

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 the period to study the seed physiological parameters like moisture content and electrical conductivity. How the different packaging materials and storage conditions influenced the moisture content and electrical conductivity 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 in the vacuum packed bag along with combination of 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 were stored in cold storage with the aluminum laminated bag.

Keywords: Vacuum-packed bag, High-density polythene 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 Maharashtra, Karnataka, Uttar Pradesh Orissa, and Gujarat, (Barakade *et al.*, 2011). It is generally known that seeds rapidly lose their viability after harvest unless special precautions are taken in their storage [23-26]. 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. The ability of seeds to germinate decreases as catabolic changes occur with age (Rao *et al.*, 2023).

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. Relative humidity plays a major role during storage. If the relative humidity is higher then seeds can absorb more moisture leading to deterioration. Supplying high-quality seeds can be achieved by an appropriate post-harvest storage technology (Shivappa, 2011).

Seeds are harmed by moisture 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 environments 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 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 such as cloth bags, high-density polythene bags (HDPE), polythene bags, aluminum laminated bags and vacuum-packed bags. Statistical analysis was done with OP stat and results were expressed. 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 bi-monthly, readings were taken.

2.1 Seed moisture (%)

The test was conducted with independently drawn five grams working sample powder (Anon., 2013). The weight of the cup in grams along with the lid was taken (M_1), and 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 °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).

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

$$\frac{(M_2 - M_1)}{M_3}$$

Where,

M₁: Weight (g) of the moisture cup + lid

M₂: Weight (g) of the moisture cup + lid + sample before drying

M₃: Weight (g) of the moisture cup + lid + sample after drying

2.2 Electrical 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 on moisture content and electrical conductivity was given in **Tables 1 to 2**.

3.1 Moisture 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. The percent increase in moisture content in the treatment combinations during the storage period was expressed in Fig 1. With the increase in storage period, increase in moisture percent from 6.81 at the 2nd month to 7.82 percent at the end of the 18th month of the storage period irrespective of storage conditions and packaging materials.

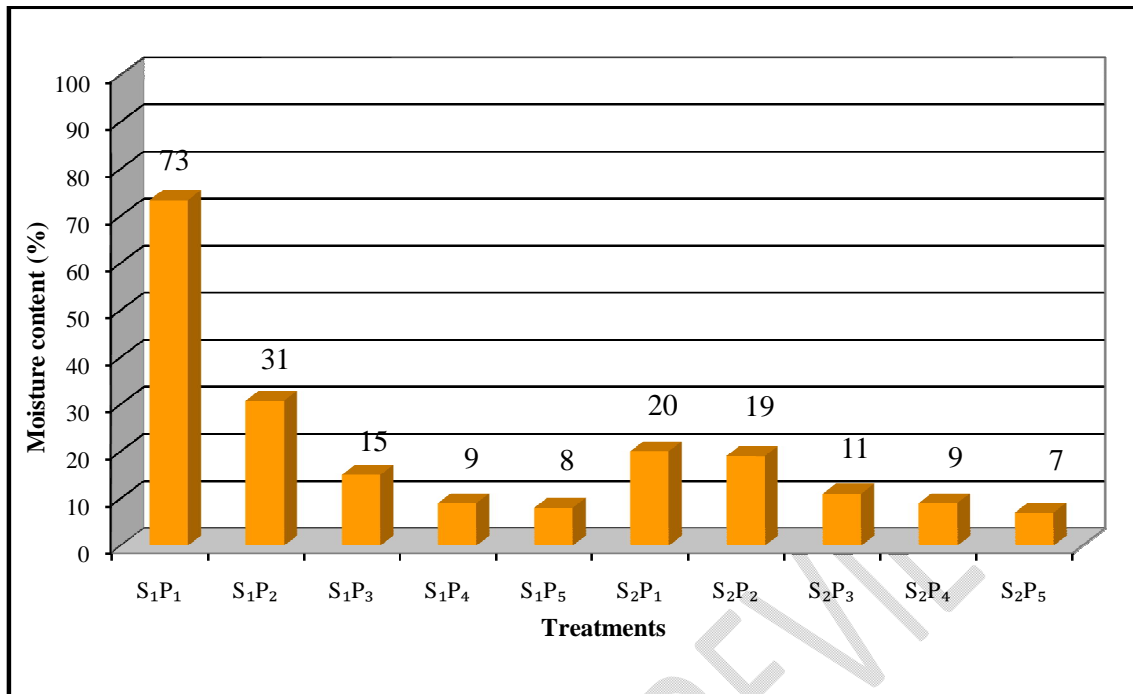


Fig. 1. Per cent increase in the moisture content of treatment interactions after 18 months of storage

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 percent and from 6.78 to 7.35 percent in ambient storage and cold storage respectively.

Packaging material (P)

Among all the packaging materials, a higher mean moisture increase was noticed in cloth bags followed by HDPE bags, polythene bags, aluminum laminated pouches, and vacuum-packed bags. Mean moisture content increased from 7.00 to 9.54 percent in cloth bags and from 6.67 to 6.97 percent in vacuum-packed bags through the storage period.

Interaction (S x P)

The interaction effect of storage conditions and packaging material on mean moisture was found to be significant throughout the storage period. Among all the treatments, combinations S₂P₅ reported significantly lowest moisture of 6.95 percent at the end of the storage period. S₁P₁ recorded significantly the highest moisture of 11.27 percent at the end of the 18 months storage period. There was a 73 percent increase in moisture content in

S₁P₁ followed by S₁P₂, (31 %), and a 7 percent increase was seen in S₂P₅. Moisture content increased as the storage progressed. The highest increase was seen in treatment S₁P₁ (73 %) then followed by S₁P₂ (31 %) and the lowest increase was seen in S₂P₅ (7 %).

3.2 Electrical conductivity

The results of electrical conductivity as influenced by storage conditions, packaging materials, and their interactions during the storage period are given in Table 2. With the increase in storage period, increase in electrical conductivity from 0.720 in the 2nd month to 0.910 dSm⁻¹ at the end of the 18th month of the 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 materials, a higher mean electrical conductivity increase was noticed in cloth bags followed by HDPE bags, polythene bags, aluminum laminated pouches, and vacuum-packed bags. Mean electrical conductivity increased from 0.726 to 1.220 dSm⁻¹ in cloth bags and from 0.710 to 0.774 dSm⁻¹ in vacuum-packed bags throughout the storage period.

Interaction (S x P)

The interaction effect of storage conditions and packaging material on mean electrical conductivity was found to be significant throughout the storage period. Among all the treatments, combinations S₂P₅ reported significantly the lowest electrical conductivity of 0.732 dSm⁻¹ at the end of the storage period, while S₁P₁ recorded significantly the highest electrical conductivity of 1.677 dSm⁻¹ at the end of the 18-month storage period.

In the present study, there was a lot of fluctuation in the seed moisture content stored in cloth bags and HDPE bags, and in ambient conditions as compared to cold conditions, less

moisture was seen in aluminum laminated pouches and vacuum-packed bags. Seeds absorbed moisture when relative humidity (RH) was high whereas, they lost the moisture when humidity was low. The differential moisture content was due to surrounding environmental conditions and the hygroscopic nature of the 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 *Pericopsis elata* and Kumar *et al.* (2017) in alfalfa.

Similarly, when seeds were stored in previous packaging materials like cloth bags, HDPE bags and kept in cold conditions, all the seeds absorbed the moisture. The sample of polythene bags used for the vacuum package was 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/m²/24 hrs at 30°C and 90.0 % RH), oxygen transmission rate (OTR) [0.91 cc/ (m² × day × atm)] and higher thickness (149.40 microns). Due to these special characteristics of the polythene bag that was used for vacuum packaging, there was very little variation in the 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 chickpeas, Meena *et al.* (2017c) in soybean, and Deepa *et al.* (2013) in chilli.

The Electrical conductivity (EC) of seed leachate is the index of vigor, 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 is negatively associated with membrane integrity, germination, and vigor.

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 the lower 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 significantly different with vacuum-packed bags stored in both conditions. These results were similar to the pattern reported by

Malimath and Merwade, (2007) in garden peas, Amruta *et al.* (2015) in black gram, Narayanaswamy (2003) in groundnut, Gnyandev *et al.* (2015) in chickpeas, 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 germination capacity (Halim *et al.*, 2012).

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 at a lesser pace in the vacuum-packed bags stored in a cold storage environment compared to other treatment combinations.

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References

1. Amjad M and Anjum M A. 2002. Evaluation of physiological quality of onion seed stored for different periods. *International Journal of Agriculture and Biology* 4(3): 365-369.
2. Amruta N, Sarika G, Umesha J B, Maruthi and Basavaraju G V, 2015, Effect of botanicals and insecticides seed treatment and containers on seed longevity of black gram under natural aging conditions. *Journal of Applied and Natural Science*, 7(1): 328-334.
3. Barakade A J, Lokhande T N and Todkari G U. 2011. Economics of onion cultivation and its marketing pattern in Satara district of Maharashtra. *International Journal of Agriculture Sciences* 3(3): 110-117.
4. Deepa G T, Chetti M B, Khetagoudar M C and Adavirao G M, 2013, Influence of vacuum packaging on seed quality and mineral contents in chilli (*Capsicum annuum* L.). *Journal of Food Science and Technology*, 50: 153-158.
5. Ellis R H and Roberts E H, 1981, The quantification of aging and survival in orthodox seeds. *Seed Science and Technology*, 9: 373-409.
6. Gnyandev B, Kurdikeri M B, Salimath P M, Ravinderkumar and kailashnath, 2015, Influence of seed size on storage potential of chickpea varieties. *International Journal of Agricultural Sciences Research*, 5(4):189-194.
7. Goel, A., Goel, A. K. and Sheoran, I. S. 2002. Changes in oxidative stress enzymes during artificial aging in cotton (*Gossypium hirsutum* L.) seeds. *Journal of Plant Physiology*, 160: 1093-100.
8. Halim M A, Hossain M M, Haque M M and Solaiman A R M, 2012, Seed quality of onion as influenced by maturity stage. *Seed Techno. J.*,3:9-12.
9. Jaya J, Wani A A, Titov A, Tomar D S, 2014, Seed quality parameters of soybean (*Glycine Max.* L.) as influenced by seed treating fungicides and botanicals and packing materials. *Indian Journal of Applied Research*, 3(4): 219-222.

10. Khanna N, Jain P and Teckchandani C K, 2017, Comparative study of quality and nutritive parameters of insect-infested Bengal gram under vacuum and modified atmosphere storage in laminated LDPE bags. *International Journal of Current Microbiology and Applied Science*, 6(12): 4303-4308.
11. Kumar P A, Channakeshava B C and Siddaraju R., 2017, Influence of seed treatments and packaging materials on seed longevity of alfalfa (*Medicago Sativa L.*) CV. RL-88. *Plant Archives*, 17(2): 1221-1227.
12. Malimath D S and Merwade M N, 2007, Effect of storage containers on seed storability of garden pea (*Pisum sativum L.*). *Karnataka Journal of Agricultural Sciences*, 20(2): 384-385.
13. Meena M K, Chetti M B and Nawalagatti C M, 2017, Seed physiological and biochemical parameters of soybean (*Glycine max*) as influenced by different packaging materials and storage conditions. *International Journal of Pure and Applied Biosciences*, 5(1): 864-875.
14. Narayanaswamy S, 2003, Effect of packaging and location of storage on groundnut seed. In: *Proceedings of National Workshop on Groundnut Seed Technology*, pp. 6-7.
15. Presley J T, 1958, Relationship of protoplast permeability of cotton seed viability and predisposition of seedling disease. *Plant Disease Reporter*, 42(7): 582.
16. Rao D, Pashwan VR, Chaitanya G, Verma B, Negi PS, et al. Physiological and biochemical changes during seed deterioration in seed –A Review. Deepak Rao., *ELSJ*. 2023;9(1):1–10.
17. Sarma A K, Devi M R, and Nigam A, 2014, Efficiency of storage device for long-term storage of cowpea seeds. *International Journal of Agriculture Environment and Biotechnology*, 7(2): 233-240.
18. Shankar S V, Pandiarajanb T and Ganapathy S, 2018, Biochemical changes of black gram grains during hermetic storage. *Research Journal of Chemical and Environmental Sciences*, 6(6): 15-21.

19. Shelar V R, Mali M S and Nagawade D R, 2015, Influence of storage conditions on quality of soybean [*Glycine max* (L.) Merrill] Seeds. *Journal of Food Legumes*, 28(2): 165-169.
20. Shivappa R, 2011, Studies on the effect of modified atmospheric storage condition on storability of onion seeds. *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences, Raichur, Karnataka.
21. Tandoh P K, Banful B, Gaveh E, James O, Amponsah, 2017, Effects of packaging materials and storage periods on seed quality and longevity dynamics of *Pericopsis elata* seeds. *Environment, Earth and Ecology*, 1(2): 27-38.
22. Veraja P and Rai P K, 2015, Effect of polymer coating, chemicals, and biocontrol agent on storability of black gram (*Vigna mungo* L.). *International Journal of Plant and Soil Science*, 8(6): 1-8.
23. Adam, Olosunde, Ojo Abisoye, Uthman Tolani, Olasoji Julius, Oluwadare Ayooluwa, and Aliyu Taiwo. 2018. "Germination Performance and Vigour of Pepper Seeds Stored in Different Environmental Conditions at Different Storage Periods". *Asian Journal of Biology* 5 (2):1-6. <https://doi.org/10.9734/AJOB/2018/39791>.
24. Aculey , P., P. K. Tandoh, and D. D. Gamenyah. 2023. "Physiological Seed Quality Responses of Three Rice Varieties to Different Storage Materials under Ambient Conditions". *Journal of Experimental Agriculture International* 45 (9):135-41. <https://doi.org/10.9734/jeai/2023/v45i92184>.
25. Kibar H, Yücesan B. Effects of storage durations at different temperatures on various physiological parameters of einkorn seed (*Triticum monuocum* L.) germination. *Journal of Stored Products Research*. 2021 Sep 1;93:101851.
26. Ludwig V, Berghetti MR, Rossato FP, Wendt LM, Schultz EE, Both V, Brackmann A. Impact of controlled atmosphere storage on physiological quality of soybean seed. *Journal of stored products research*. 2021 Jan 1;90:101749.

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)									
S₁: Ambient	6.82	6.94	7.04	7.16	7.33	7.52	7.74	7.92	8.27
S₂: 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)									
P₁: Cloth bag	7.00	7.20	7.37	7.54	7.89	8.20	8.65	8.90	9.54
P₂: High density polythene bag	6.85	6.99	7.10	7.27	7.48	7.63	7.77	7.90	8.12
P₃: Polythene bags (700 gauge)	6.76	6.79	6.83	6.87	6.96	7.00	7.10	7.23	7.35
P₄: Aluminum laminated pouch	6.73	6.74	6.77	6.81	6.82	6.83	6.85	6.98	7.08
P₅: 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)									
S₁P₁	7.02	7.35	7.61	7.88	8.42	8.95	9.73	10.12	11.27
S₁P₂	6.89	7.11	7.21	7.43	7.62	7.87	8.05	8.18	8.50
S₁P₃	6.77	6.80	6.87	6.92	7.03	7.13	7.27	7.38	7.50
S₁P₄	6.74	6.76	6.79	6.84	6.85	6.86	6.88	7.00	7.11
S₁P₅	6.69	6.71	6.73	6.75	6.77	6.80	6.81	6.93	7.00
S₂P₁	6.99	7.07	7.13	7.20	7.36	7.45	7.58	7.70	7.82
S₂P₂	6.82	6.88	7.00	7.11	7.34	7.40	7.49	7.62	7.75
S₂P₃	6.76	6.78	6.81	6.83	6.90	6.88	6.93	7.08	7.20
S₂P₄	6.72	6.73	6.75	6.78	6.79	6.81	6.82	6.97	7.07
S₂P₅	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)									
S₁: Ambient	0.744	0.747	0.757	0.770	0.804	0.860	0.905	0.960	1.064
S₂: 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)									
P₁: Cloth bag	0.726	0.728	0.747	0.770	0.821	0.926	1.00	1.090	1.220
P₂: High density polythene bag	0.722	0.725	0.728	0.736	0.755	0.778	0.799	0.838	0.939
P₃: Polythene bags (700 gauge)	0.717	0.720	0.723	0.729	0.749	0.764	0.779	0.799	0.816
P₄: Aluminum laminated pouch	0.712	0.715	0.719	0.725	0.736	0.743	0.754	0.770	0.797
P₅: 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)									
S₁P₁	0.755	0.759	0.793	0.828	0.922	1.123	1.270	1.423	1.677
S₁P₂	0.749	0.753	0.756	0.763	0.791	0.832	0.865	0.925	1.107
S₁P₃	0.743	0.746	0.749	0.753	0.785	0.805	0.827	0.853	0.870
S₁P₄	0.739	0.741	0.745	0.754	0.762	0.770	0.783	0.805	0.850
S₁P₅	0.736	0.739	0.742	0.754	0.762	0.771	0.780	0.794	0.817
S₂P₁	0.697	0.699	0.702	0.713	0.721	0.730	0.740	0.765	0.780
S₂P₂	0.695	0.697	0.701	0.709	0.720	0.726	0.733	0.752	0.772
S₂P₃	0.693	0.695	0.697	0.706	0.714	0.723	0.732	0.745	0.763
S₂P₄	0.687	0.690	0.694	0.698	0.710	0.717	0.726	0.737	0.745
S₂P₅	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)