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

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ABSTRACT

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.

Keywords
Aluminium-laminated pouch, Cloth bag, Polythene bag, Silica gel and Vacuum packing

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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 aluminium-laminated pouches with vacuum packing + silica gel (100 g/kg seed) (T9) 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) (T8) and seeds packed in aluminium-laminated pouches with vacuum packing (T7).

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 aluminium-laminated pouches with vacuum packing + silica gel (100 g/kg seed) (T9) 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) (T8) and seeds packed in aluminium-laminated pouches with vacuum packing (T7) as compared to (T1) 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 (Jacqueline 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. No. | 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⁻¹)             | 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         |

T₁: Cloth bag  
T₂: Polythene bag (700 gauge)  
T₃: Aluminium-laminated pouches  
T₄: T₂ + Silica gel (100 g/kg seed)  
T₅: T₃ + Silica gel (100 g/kg seed)  
T₆: Polythene bag (700 gauge) with vacuum packing  
T₇: Aluminium-laminated pouches with vacuum packing  
T₈: T₆ + Silica gel (100 g/kg seed)  
T₉: T₇ + 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 |
|------------|------------------|-------------------|----|----|----|----|----|----|
| T1         | 90.3 (70.9)      | 88.3 (70.1)       | 85.3 (67.5) | 82.3 (65.1) | 80.3 (63.7) | 78.0 (62.0) |
| T2         | 90.3 (71.9)      | 90.0 (71.6)       | 88.3 (70.1) | 85.0 (67.2) | 85.3 (67.5) | 83.3 (65.9) |
| T3         | 91.0 (72.6)      | 90.7 (72.2)       | 90.0 (71.6) | 85.0 (67.2) | 86.0 (68.0) | 84.3 (66.7) |
| T4         | 90.7 (72.3)      | 90.3 (72.0)       | 89.0 (70.6) | 86.0 (68.0) | 85.3 (67.5) | 84.3 (66.7) |
| T5         | 90.7 (72.2)      | 90.3 (71.9)       | 90.3 (71.9) | 86.3 (68.3) | 85.0 (67.2) | 84.7 (67.0) |
| T6         | 91.0 (72.7)      | 90.7 (72.2)       | 89.7 (71.3) | 86.7 (68.6) | 85.3 (67.5) | 84.7 (67.0) |
| T7         | 91.0 (72.6)      | 90.7 (72.2)       | 90.0 (71.6) | 86.3 (68.3) | 85.7 (67.8) | 84.7 (67.0) |
| T8         | 91.0 (72.6)      | 90.7 (72.4)       | 90.0 (71.6) | 87.7 (69.4) | 85.7 (67.8) | 84.0 (66.4) |
| T9         | 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 |
|------------|------------------|-------------------|----|----|----|----|----|----|
| T1         | 11.94            | 11.25             | 10.15 | 9.09 | 7.34 | 6.85 |
| T2         | 12.41            | 12.17             | 11.19 | 10.18 | 9.11 | 8.92 |
| T3         | 12.35            | 12.19             | 11.23 | 10.20 | 9.12 | 8.93 |
| T4         | 12.35            | 12.17             | 11.28 | 10.23 | 9.12 | 8.97 |
| T5         | 12.39            | 12.16             | 11.35 | 10.29 | 9.15 | 8.97 |
| T6         | 12.39            | 12.17             | 11.32 | 10.29 | 9.14 | 8.99 |
| T7         | 12.49            | 12.19             | 11.39 | 10.42 | 9.20 | 9.03 |
| T8         | 12.51            | 12.19             | 11.39 | 10.40 | 9.19 | 9.05 |
| T9         | 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
T1: Cloth bag
T2: Polythene bag (700 gauge)
T3: Aluminium-laminated pouches
T4: T2 + Silica gel (100 g/kg seed)
T5: T3 + Silica gel (100 g/kg seed)
T6: Polythene bag (700 gauge) with vacuum packing
T7: Aluminium-laminated pouches with vacuum packing
T8: T6 + Silica gel (100 g/kg seed)
T9: T7 + 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    |
| T₁         | 7.90  | 7.52  | 6.39  | 5.95  | 4.63  | 4.15  |
| T₂         | 8.33  | 8.19  | 7.82  | 6.61  | 6.08  | 5.70  |
| T₃         | 8.33  | 8.20  | 7.70  | 6.63  | 6.08  | 5.79  |
| T₄         | 8.37  | 8.22  | 7.81  | 6.70  | 6.09  | 5.71  |
| T₅         | 8.37  | 8.22  | 7.82  | 6.72  | 6.10  | 5.75  |
| T₆         | 8.47  | 8.21  | 7.93  | 6.75  | 6.10  | 5.81  |
| T₇         | 8.33  | 8.22  | 7.95  | 6.77  | 6.12  | 5.81  |
| T₈         | 8.30  | 8.24  | 7.95  | 6.90  | 6.13  | 5.83  |
| T₉         | 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    | 0.31  | 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    |
| T₁         | 1772  | 1657  | 1411  | 1238  | 961   | 858   |
| T₂         | 1874  | 1832  | 1679  | 1428  | 1286  | 1219  |
| T₃         | 1882  | 1848  | 1704  | 1430  | 1297  | 1242  |
| T₄         | 1879  | 1842  | 1699  | 1456  | 1298  | 1246  |
| T₅         | 1882  | 1841  | 1731  | 1468  | 1296  | 1254  |
| T₆         | 1898  | 1848  | 1727  | 1477  | 1301  | 1253  |
| T₇         | 1895  | 1851  | 1740  | 1483  | 1311  | 1241  |
| T₈         | 1894  | 1852  | 1740  | 1518  | 1314  | 1264  |
| T₉         | 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
T₁: Cloth bag
T₂: Polythene bag (700 gauge)
T₃: Aluminium-laminated pouches
T₄: T₂ + Silica gel (100 g/kg seed)
T₅: T₃ + Silica gel (100 g/kg seed)
T₆: Polythene bag (700 gauge) with vacuum packing
T₇: Aluminium-laminated pouches with vacuum packing
T₈: T₆ + Silica gel (100 g/kg seed)
T₉: T₇ + Silica gel (100 g/kg seed)
**Table 6** Effect of storage methods on seedling dry weight of onion during storage

| Treatments | 2   | 4   | 6   | 8   | 10  | 12  |
|------------|-----|-----|-----|-----|-----|-----|
| T₁         | 39.33 | 37.33 | 34.17 | 32.33 | 30.00 | 27.00 |
| T₂         | 40.67 | 40.67 | 36.17 | 34.50 | 34.17 | 32.67 |
| T₃         | 40.00 | 40.00 | 36.50 | 35.00 | 34.50 | 33.00 |
| T₄         | 40.00 | 40.00 | 36.33 | 35.17 | 34.50 | 33.00 |
| T₅         | 40.00 | 40.00 | 36.67 | 35.83 | 34.00 | 32.33 |
| T₆         | 42.00 | 40.00 | 36.33 | 36.00 | 35.00 | 32.67 |
| T₇         | 41.33 | 40.00 | 37.00 | 35.50 | 34.00 | 32.67 |
| T₈         | 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 | 2         | 4         | 6         | 8         | 10        | 12        |
|------------|-----------|-----------|-----------|-----------|-----------|-----------|
| T₁         | 0.446     | 0.475     | 0.655     | 0.692     | 0.753     | 0.802     |
| T₂         | 0.421     | 0.445     | 0.564     | 0.579     | 0.673     | 0.700     |
| T₃         | 0.420     | 0.450     | 0.541     | 0.573     | 0.671     | 0.696     |
| T₄         | 0.425     | 0.447     | 0.551     | 0.570     | 0.673     | 0.692     |
| T₅         | 0.423     | 0.441     | 0.526     | 0.571     | 0.672     | 0.697     |
| T₆         | 0.426     | 0.440     | 0.550     | 0.562     | 0.674     | 0.695     |
| T₇         | 0.423     | 0.447     | 0.543     | 0.567     | 0.671     | 0.696     |
| T₈         | 0.422     | 0.445     | 0.542     | 0.560     | 0.669     | 0.685     |
| T₉         | 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

- T₁: Cloth bag
- T₂: Polythene bag (700 gauge)
- T₃: Aluminium-laminated pouches
- T₄: T₁ + Silica gel (100 g/kg seed)
- T₅: T₃ + Silica gel (100 g/kg seed)
- T₆: Polythene bag (700 gauge) with vacuum packing
- T₇: Aluminium-laminated pouches with vacuum packing
- T₈: T₆ + Silica gel (100 g/kg seed)
- T₉: T₇ + 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  | 12  |
| T₁         | 1.955 | 1.877 | 1.549 | 1.340 | 1.174 | 1.013 |
| T₂         | 2.082 | 2.025 | 1.835 | 1.698 | 1.705 | 1.566 |
| T₃         | 2.156 | 2.117 | 1.816 | 1.716 | 1.703 | 1.568 |
| T₄         | 2.099 | 2.037 | 1.811 | 1.798 | 1.704 | 1.565 |
| T₅         | 2.130 | 2.041 | 1.875 | 1.772 | 1.708 | 1.570 |
| T₆         | 2.149 | 2.009 | 1.836 | 1.786 | 1.702 | 1.573 |
| T₇         | 2.103 | 2.006 | 1.851 | 1.784 | 1.707 | 1.570 |
| T₈         | 2.158 | 2.040 | 1.912 | 1.828 | 1.710 | 1.576 |
| T₉         | 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  |
| T₁         | 17.57 | 15.83 | 14.17 | 13.00 | 12.17 | 9.99 |
| T₂         | 17.98 | 16.50 | 16.33 | 15.10 | 14.12 | 11.82 |
| T₃         | 17.87 | 16.00 | 16.34 | 15.22 | 14.16 | 11.87 |
| T₄         | 17.81 | 16.50 | 16.32 | 15.34 | 14.22 | 11.79 |
| T₅         | 17.96 | 16.50 | 16.42 | 15.30 | 14.21 | 11.85 |
| T₆         | 17.94 | 16.50 | 16.34 | 15.43 | 14.33 | 11.87 |
| T₇         | 17.95 | 16.67 | 16.48 | 15.46 | 14.43 | 12.09 |
| T₈         | 18.00 | 17.06 | 16.53 | 15.83 | 14.53 | 12.35 |
| T₉         | 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
T₁: Cloth bag
T₂: Polythene bag (700 gauge)
T₃: Aluminium-laminated pouches
T₄: T₂ + Silica gel (100 g/kg seed)
T₅: T₃ + Silica gel (100 g/kg seed)
T₆: Polythene bag (700 gauge) with vacuum packing
T₇: Aluminium-laminated pouches with vacuum packing
T₈: T₆ + Silica gel (100 g/kg seed)
T₉: T₇ + 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
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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