Evaluation of seed physiological parameters of onionas influenced by different packaging materials and storage conditions

Abstract

A lab experiment was conducted for 18 months of period *i.e.,*from April 2021-Sep 2022 at NSP, Seed unit, UAS, Dharwad to study seed physiological parameters like moisture content and electrical conductivity as influenced by different packaging materials and storage conditions were evaluated.Onion seeds were evaluated at bi-monthly intervals, and the experimental design followed was a Factorial completely randomized design (FCRD) with 3 replications and 2 factors, namely storage conditions such as ambient and cold storage and storage containers (cloth bag, high-density polythene bag (HDPE), polythene bag (700 gauge), aluminum laminated bag, vacuum packed bag), the results revealed that the seeds stored with the treatment with vacuum packed bagand stored in cold storage gave good results at the end of 18 months of storage period*i.e.,* Seed moisture content (6.95 %) and electrical conductivity (0.732 dSm^{-1})respectively compared to other treatments. Next to the vacuum packed bag with cold storage, the best results were seen in the treatment in which Onion seeds stored in cold storage with the aluminum laminated bag.

Keywords: Vacuumpacked bag, cold storage, Ambient storage, Moisture content, Electrical conductivity

1. Introduction

Onion (*Allium cepa* L.) is one of the major bulb crops grown in the world.It holds a significant place in the world due to its widespread cultivation area and high demand for its consumption. Most of the onion produced in India comes from Maharastra, Karnataka, Uttar Pradesh Orissa, andGujarath, (Barakade*et al.,* 2011). It is generally known that seeds rapidly lose its viability after harvest unless special precautions are taken in their storage. The seed possesses the highest vigor at the time of physiological maturity and gradually decreases as the storage period increases (Goel *et al.,* 2003). The percentage and rate of germination of onion seeds also vary considerably among seed lots and this leads to difficulties in establishing optimum plant populations in the field. It has long been known that the factors, that have the greatest influence on the longevity of seeds in storage, are moisture, temperature, and oxygen partial pressure (Amjad and Anjum 2002). Maintaining seed viability for a longer period is very essential to preserve the genetic integrity of stored samples. Storage temperature and moisture content are the most important factors affecting seed longevity, with seed moisture content usually being more influential than temperature.

Majorly the initial quality of seeds, moisture level, relative humidity (RH %), and storage conditions have considerable influence on seed storage. However, if the seeds are stored in controlled conditions, it is suitable for maintenance of the seed quality for a longer duration. Prolong the storage period, especially in natural environments under tropical and subtropical areas, seed deterioration will be higher. The viability and vigor largely depend on the genotypes, production, mechanical injury to the seed, initial seed quality, seed treatment, packaging material, and storage conditions (Verma *et al.*, 1993).Supplying high quality seeds can be achieved by an appropriate post harvest storage technology (Shivappa, 2011).

Seeds are harmed by moist seeds and higher storage temperatures. (Ellis *et al*., 1981).The present investigation has been carried out to find out the effect of different storage containers and storage environment on the seed physiological parameters of onion seeds.

2.Material and methods

At the NSP, Seed unit, UAS, Dharwad, a lab experiment was conducted from April 2021 to September 2022. The seed physiological parameters such as moisture content and electrical conductivity were assessed, and the experiment design used wasa Factorial Completely Randomised Design (FCRD) with 3 replications and 2 factors, namely storage conditions such as ambient and cold storage and storage containers such as cloth bags, high-density polythene bags (HDPE), polythene bags, aluminum laminated bags and vacuum packed bags. The seeds were stored for 18 months. Arka Kalyan variety was used for the study. The seed is purchased from the University of Horticultural Sciences, Bagalkot. Every bimonthly, readings were taken.

2.1Seed moisture (%)

The test was conducted in independently drawn five gram working sample powder (Anon., 2013). The weight of the cup in grams along with the lid was taken (M_1), then five grams of coarse ground seed material was added to the cup (M_2). The samples were incubated in a hot air oven at 103 ^{o}C for 24 hours. After the completion of the drying period, the moisture cups were removed and kept in the desiccator for 15-20 minutes and then the weight was taken (M_3).

$$\text{Seed moisture (\%)} = \frac{(M_2 - M_3)}{\quad} \times 100$$

$$\overline{\quad (M_2 - M_1) \quad}$$

Where,

M_1: Weight (g) of the moisture cup + lid

M_2: Weight (g) of the moisture cup + lid + sample before drying

M_3: Weight (g) of the moisture cup + lid + sample after drying

2.2Electrical conductivity of seed leachate (dS m^{-1})

All seeds were thoroughly washed in distilled water. Then, the seeds were soaked in 25 ml distilled water and kept in incubation at room temperature for twelve hours. The seed leachate was collected and the volume was made up to 25 ml by adding distilled water. The electrical conductivity of the seed leachate was measured with the digital conductivity bridge (ELICO) with a cell constant of 1.0 and the mean values were expressed in deci-Simons per meter (dS m^{-1}) (Presley, 1958).

3. Results and discussion

There was a significant effect of storage containers and duration under ambient and cold temperatures onmoisture content and electrical conductivity was given in tables 1 to 2.

3.1Moisture Content

The results of moisture content as influenced by storage conditions, packaging materials, and their interactions during the storage period are given in table 1. Percent increase in moisture content in the treatment combinations during storage period was expressed in fig 1. With the increase in storage period, increase in moisture per cent from 6.81 at 2nd month to 7.82 per cent at the end of 18th month of storage period irrespective of storage conditions and packaging materials.

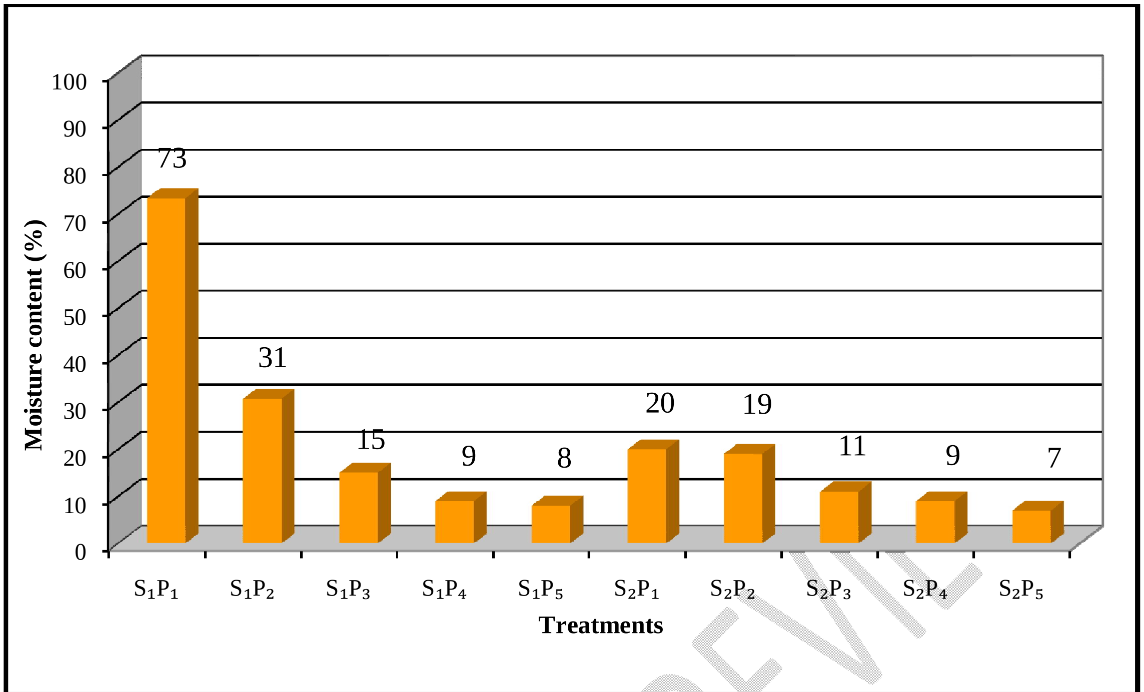

Fig. 1. Per cent increase in the moisture content of treatment interactions after 18 months of storage

Storage conditions (S)

Regardless of initial storage conditions and their packaging material higher mean moisture was noticed in ambient storage compared to cold storage throughout the storage period (18 months). The increase in mean moisture was from 6.82 to 8.27 per cent and from 6.78 to 7.35 per cent in ambient storage and cold storage respectively.

Packaging material (P)

Among all the packaging material, higher mean moisture increase was noticed in cloth bag followed by HDPE bag, polythene bag, aluminum laminated pouch and vacuum packed bag. Mean moisture content increased from 7.00 to 9.54 per cent in cloth bag and from 6.67 to 6.97 per cent in vacuum packed bags through the storage period.

Interaction (S x P)

Interaction effect of storage conditions and packaging material on mean moisture was found to be significant throughout the storage period. Among all the treatment, combinations S_2P_5 reported significantly lowest moisture of 6.95 per cent at the end of the storage period. S_1P_1 recorded significantly highest moisture of 11.27 per cent at the end of 18 months storage period. There was 73 per cent increase in moisture content in S_1P_1 followed by $S_1P_{2,}$ (31 %)

increase and 7 per cent increase was seen in S_2P_5. Moisture content increased as the storage progressed. Highest increase was seen in treatment S_1P_1 (73 %) then followed by S_1P_2 (31 %) and lowest increase was seen in S_2P_5 (7 %).

3.2 Electrical conductivity

The results of electrical conductivity as influenced by storage conditions, packaging materials and their interactions during storage period is given in table 2. With the increase in storage period, increase in electrical conductivity from 0.720 at 2nd month to 0.910 dSm^{-1} at the end of 18th month of storage period irrespective of storage conditions and packaging materials.

Storage conditions (S)

Regardless of initial storage conditions and their packaging material higher mean electrical conductivity was noticed in ambient storage compared to cold storage throughout the storage period (18 months). The increase in mean electrical conductivity was from 0.744 to 1.064 dSm^{-1} and from 0.691 to 0.758 dSm^{-1} in ambient storage and cold storage respectively.

Packaging material (P)

Among all the packaging material, higher mean electrical conductivity increase was noticed in cloth bag followed by HDPE bag, polythene bag, aluminum laminated pouch and vacuum packed bag. Mean electrical conductivity increased from 0.726 to 1.220 dSm^{-1} in cloth bag and from 0.710 to 0.774 dSm^{-1} in vacuum packed bags throughout the storage period.

Interaction (S x P)

Interaction effect of storage conditions and packaging material on mean electrical conductivity was found to be significant throughout the storage period. Among all the treatment, combinations S_2P_5 reported significantly lowest electrical conductivity of 0.732 dSm^{-1} at the end of the storage period, while S_1P_1 recorded significantly highest electrical conductivity of 1.677 dSm^{-1} at the end of 18 months storage period.

In the present study, there was lot of fluctuation in the seed moisture content stored in cloth bag and HDPE bag and in ambient condition as compared to cold condition, less moisture was seen in aluminum laminated pouches and vacuum packed bags.Seeds absorbed moisture when relative humidity (RH) was high whereas, they have lost the moisture when humidity was low. The differential moisture content was due to surrounding environmental conditions and hygroscopic nature of seeds. Similar results were also reported by Shelar *et al.* (2015) in onion, Jaya *et al.* (2014) in soybean, Sarma *et al.* (2014) in cowpea, Veraja and Rai (2015) in blackgram, Gnyandev *et al.* (2015) in chickpea, Amruta *et al.* (2015) in blackgram, Shankar *et al.* (2018) in blackgram, Tandoh *et al.* (2017) in seeds of *Pericopsiselata*and Kumar *et al.* (2017) in alfalfa.

Similarly, when seeds were stored in pervious packaging materials like cloth bag, HDPE bags and kept in cold condition, all the seeds have absorbed the moisture.The sample of polythene bag used for vacuum package were checked for its Water transmission rate and Oxygen transmission rate. As vacuum polythene bag had very less water vapour transmission rate (WTR) (0.95 g/m^2/24 hrs at 30ºC and 90.0 % RH), oxygen transmission rate (OTR) [0.91 cc/ (m^2 × day × atm)] and higher thickness (149.40 microns). Due to these special characters of polythene bag that was used for vacuum packaging, there was very little variation in moisture content of the seeds throughout the storage period both in cold and ambient storage conditions. These results are in accordance with Khanna *et al.* (2017) in chickpea, Meena *et al.* (2017c) in soybean, and Deepa *et al.* (2013) in chilli.

The Electrical conductivity **(**EC) of seed leachate is index of vigour, seed viability and deterioration. Generally, higher values of EC indicate a higher rate of seed deterioration as they are positively correlated, whereas, leaching of sugars and amino acids from seed membranes are negatively associated with membrane integrity and germination and vigour.

In the present study, as the storage period progressed, the electrical conductivity of seed leachate was increased and higher values of EC were recorded in cloth bags and HDPE bags in both ambient and cold conditions. However, it was more in ambient condition as compared to the cold storage condition as there was a higher rate of seed deterioration. Due to less rate of seed deterioration in vacuum packed bags, the lower EC was recorded, irrespective of storage conditions. At the end of the storage period, higher EC was recorded in cloth bags and HDPE bags and these treatments were in significant difference with vacuum packed bags stored in both conditions. These results were similar to the pattern as reported by

Malimath and Merwade, (2007) in garden pea, Amruta *et al.* (2015) in blackgram, Narayanaswamy (2003) in groundnut, Gnyandev *et al.* (2015) in chickpea, Shelar *et al.* (2015) in soybean, and Kumar *et al.* (2017) in Alfalfa.

The causes for the increase in the EC of seeds is due to loss of cell membrane integrity with the advancement in the storage period as membrane integrity of the seed has a greater influence on seed performance. Similarly, the negative relationship between EC and seed germination indicated low-quality seed and lowered the germination capacity (Halim *et al.,* 2012). Reason for higher electrolytes leakage was due to peroxidation of unsaturated fatty acids of the bio membrane as reported by Vieira *et al.* (1999).

Conclusion:

It was concluded that different storage conditions and storage containers play a significant role in the moisture content and electrical conductivity of onion seeds. Moisture content and electrical conductivity of the onion seeds were increased as the storage progressed but with less in the vacuum packed bag stored in cold storage than other treatment combinations. The rate of seed deterioration and loss of seed viability may be due to a combination of various factors such as genotypical and environmental factors.

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Table 1. Influence of packaging material and storage conditions on seed moisture content (%) during storage in onion seeds

Treatments	Storage (Months)								
	2	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**
Storage conditions (S)									
S_1: Ambient	6.82	6.94	7.04	7.16	7.33	7.52	7.74	7.92	8.27
S_2: Cold	6.78	6.82	6.87	6.92	7.02	7.06	7.12	7.24	7.35
S. Em (±)	0.004	0.015	0.008	0.007	0.02	0.02	0.02	0.008	0.02
C. D. (1%)	0.017	0.065	0.035	0.030	0.10	0.09	0.11	0.036	0.08
Packaging materials (P									
P_1: Cloth bag	7.00	7.20	7.37	7.54	7.89	8.20	8.65	8.90	9.54
P_2: High density polythene bag	6.85	6.99	7.10	7.27	7.48	7.63	7.77	7.90	8.12
P_3: Polythene bags (700 gauge)	6.76	6.79	6.83	6.87	6.96	7.00	7.10	7.23	7.35
P_4: Aluminum laminated pouch	6.73	6.74	6.77	6.81	6.82	6.83	6.85	6.98	7.08
P_5: Vacuum packed bags	6.67	6.68	6.71	6.73	6.76	6.79	6.80	6.90	6.97
S. Em (±)	0.006	0.024	0.013	0.011	0.03	0.03	0.04	0.01	0.03
C. D. (1%)	0.027	0.103	0.056	0.048	0.16	0.15	0.17	0.05	0.14
Interaction (S x P)									
S_1P_1	7.02	7.35	7.61	7.88	8.42	8.95	9.73	10.12	11.27
S_1P_2	6.89	7.11	7.21	7.43	7.62	7.87	8.05	8.18	8.50
S_1P_3	6.77	6.80	6.87	6.92	7.03	7.13	7.27	7.38	7.50
S_1P_4	6.74	6.76	6.79	6.84	6.85	6.86	6.88	7.00	7.11
S_1P_5	6.69	6.71	6.73	6.75	6.77	6.80	6.81	6.93	7.00
S_2P_1	6.99	7.07	7.13	7.20	7.36	7.45	7.58	7.70	7.82
S_2P_2	6.82	6.88	7.00	7.11	7.34	7.40	7.49	7.62	7.75
S_2P_3	6.76	6.78	6.81	6.83	6.90	6.88	6.93	7.08	7.20
S_2P_4	6.72	6.73	6.75	6.78	6.79	6.81	6.82	6.97	7.07
S_2P_5	6.65	6.66	6.69	6.72	6.75	6.78	6.79	6.87	6.95
Mean	**6.81**	**6.88**	**6.96**	**7.05**	**7.18**	**7.29**	**7.44**	**7.58**	**7.82**
S. Em (±)	**0.009**	**0.030**	**0.019**	**0.016**	**0.05**	**0.05**	**0.05**	**0.01**	**0.04**
C. D. (1%)	**0.038**	**0.14**	**0.080**	**0.069**	**0.22**	**0.21**	**0.24**	**0.08**	**0.19**
C.V (%)	**0.24**	**0.88**	**0.48**	**0.41**	**1.31**	**1.24**	**1.39**	**0.45**	**1.05**

NS: Non-significant, **Storage conditions (S): S1:** Ambient storage, **S2:** Cold storage, **Packaging materials (P): P1:** Cloth bag, **P2:** High density polythene bag, **P3:** Polythene bags (700 gauge), **P4:**Aluminum laminated pouch, **P5:** Vacuum packed bags (Initial=6.50 %)

Table 2. Influence of packaging material and storage conditions on electrical conductivity (dSm^{-1}) of seed leachates during storage in onion seeds

Treatments	Storage (Months)								
	2	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**
Storage conditions (S)									
S_1: Ambient	0.744	0.747	0.757	0.770	0.804	0.860	0.905	0.960	1.064
S_2: Cold	0.691	0.693	0.697	0.704	0.713	0.721	0.729	0.743	0.758
S. Em (±)	0.0002	0.0002	0.002	0.0003	0.001	0.002	0.001	0.002	0.004
C. D. (1%)	0.0008	0.001	0.009	0.001	0.006	0.010	0.007	0.011	0.020
Packaging materials (P)									
P_1: Cloth bag	0.726	0.728	0.747	0.770	0.821	0.926	1.00	1.090	1.220
P_2: High density polythene bag	0.722	0.725	0.728	0.736	0.755	0.778	0.799	0.838	0.939
P_3: Polythene bags (700 gauge)	0.717	0.720	0.723	0.729	0.749	0.764	0.779	0.799	0.816
P_4: Aluminum laminated pouch	0.712	0.715	0.719	0.725	0.736	0.743	0.754	0.770	0.797
P_5: Vacuum packed bags	0.710	0.712	0.716	0.724	0.732	0.739	0.747	0.756	0.774
S. Em (±)	0.0003	0.0004	0.003	0.0005	0.002	0.003	0.002	0.004	0.007
C. D. (1%)	0.001	0.001	0.015	0.002	0.010	0.016	0.010	0.018	0.032
Interaction (S x P)									
S_1P_1	0.755	0.759	0.793	0.828	0.922	1.123	1.270	1.423	1.677
S_1P_2	0.749	0.753	0.756	0.763	0.791	0.832	0.865	0.925	1.107
S_1P_3	0.743	0.746	0.749	0.753	0.785	0.805	0.827	0.853	0.870
S_1P_4	0.739	0.741	0.745	0.754	0.762	0.770	0.783	0.805	0.850
S_1P_5	0.736	0.739	0.742	0.754	0.762	0.771	0.780	0.794	0.817
S_2P_1	0.697	0.699	0.702	0.713	0.721	0.730	0.740	0.765	0.780
S_2P_2	0.695	0.697	0.701	0.709	0.720	0.726	0.733	0.752	0.772
S_2P_3	0.693	0.695	0.697	0.706	0.714	0.723	0.732	0.745	0.763
S_2P_4	0.687	0.690	0.694	0.698	0.710	0.717	0.726	0.737	0.745
S_2P_5	0.685	0.687	0.691	0.696	0.703	0.709	0.714	0.765	0.732
Mean	**0.72**	**0.72**	**0.72**	**0.74**	**0.76**	**0.79**	**0.82**	**0.85**	**0.91**
S. Em (±)	**0.0004**	**0.0006**	**0.005**	**0.0007**	**0.003**	**0.005**	**0.004**	**0.006**	**0.011**
C. D. (1%)	**0.001**	**0.002**	**0.021**	**0.003**	**0.014**	**0.023**	**0.017**	**0.026**	**0.046**
C.V (%)	**0.11**	**0.16**	**1.25**	**0.18**	**0.82**	**1.21**	**0.87**	**1.29**	**2.12**

NS: Non-significant, Storage conditions (S): S1: Ambient storage, **S2:** Cold storage, **Packaging materials (P): P1:** Cloth bag, **P2:** High density polythene bag, **P3:** Polythene bags (700 gauge), **P4:**Aluminum laminated pouch, **P5:** Vacuum packed bags (Initial=0.670 dSm^{-1})