27	93.13	25.2	24.85	25.03	26.23	24.69	25.46	2,389.04	2,281.79	2,335.42	2492.11	2253.02	2372.56
	P3	91.90	89.17	90.18	90.62	89.43	90.03	28.1	23.37	25.74	29.03	23.13	26.08	2,563.61	2,083.69	2,323.65	2630.42	2068.97	2349.69
	P4	87.24	86.03	86.64	87.51	85.63	86.57	23.73	23.46	23.60	24.83	23.24	24.04	2,070.06	2,018.18	2,044.12	2173.53	1989.83	2081.68
	P5	85.50	84.67	85.08	85.80	84.60	85.20	22.68	18.7	20.69	22.80	18.11	20.46	1,938.46	1,583.52	1,760.99	1956.59	1532.12	1744.35
C2	P1	96.53	93.53	95.03	95.90	93.80	94.85	27.14	26.36	26.75	27.78	26.62	27.20	2,619.20	2,465.35	2,542.28	2664.61	2497.27	2580.94
	P2	90.94	88.47	89.70	91.50	88.57	90.03	26.11	23.23	24.67	26.48	23.37	24.93	2,373.82	2,055.12	2,214.47	2422.62	2070.09	2246.35
	P3	78.37	78.00	78.19	78.00	77.27	77.63	21.96	20.8	21.38	22.97	22.40	22.68	1,721.69	1,621.07	1,671.38	1791.66	1730.88	1761.27
	P4	66.40	75.80	71.10	65.93	74.37	70.15	17.62	14.43	16.03	18.59	15.13	16.86	1,170.67	1,095.31	1,132.99	1225.90	1126.24	1176.07
	P5	68.53	61.17	64.85	68.13	60.07	64.10	11.98	7.84	9.91	12.80	10.25	11.53	822.23	480.417	651.32	871.87	615.57	743.72
C3	P1	96.53	93.53	95.03	95.90	93.80	94.85	27.14	26.36	26.75	26.72	26.62	26.67	2,619.20	2,465.35	2,542.28	2664.61	2497.27	2580.94
	P2	94.97	92.67	93.82	94.80	92.90	93.85	25.83	26.4	26.12	26.53	26.44	26.49	2,453.30	2,446.61	2,449.96	2515.33	2456.04	2485.68
	P3	95.10	92.00	93.55	94.27	91.90	93.08	26.65	24.83	25.74	27.44	24.65	26.05	2,534.73	2,284.05	2,409.39	2587.00	2265.10	2426.05
	P4	92.87	90.67	91.77	91.97	89.90	90.93	26.08	20.41	23.25	26.71	20.77	23.74	2,422.58	1,850.61	2,136.60	2456.13	1866.98	2161.56
	P5	90.45	88.33	89.39	89.63	87.90	88.76	24.39	19.7	22.05	25.10	20.74	22.92	2,205.66	1,740.44	1,973.05	2249.33	1822.86	2036.09
Interactions																			
Varieties	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	V1	V2	Mean	
Container																			
C1	91.05	89.05	90.05	90.97	88.95	89.96	25.37	23.35	24.36	26.14	23.16	24.65	2,316.07	2,086.51	2,201.29	2,383.45	2,068.24	2,225.85	
C2	80.15	79.39	79.77	79.89	78.81	79.35	20.96	18.53	19.75	21.72	19.56	20.64	1,741.52	1,543.46	1,642.49	1,795.33	1,608.01	1,701.67	
C3	93.98	91.44	92.71	93.31	91.28	92.30	26.02	23.54	24.78	26.50	23.84	25.17	2,447.09	2,157.41	2,302.25	2,474.11	2,181.65	2,327.88	
P1	96.53	93.53	95.03	95.90	93.80	94.85	27.14	26.36	26.75	27.43	26.62	27.03	2,619.20	2,465.35	2,542.28	2,630.65	2,497.27	2,563.96	
P2	93.57	90.99	92.28	93.77	90.91	92.34	25.71	24.83	25.27	26.41	24.83	25.62	2,405.39	2,261.17	2,333.28	2,476.68	2,259.72	2,368.20	
P3	88.22	86.39	87.30	87.63	86.20	86.91	25.57	23.00	24.29	26.48	23.39	24.94	2,273.34	1,996.27	2,134.81	2,336.36	2,021.65	2,179.00	
P4	82.17	84.17	83.17	81.80	83.30	82.55	22.48	19.43	20.96	23.38	19.71	21.55	1,887.77	1,654.70	1,771.24	1,951.85	1,661.02	1,806.44	
P5	81.50	78.06	79.78	81.19	77.52	79.35	19.68	15.41	17.55	20.23	16.37	18.30	1,655.45	1,268.13	1,461.79	1,692.60	1,323.52	1,508.06	
Mean(V)	88.40	86.63		88.06	86.35		24.12	21.81		24.79	22.19		2168.23	1929.13		2217.63	1952.63		
Mean	SEm	CD		SEm	CD		SEm(±)	CD		SEm	CD		SEm	CD		SEm	CD		
	(±)	(P=0.05)		(±)	(P=0.05)			(P=0.05)		(±)	(P=0.05)		(±)	(P=0.05)		(±)	(P=0.05)		
Container (C)	0.21	0.60		0.13	0.35		0.16	0.46		0.13	0.37		14.62	41.38		12.54	35.47		
Period (P)	0.27	0.77		0.16	0.46		0.21	0.60		0.17	0.48		18.88	53.42		16.18	45.79		
Varieties (V)	0.17	0.59		0.10	0.29		0.13	0.38		0.11	0.31		11.94	33.78		10.23	28.96		
C X P	0.47	1.33		0.28	0.79		0.37	1.03		0.30	0.84		32.69	92.52		28.03	79.30		
C X V	0.30	0.84		0.18	0.50		0.23	N.S		0.19	N.S		20.68	N.S		17.73	50.16		
P X V	0.39	1.09		0.23	0.65		0.30	0.84		0.24	0.68		26.70	75.54		22.89	64.75		
C X P X V	0.67	1.89		0.40	1.12		0.52	1.46		0.42	1.18		46.24	130.84		39.64	112.15		

C-Container, P-Storage Period, V-Variety; C1-earthen pot, C2-cloth bag, C3-polythene bag; P1- 0 month, P2-2months, P3-4 months, P4-6 months, P5-8 months; V1-NADI#1, V2-DBW303

Table 2: Effect of containers and storage duration on Biochemical parameters of wheat genotypes

	Soluble protein content (mg g ⁻¹)							Alpha Amylase (μmol min ⁻¹)					
		First year			Second year			First year			Second year		
Container		V1	V2	C X P	V1	V2	C X P	V1	V2	C X P	V1	V2	C X P
C1	P1	12.31	11.29	11.80	10.38	11.29	10.83	0.429	0.440	0.435	0.470	0.493	0.482
	P2	11.47	11.41	11.44	10.08	10.87	10.47	0.430	0.422	0.426	0.456	0.460	0.458
	P3	9.69	8.16	8.92	12.74	9.16	10.95	0.402	0.340	0.371	0.455	0.438	0.447
	P4	8.69	6.90	7.80	11.76	8.15	9.96	0.332	0.273	0.303	0.437	0.333	0.385
	P5	7.793	6.027	6.91	9.75	7.28	8.51	0.240	0.215	0.228	0.245	0.228	0.237
C2	P1	12.31	11.29	11.80	10.38	11.29	10.83	0.429	0.440	0.435	0.470	0.493	0.482
	P2	9.57	7.53	8.55	10.08	10.14	10.11	0.399	0.410	0.405	0.456	0.558	0.507
	P3	9.13	6.92	8.02	10.48	9.25	9.87	0.377	0.362	0.370	0.211	0.210	0.211
	P4	8.65	5.95	7.30	9.96	7.79	8.88	0.291	0.266	0.279	0.182	0.236	0.209
	P5	8.72	5.21	6.97	7.95	7.01	7.48	0.241	0.181	0.211	0.175	0.194	0.185
C3	P1	12.31	11.29	11.80	10.38	11.29	10.83	0.429	0.444	0.437	0.470	0.493	0.482
	P2	13.20	10.86	12.03	10.08	11.20	10.64	0.487	0.447	0.467	0.460	0.487	0.474
	P3	12.57	9.98	11.28	13.17	10.74	11.95	0.467	0.433	0.450	0.443	0.467	0.455
	P4	11.15	9.58	10.37	12.72	10.11	11.42	0.426	0.308	0.367	0.364	0.397	0.381
	P5	10.16	8.93	9.55	9.75	8.96	9.36	0.268	0.216	0.242	0.309	0.267	0.288
Varietal Mean (V)		10.51	8.76		10.64	9.64		0.376	0.346		0.374	0.384	
Interactions													
Varieties		V1	V2		V1	V2		V1	V2		V1	V2	
Container				Mean			Mean			Mean			Mean
C1		9.99	8.76	9.37	10.94	9.35	10.15	0.367	0.338	0.352	0.413	0.390	0.402
C2		9.68	7.38	8.53	9.77	9.10	9.43	0.347	0.332	0.340	0.299	0.339	0.319
C3		11.88	10.13	11.00	11.22	10.46	10.84	0.415	0.369	0.392	0.409	0.422	0.415
P1		12.31	11.29	11.80	10.38	11.29	10.83	0.434	0.434	0.437	0.470	0.493	0.482
P2		11.41	9.93	10.67	10.08	10.74	10.41	0.426	0.404	0.467	0.457	0.502	0.480
P3		10.46	8.35	9.41	10.13	9.91	10.12	0.371	0.37	0.45	0.370	0.372	0.371
P4		9.50	7.48	8.49	11.48	8.68	10.08	0.303	0.279	0.367	0.328	0.322	0.325
P5		8.89	6.72	7.81	9.15	7.75	8.45	0.228	0.211	0.242	0.243	0.230	0.236
Mean		SEm(±)	CD(P=0.05)		SEm(±)	CD(P=0.05)		SEm(±)	CD(P=0.05)		SEm(±)	CD(P=0.05)	
SContainer (C)		0.03	0.10		0.06	0.16		0.004	0.013		0.006	0.018	
Storage Period (P)		0.04	0.13		0.07	0.21		0.006	0.016		0.008	0.023	
Varieties (V)		0.03	0.08		0.05	0.13		0.004	0.010		0.005	N.S	
C X P		0.08	0.22		0.13	0.36		0.010	0.028		0.014	0.040	
C X V		0.05	0.14		0.08	0.23		0.006	N.S		0.009	0.025	
P X V		0.06	0.18		0.10	0.29		0.008	0.023		0.012	N.S	
C X P X V		0.11	0.31		0.18	0.50		0.014	N.S		0.020	N.S	

C-Container, P-Storage Period, V-Variety; C1-earthen pot, C2-cloth bag, C3-polythene bag; P1- 0 month, P2-2months, P3-4 months, P4-6 months, P5-8 months; V1-NADI#1, V2-DBW303

Table 3: Effect of containers and storage duration on Biochemical parameters of wheat genotypes

Container		Peroxidase ($\mu\text{mol min}^{-1}$)						Electrical Conductivity ($\mu\text{S cm}^{-1}\text{g}^{-1}$)					
		First year			Second year			First year			Second year		
		V1	V2	C X P	V1	V2	C X P	V1	V2	C X P	V1	V2	C X P
C1	P1	4.54	4.28	4.41	4.47	4.21	4.34	40.07	32.59	36.33	38.34	30.86	34.60
	P2	4.58	4.38	4.48	4.47	4.31	4.39	42.56	38.38	40.47	42.39	38.23	40.31
	P3	4.17	4.11	4.14	4.19	4.13	4.16	48.64	45.89	47.27	48.47	45.78	47.13
	P4	3.88	4.02	3.95	3.77	3.68	3.73	52.52	68.14	60.33	52.35	68.00	60.18
	P5	3.45	3.34	3.39	3.45	3.23	3.34	129.81	127.70	128.75	111.07	124.52	117.79
C2	P1	4.54	4.28	4.41	4.47	4.21	4.34	40.07	32.59	36.33	38.34	30.86	34.60
	P2	4.58	4.39	4.49	4.48	4.38	4.43	41.88	41.93	41.91	42.41	32.59	37.50
	P3	3.80	3.67	3.74	3.48	3.46	3.47	51.98	45.26	48.62	55.65	42.92	49.29
	P4	3.27	3.12	3.20	3.11	3.04	3.08	63.07	77.53	70.30	63.79	75.21	69.50
	P5	2.90	2.86	2.88	2.93	2.77	2.85	136.47	155.97	146.22	126.33	130.63	128.48
C3	P1	4.54	4.28	4.41	4.47	4.21	4.34	40.07	32.59	36.33	38.34	30.86	34.60
	P2	4.63	4.37	4.50	4.52	4.32	4.42	44.07	36.59	40.33	42.34	34.86	38.60
	P3	4.34	4.17	4.26	4.36	4.09	4.23	48.74	41.22	44.98	47.01	39.50	43.26
	P4	4.28	4.02	4.15	4.23	3.77	4.00	49.94	61.08	55.51	48.21	59.35	53.78
	P5	3.92	3.82	3.87	3.83	3.57	3.70	115.43	119.33	117.38	99.23	110.26	104.74
Varietal Mean (V)		4.09	3.94			4.02	3.83		63.02	63.79		60.63	
Interactions													
Varieties		V1	V2		V1	V2		V1	V2		V1	V2	
Container				Mean			Mean			Mean			Mean
C1		4.12	4.02	4.07	4.07	3.91	3.99	62.72	62.54	62.63	58.53	61.48	60.00
C2		3.82	3.66	3.74	3.69	3.57	3.63	66.70	70.66	68.68	65.31	62.44	63.88
C3		4.34	4.13	4.24	4.28	3.99	4.14	59.65	58.17	58.91	55.03	54.96	55.00
P1		4.54	4.28	4.41	4.47	4.21	4.34	40.07	32.59	36.33	38.34	30.86	34.60
P2		4.60	4.38	4.49	4.49	4.34	4.41	42.84	38.97	40.90	42.38	35.23	38.81
P3		4.11	3.98	4.05	4.01	3.89	3.95	49.79	44.13	46.96	50.38	42.73	46.56
P4		3.81	3.72	3.76	3.70	3.50	3.60	55.18	68.92	62.05	54.79	67.52	61.15
P5		3.42	3.34	3.38	3.40	3.19	3.30	127.24	134.34	130.79	112.21	121.80	117.01
Mean		SEm($\pm$)	CD(P=0.05)		SEm($\pm$)	CD(P=0.05)		SEm($\pm$)	CD(P=0.05)		SEm($\pm$)	CD(P=0.05)	
Container (C)		0.02	0.05		0.02	0.06		0.45	1.29		0.86	2.42	
Storage Period (P)		0.02	0.06		0.03	0.08		0.59	1.66		1.11	3.13	
Varieties (V)		0.01	0.04		0.02	0.05		0.37	N.S		0.70	1.98	
C X P		0.04	0.11		0.05	0.14		1.02	2.87		1.91	5.41	
C X V		0.02	N.S		0.03	0.09		0.64	1.82		1.21	N.S	
P X V		0.03	0.09		0.04	N.S		0.83	2.35		1.56	4.42	
C X P X V		0.05	N.S		0.07	N.S		1.44	4.06		2.71	N.S	

C-Container, P-Storage Period, V-Variety; C1-earthen pot, C2-cloth bag, C3-polythene bag; P1- 0 month, P2-2months, P3-4 months, P4-6 months, P5-8 months; V1-NADI#1, V2-DBW303

Conclusion

Maintaining harvested seeds until next sowing while compromising its quality is the major constrain among farmers. The seeds when stored in high moisture conditions deteriorate quickly, ultimately leading to less vigour seeds which fail to perform better under field condition. Therefore, storing the seed in proper container is very important to prohibit the seed from exposure to open environment. From the above results storing of wheat seed in polythene bag (C3) had showed better results with respect to physiological and biochemical parameters when compared to other two containers such as earthen pot and cloth bag (C1, C2) which are moisture pervious. Since wheat seeds are hygroscopic in nature, storing them under polythene bag protects them from exposing to moisture in surrounding environment resulting in enhancing its seed longevity and reduce seed aging process.

Conflicts of Interest

The authors declare no conflict of interest.

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