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Evaluation of the Best Storage Methods for Maintaining Seed Quality of Onion

Ashok[1]*, Basave Gowda[1], S.R. Doddagoudar[1], S.N. Vasudevan[4], M.G. Patil[2] and Arunkumar Hosamani[3]

[1]Department of Seed Science and Technology, [2]Department of Horticulture,
[3]Department of Agricultural Entomology, UAS, Raichur-584 104, India
[4]ADR, Department of Seed Science and Technology, University of Agricultural Sciences, Bangalore, India

**Corresponding author*

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A B S T R A C T

The lab experiment was laid out with completely randomised block design to study the effect of different seed packing materials with silica gel and vacuum packing on seed longevity of onion variety Arka Kalyan with three replications for twelve months at Seed Testing and Research laboratory, Seed Unit, University of Agricultural Sciences, Raichur. The results showed that, the impervious containers recorded minimum seed deterioration compared to previous container (cloth bag). It was notified that the minimum seed deterioration of quality parameters were found in seeds packed in aluminum-laminated pouches with vacuum packing + silica gel (100 g/kg seed) viz., seed germination (84.7 %), root length (9.10 cm), shoot length (5.84 cm), seedling vigour index (1265), seedling dry weight (32.67 mg), electrical conductivity (0.684 dSm-1), dehydrogenase enzyme activity (1.591 OD value) and α-amylase enzyme activity (12.38 mm) which were on par with seeds packed in polythene bag (700 gauge) with vacuum packing + silica gel (100 g/kg seed), aluminum-laminated pouches with vacuum packing, polythene bag (700 gauge) with vacuum packing, aluminum-laminated pouches silica gel (100 g/kg seed), polythene bag (700 gauge) silica gel (100 g/kg seed), aluminum-laminated pouches and polythene bag (700 gauge) over control (78.0 %, 6.85 cm, 4.15 cm, 858, 27.00 mg, 0.802 dSm^{-1}, 1.013 OD value and 9.99 mm, respectively) after twelve months of storage period.

Introduction

Onion (*Allium cepa* L.) is one of the important commercial vegetable crops grown in India. It is widely grown in different parts of the country mainly by small and marginal farmers. Onion is cross pollinated crop and efficient pollination depends largely on presence of insects in the area and their activity at flowering time. It is essential to ensure that there is sufficient population of pollinating insects including honeybees to achieve the full potential of onion seed and consequent higher seed yield. India produces around 168 lakh tons of onion annually ranking second in the world. The production has increased more than five times during past three decades. The reason for increase in production is mainly due to increase in area under onion cultivation from 1.94 lakh ha during 1974-75 to 10.51 lakh ha in 2016-17. Onion is extremely important vegetable crop not only for internal consumption but also as highest foreign exchange earner among the fruits and vegetables. It occupies an area of 1064 thousand ha, with production of 15118 thousand tons. India is the 2nd largest producer of onion, in the world next only to China but the productivity of onion in India is very low *i.e.* 14.21 tons/ ha as compared to China and other countries like, Egypt, Netherlands & Iran *etc.*, (Annon., 2017).

The major onion producing states are Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Rajasthan, Bihar, Andhra Pradesh, Haryana, West Bengal, Uttar Pradesh, Chhattisgarh, Odisha, Tamil Nadu, Jharkhand and Telangana in the country. These states account for 97 per cent of the total production of the country. As per the third advance estimates, the production of onion during the year 2016-17 is likely to be 3.8 per cent higher from the previous year. Among the different onion growing states, Maharashtra is the major onion producing state with 30.41 per cent of production share, followed by Karnataka, Madhya Pradesh, Rajasthan and Gujarat with 15.51, 13.66, 6.49 and 6.31 per cent share, respectively during year 2016-17.

The seeds need to be stored after harvest till the next sowing or until further use. The onion seeds are found to be poor storer (Nagaveni, 2005). Onion is multiplied through seed. The quality of seed plays an important role in enhancing production and productivity of crops. It is a well-known fact that the seed moisture plays a major role in the viability and vigour of the seed during storage (Joshi *et al.*, 2007; Padma and Reddy, 2000). Similarly packing of seed also play a vital role in enhancing the shelf life of the seeds (Garg and Chandra, 2005; Joshi *et al.*, 2007; Rao *et al.,* 2006). Since, onion seed losses its viability and vigour rapidly thus the role of soil moisture and packing material is more vital for good productivity of crops. The present investigation was under taken to prolong the seed viability and vigour of onion under ambient conditions using different seed packing materials with silica gel and vacuum packing.

Materials and Methods

Storage experiment was conducted to evaluate the best storage methods for maintaining seed quality of onion for a period of twelve months starting from July-2017 to June-18 at Seed Quality Assurance and Research Laboratory, Seed Unit, University of Agricultural Sciences, Raichur. The experiment consisted of totally 9 treatments containing different packaging materials along with the silica gel and vacuum packing and which is replicated thrice. The treated seeds (with bavistin @ 2 g/kg seed) were dried to low moisture content (6 %) using silica gel @ 0.1:1 gel to seed ratio, w/w (500 g/kg seeds). The seeds were packed in cloth bag, polythene bag (700 gauge) and aluminium laminated pouches along with silica gel (100 g/kg seed) for specific treatment as per the treatment and stored under ambient conditions. Seed quality evaluations were made initially and subsequently at bimonthly intervals for 12 months and the cloth bag packed seed samples were used as control.

The effect of different seed packing materials with silica gel and vacuum packing on seed quality of onion were assessed in terms of seed quality parameters like germination per cent, root length (cm), shoot length (cm), seedling vigour index, seedling dry weight (mg), electrical conductivity (dSm^{-1}), dehydrogenase enzyme activity (OD value) and amylase enzyme activity (mm).

Results and Discussion

Seed quality parameters

Seed is the nucleus of life and is subjected to continuous ageing once it has reached maturity. This phenomenon results in an irreversible change in seed quality ultimately affecting viability. The quantitative deterioration during storage is mainly attributed to period of storage (Delouche and Baskin, 1973) and seed treatment (Basu and Rudrapal, 1980) besides, other factors like seed moisture content, temperature, relative humidity and storage containers.

During storage, viability and vigour are lost due to many biotic factors like micro flora. The storage fungi cause considerable damage and are responsible for deterioration and reduction in storage potential of seed. Seed deterioration is irreversible, inevitable, irreparable, but the rate of deterioration can be slowdown by certain seed enhancement techniques like by using different seed packing materials, desiccant like silica gel and vacuum packing which reduce the quantitative and qualitative loss besides maintaining quality of the seed for longer storage.

In the present study packing material, silica gel and vacuum packing had a significant effect on germination (%), shoot length (cm), root length (cm) and seedling vigour index. Seeds packed in aluminum-laminated pouches with vacuum packing + silica gel (100 g/kg seed) (T_9) maintained significantly higher germination (%), shoot length (cm), root length (cm), seedling vigour index, seedling dry weight (mg), lower EC (dS/m), dehydrogenase and α-amylase enzyme activity and maintained good seed health throughout the storage period followed by the seeds packed in polythene bag (700 gauge) with vacuum packing + silica gel (100 g/kg seed) (T_8) and seeds packed in aluminium-laminated pouches with vacuum packing (T_7).

With the advancement of storage period, all the seed quality parameters decreased drastically irrespective of packing material, silica gel and vacuum packing. At the end of storage period the seeds packed in aluminum-laminated pouches with vacuum packing + silica gel (100 g/kg seed) (T_9) maintained significantly higher seed germination (84.7 %), shoot length (5.84 cm), root length (9.10 cm), seedling vigour index (1265), seedling dry weight (32.67 mg), lower EC (0.684 dS/m), higher dehydrogenase (1.591 OD value) and α-amylase enzyme activity (12.38 mm) and good seed health throughout the storage period followed by seeds packed in polythene bag (700 gauge) with vacuum packing + silica gel (100 g/kg seed) (T_8) and seeds packed in aluminium-laminated pouches with vacuum packing (T_7) as compared to (T_1) seeds packed in cloth bag (78.0 %), 4.15 cm, 6.85 cm, 858, 27.00 mg, 0.802 dS/m, 1.013 OD value and 9.99 mm, respectively).

The present study revealed that the seeds stored in impervious containers *viz.*, aluminium laminated pouch and polyethylene bag maintained higher germination, root length, shoot length, seedling vigour index, seedling dry weight, dehydrogenase activity (OD value), α-amylase enzyme activity and lower EC (dS/m) as compared to pervious container *i.e.*, cloth bag. With the advancement of storage period, moisture content increased progressively, whereas the rate of increase in moisture content was low in case of aluminium laminated pouch followed by polyethylene bag compared to cloth bag, which may due to the moisture vapour proof nature of aluminium foil pouch and polyethylene bag respectively, due to which lesser seed deterioration was observed (Jacqualine and Selvaraj, 1988 in brinjal;

Venkatasalam, 2001 in tomato). The seeds stored in aluminium laminated pouch and polythene bag (700 gauge) along with silica gel and vacuum packing maintained satisfactory germination up to 12 months of storage period compared to seeds stored in cloth bag which shows drastic reduction and retained viability up to 12 months of storage only *i.e.*, 80.3 per cent. Significant and lower qualitative parameters observed in cloth bag during entire storage period may be due its permeable nature and it might have favoured the longer fluctuations in moisture content leading to faster metabolic and respiratory activity of seeds compared to the aluminium laminated pouch and polyethylene bag where in seed qualitative parameters were comparatively superior with reduced EC value and moisture content due to impervious nature and also evidenced with high dehydrogenase activity (Shelar *et al.*, 1992; Pandey *et al.*, 1994 and Padma and Reddy, 2000; Veena *et al.*, 2008 in onion seeds).

The results showed that the lower internal seed moisture was found to be beneficial in maintaining seed germination in vacuum packed and airtight containers like aluminium laminated pouch and polyethylene bag along with silica gel than cloth bag. The viability and vigour of seed to a great extend depends on the storability which is determined by the moisture, seed relative humidity and temperature. High content of seed moisture and relative humidity are congenial for seed metabolites as well as for growth of fungus. The onion seed are hygroscopic and absorb moisture from surrounding environment and rapidly lose viability. This may be reason of higher viability in vacuum packed containers with silica gel. The results are in concurrence with the earlier finding of Saxena *et al.*, (1987), Padma and Reddy (2000); Nagaveni (2005), Rao *et al.*, (2006); Swaran Lata and Sharma (2008), Nassari *et al.*, (2014), Tripathi and Lawande (2014), Mollah *et al.*, (2016) and Patel *et al.*, (2017). It has been reported that lepoxygenase enzyme generate free radicals as the seed moisture increases (Table 1–9).

Table.1 Initial quality parameters of onion seeds before storage

Sl.	Seed quality parameters	Initial level
1.	Germination (%)	**93.33**
2.	Root length (cm)	**12.95**
3.	Shoot length (cm)	**9.24**
4.	Seedling vigour index	**2071**
5.	Seedling dry weight (mg/seedling^{-10})	**42.92**
6.	Electrical conductivity (dS/m)	**0.392**
7.	Dehydrogenase enzyme activity (OD value)	**2.278**
8.	**α- Amylase enzyme activity (mm)**	**18.57**

T_1: Cloth bag
T_2: Polythene bag (700 gauge)
T_3: Aluminium-laminated pouches
T_4: T_2 + Silica gel (100 g /kg seed)
T_5: T_3 + Silica gel (100 g/kg seed)
T_6: Polythene bag (700 gauge) with vacuum packing
T_7: Aluminum-laminated pouches with vacuum packing
T_8: T_6 + Silica gel (100 g/kg seed)
T_9: T_7 + Silica gel (100 g/kg seed)

Table.2 Effect of storage methods on germination of onion seeds during storage

Treatments	Germination (%)					
	Months of storage					
	2	4	6	8	10	12
T_1	89.3 (70.9)	88.3 (70.1)	85.3 (67.5)	82.3 (65.1)	80.3 (63.7)	78.0 (62.0)
T_2	90.3 (71.9)	90.0 (71.6)	88.3 (70.1)	85.0 (67.2)	85.3 (67.5)	83.3 (65.9)
T_3	91.0 (72.6)	90.7 (72.2)	90.0 (71.6)	85.0 (67.2)	86.0 (68.0)	84.3 (66.7)
T_4	90.7 (72.3)	90.3 (72.0)	89.0 (70.6)	86.0 (68.0)	85.3 (67.5)	84.3 (66.7)
T_5	90.7 (72.2)	90.3 (71.9)	90.3 (71.9)	86.3 (68.3)	85.0 (67.2)	84.7 (67.0)
T_6	91.0 (72.7)	90.7 (72.2)	89.7 (71.3)	86.7 (68.6)	85.3 (67.5)	84.7 (67.0)
T_7	91.0 (72.6)	90.7 (72.2)	90.0 (71.6)	86.3 (68.3)	85.7 (67.8)	84.7 (67.0)
T_8	91.0 (72.6)	90.7 (72.4)	90.0 (71.6)	87.7 (69.4)	85.7 (67.8)	84.0 (66.4)
T_9	92.3 (73.9)	91.7 (73.3)	90.3 (71.9)	89.3 (70.9)	87.0 (68.9)	84.7 (67.0)
Mean	**90.8 (72.4)**	**90.4 (72.0)**	**89.2 (70.9)**	**86.1 (68.1)**	**85.1 (67.2)**	**83.7 (66.3)**
S.Em±	0.8	1.0	0.6	0.5	0.6	0.8
CD at 1 %	NS	NS	2.6	1.9	2.4	3.3

NS: Non Significant *Figures in the parentheses indicates arc sine transformed values

Table.3 Effect of storage methods on root length of onion seeds during storage

Treatments	Root length (cm)					
	Months of storage					
	2	4	6	8	10	12
T_1	11.94	11.25	10.15	9.09	7.34	6.85
T_2	12.41	12.17	11.19	10.18	9.11	8.92
T_3	12.35	12.19	11.23	10.20	9.12	8.93
T_4	12.35	12.17	11.28	10.23	9.12	8.97
T_5	12.39	12.16	11.35	10.29	9.15	8.97
T_6	12.39	12.17	11.32	10.29	9.14	8.99
T_7	12.49	12.19	11.39	10.40	9.19	9.05
T_8	12.51	12.19	11.39	10.42	9.20	9.03
T_9	12.92	12.21	11.65	10.50	9.22	9.10
Mean	**12.42**	**12.08**	**11.22**	**10.18**	**8.95**	**8.76**
S.Em±	0.23	0.09	0.15	0.15	0.21	0.13
CD at 1 %	NS	0.36	0.63	0.61	2.8	0.53

NS: Non Significant
T_1: Cloth bag
T_2: Polythene bag (700 gauge)
T_3: Aluminium-laminated pouches
T_4: T_2 + Silica gel (100 g /kg seed)
T_5: T_3 + Silica gel (100 g/kg seed)
T_6: Polythene bag (700 gauge) with vacuum packing
T_7: Aluminum-laminated pouches with vacuum packing
T_8: T_6 + Silica gel (100 g/kg seed)
T_9: T_7 + Silica gel (100 g/kg seed)

Table.4 Effect of storage methods on shoot length of onion seeds during storage

Treatments	Shoot length (cm)					
	Months of storage					
	2	4	6	8	10	12
T_1	7.90	7.52	6.39	5.95	4.63	4.15
T_2	8.33	8.19	7.82	6.61	6.08	5.70
T_3	8.33	8.20	7.70	6.63	6.08	5.79
T_4	8.37	8.22	7.81	6.70	6.09	5.71
T_5	8.37	8.22	7.82	6.72	6.10	5.75
T_6	8.47	8.21	7.93	6.75	6.10	5.81
T_7	8.33	8.22	7.95	6.77	6.12	5.81
T_8	8.30	8.24	7.95	6.90	6.13	5.83
T_9	8.53	8.23	7.99	6.97	6.14	5.84
Mean	**8.33**	**8.14**	**7.71**	**6.67**	**5.94**	**5.60**
S.Em±	0.13	0.05	0.08	0.12	0.15	0.12
CD at 1 %	NS	0.19	0.31	0.47	0.62	0.50

NS: Non Significant

Table.5 Effect of storage methods on seedling vigour index of onion seeds during storage

Treatments	Seedling vigour index					
	Months of storage					
	2	4	6	8	10	12
T_1	1772	1657	1411	1238	961	858
T_2	1874	1832	1679	1428	1286	1219
T_3	1882	1848	1704	1430	1297	1242
T_4	1879	1842	1699	1456	1298	1246
T_5	1882	1841	1731	1468	1296	1254
T_6	1898	1848	1727	1477	1301	1253
T_7	1895	1851	1740	1483	1311	1241
T_8	1894	1852	1740	1518	1314	1264
T_9	1981	1874	1774	1561	1336	1265
Mean	**1884**	**1827**	**1690**	**1451**	**1267**	**1205**
S.Em±	28	23	20	17	22	22
CD at 1 %	NS	92	81	68	89	88

NS: Non Significant
T_1: Cloth bag
T_2: Polythene bag (700 gauge)
T_3: Aluminium-laminated pouches
T_4: T_2 + Silica gel (100 g/kg seed)
T_5: T_3 + Silica gel (100 g/kg seed)
T_6: Polythene bag (700 gauge) with vacuum packing
T_7: Aluminum-laminated pouches with vacuum packing
T_8: T_6 + Silica gel (100 g/kg seed)
T_9: T_7 + Silica gel (100 g/kg seed)

Table.6 Effect of storage methods on seedling dry weight of onion during storage

Treatments	Seedling dry weight (mg)					
	Months of storage					
	2	4	6	8	10	12
T_1	39.33	37.33	34.17	32.33	30.00	27.00
T_2	40.67	40.67	36.17	34.50	34.17	32.67
T_3	40.00	40.00	36.50	35.00	34.50	32.67
T_4	40.00	40.00	36.33	35.17	34.50	33.00
T_5	40.00	40.00	36.67	35.83	34.00	32.33
T_6	42.00	40.00	36.33	36.00	35.00	32.67
T_7	41.33	40.33	36.83	35.83	34.00	33.00
T_8	41.33	40.00	37.00	35.50	34.00	32.67
T_9	42.33	41.33	38.17	36.00	34.33	32.67
Mean	**40.78**	**39.96**	**36.46**	**35.13**	**33.83**	**32.07**
S.Em±	1.53	1.51	0.51	0.53	0.70	0.82
CD at 1 %	NS	NS	2.09	2.16	2.87	3.32

NS: Non Significant

Table.7 Effect of storage methods on electrical conductivity of onion seeds during storage

Treatments	Electrical conductivity (dSm^{-1})					
	Months of storage					
	2	4	6	8	10	12
T_1	0.446	0.475	0.655	0.692	0.753	0.802
T_2	0.421	0.445	0.564	0.579	0.673	0.700
T_3	0.420	0.450	0.541	0.573	0.671	0.696
T_4	0.425	0.447	0.551	0.570	0.673	0.692
T_5	0.423	0.441	0.526	0.571	0.672	0.697
T_6	0.426	0.440	0.550	0.562	0.674	0.695
T_7	0.423	0.447	0.543	0.567	0.671	0.696
T_8	0.422	0.445	0.542	0.560	0.669	0.685
T_9	0.418	0.442	0.521	0.560	0.659	0.684
Mean	**0.425**	**0.448**	**0.555**	**0.582**	**0.680**	**0.705**
S.Em±	0.011	0.022	0.013	0.012	0.010	0.008
CD at 1 %	NS	NS	0.052	0.048	0.040	0.033

NS: Non Significant
T_1: Cloth bag
T_2: Polythene bag (700 gauge)
T_3: Aluminium-laminated pouches
T_4: T_2 + Silica gel (100 g/kg seed)
T_5: T_3 + Silica gel (100 g/kg seed)
T_6: Polythene bag (700 gauge) with vacuum packing
T_7: Aluminum-laminated pouches with vacuum packing
T_8: T_6 + Silica gel (100 g/kg seed)
T_9: T_7 + Silica gel (100 g/kg seed)

Table.8 Effect of storage methods on dehydrogenase enzyme activity of onion seeds during storage

Treatments	Dehydrogenase enzyme activity (OD value)					
	Months of storage					
	2	4	6	8	10	
T_1	1.955	1.877	1.549	1.340	1.174	1.013
T_2	2.082	2.025	1.835	1.698	1.705	1.566
T_3	2.156	2.117	1.816	1.716	1.703	1.568
T_4	2.099	2.037	1.811	1.798	1.704	1.565
T_5	2.130	2.041	1.875	1.772	1.708	1.570
T_6	2.149	2.009	1.836	1.786	1.702	1.573
T_7	2.103	2.006	1.851	1.784	1.707	1.570
T_8	2.158	2.040	1.912	1.828	1.710	1.576
T_9	2.223	2.153	1.970	1.860	1.727	1.591
Mean	**2.117**	**2.034**	**1.828**	**1.731**	**1.649**	**1.510**
S.Em±	0.15	0.13	0.06	0.04	0.03	0.02
CD at 1 %	NS	NS	0.24	0.17	0.13	0.09

NS: Non Significant

Table.9 Effect of storage methods on α-amylase enzyme activity of onion seeds during storage

Treatments	α-amylase enzyme activity (mm)					
	Months of storage					
	2	4	6	8	10	12
T_1	17.57	15.83	14.17	13.00	12.17	9.99
T_2	17.98	16.50	16.33	15.10	14.12	11.82
T_3	17.87	16.00	16.34	15.22	14.16	11.87
T_4	17.81	16.50	16.32	15.34	14.22	11.79
T_5	17.96	16.50	16.42	15.30	14.21	11.85
T_6	17.94	16.50	16.34	15.43	14.33	11.87
T_7	17.95	16.67	16.48	15.46	14.43	12.09
T_8	18.00	17.06	16.53	15.83	14.53	12.35
T_9	18.00	17.17	16.62	15.89	14.61	12.38
Mean	**17.90**	**16.52**	**16.17**	**15.18**	**14.09**	**11.78**
S.Em±	0.22	0.31	0.15	0.28	0.18	0.35
CD at 1 %	NS	NS	0.63	1.15	0.73	1.42

NS: Non Significant
T_1: Cloth bag
T_2: Polythene bag (700 gauge)
T_3: Aluminium-laminated pouches
T_4: T_2 + Silica gel (100 g/kg seed)
T_5: T_3 + Silica gel (100 g/kg seed)
T_6: Polythene bag (700 gauge) with vacuum packing
T_7: Aluminum-laminated pouches with vacuum packing
T_8: T_6 + Silica gel (100 g/kg seed)
T_9: T_7 + Silica gel (100 g/kg seed)

Plate.1 Seed germination (%) of onion seeds stored in cloth bag and aluminium laminated pouches + silica gel along with vacuum packing after 12 months of storage

Plate.2 Seedling length of onion seeds stored in cloth bag (T1) and aluminium laminated pouches + silica gel along with vacuum packing (T9) after 12 months of storage

Plate.3 Effect of different storage methods on dehydrogenase enzyme activity (OD value) of onion seeds after 12 months of storage

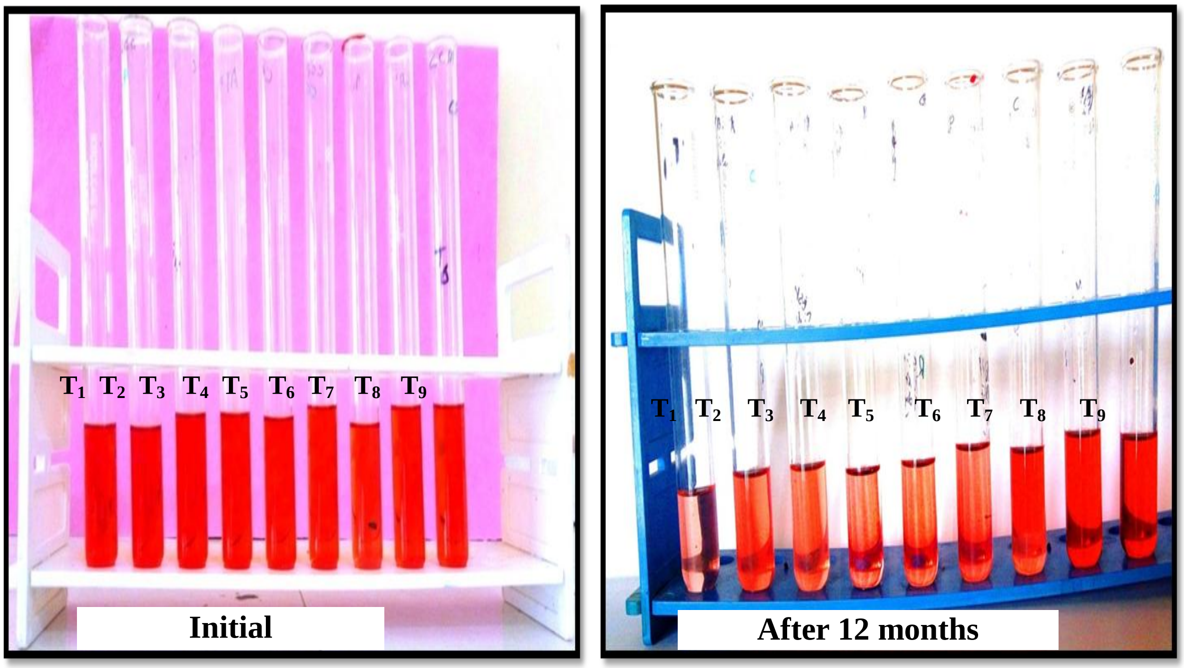
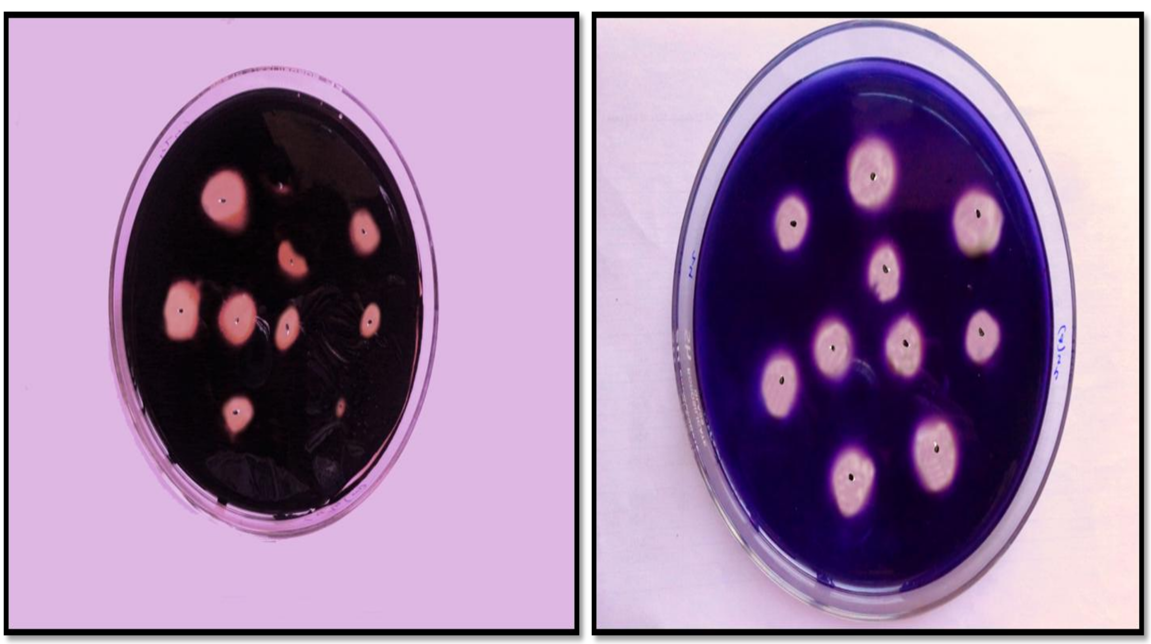


Plate.4 α-amylase enzyme activity (mm) of seeds stored in cloth bag (T1) and aluminium-laminated pouch + silica gel along with vacuum packing (T9) after 12 months of storage



T_1: Control

T_9: aluminium laminated pouches + silica gel along with vacuum packing

These are responsible for chromosomal abnormalities which adversely affect germination of seed and seedling growth. As the seed aged, the proportionate of genetic mutation increase. Many of these mutations can be detected as chromosomal aberrations. These chromosomal aberrations delay seedling growth and adversely affect seed germination and other quality parameters (Murata *et al.,* 1984 in barley; Saxena *et al.*, 1987; Nagaveni 2005; Tripathi and Lawande, 2014; Mollah *et al.,* 2016; Patel *et al.*, 2017 in onion seeds; Nassari *et al.,* 2014 in tomato seeds). Therefore, it is necessary to use superior container along with vacuum pack and silica gel to slow down the deterioration of seed viability under storage.

Onion seeds stored in any one of the impervious container studied recorded higher seed germination and other quality parameters, however, polythene bag (700 gauge) can be used for onion seed storage due to low cost and best over pervious container *i.e.,* cloth bag.

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