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Effect of different containers and storage conditions on seed quality parameters during storage in onion seed (*Allium cepa* L.)

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Abstract
A lab experiment was conducted during April 2021-Sep 2022 at NSP, Seed unit, UAS, Dharwad. The experimental design was Factorial completely randomised design having 3 replications and 2 factors *i.e.* storage conditions like ambient and cold storage and storage containers (cloth bag, high density polythene bag (HDPE), polythene bag, aluminum laminated bag, vacuum packed bag) and stored for 18 months of period and seed quality parameters like Speed of germination, Mean seedling length and mean germination time were evaluated at bimonthly intervals, the results revealed that, the treatment with vacuum packed bags and stored in cold storage gave good results at the end of 18 months of storage period. Speed of germination (43.12), mean seedling length (16.58) and mean germination time (1.40 days) respectively compared to other seed stored in different packaging materials that is stored in ambient and cold storage conditions.

Keywords: Vacuum packed bag, ambient storage, cold storage, speed of germination, mean germination time

1. Introduction
Onion (*Allium cepa* L.) is considered as one of the important vegetables among bulb crops which comes under the family Amaryllidaceae. It occupies a major position in the world as it is cultivated in majority of the countries and has huge demand for its consumption. Seed is the basic and crucial input in agriculture. Seeds are practically worthless if, they fail to give healthy and vigorous plants upon planting. The successful production of any crop depends on the quality of seeds used for sowing. Although seed quality is governed by genetic makeup, seed storage and retention of viability are important for seed vigour (Deepa *et al.*, 2013) [6].
Majorly the initial quality of seeds, moisture level, relative humidity (RH %) and storage conditions have considerable influence on seed storability. However, if the seeds are stored in controlled conditions which is suitable for maintenance of the seed quality for longer duration. As onion seed is one of the short lived compared to other crop species so seed sellers practice mixing of old seed with freshly harvested seed for getting more profits. This practice result in decreasing transplants required in the field. Prolong the storage period especially in natural environments under tropical and subtropical areas, seed deterioration will be higher.
Seed viability and vigour may decline due to deterioration processes as it is inexorable and irreversible process, which leads to increase in the free radicals and their chain elongation, modifications in the structure of proteins, food reserves depletion, increase in fat acidity, alterations in the activity of enzymes, membrane related damages, chromosomal aberrations and finally increase in the respiration rate of the seeds. Normally the extent of deterioration will increase when seed moisture levels and the temperature of the storage place increases. Moist seeds and increased storage temperatures cause injury to seed (Ellis *et al*., 1981) [17]. Irrespective of initial seed quality, unfavourable storage conditions, particularly ambient temperature and relative humidity, contribute to accelerating seed deterioration during storage. Hence, it is difficult to assess the effective storage period because the storability of the seed is a function of initial seed quality and the storage conditions and may vary among different seed types (Anfinrud, 1997; Fabrizius *et al*. 1999; Heatherly and Elmore, 2004) [2, 7, 8].

2. Material and Methods

A lab experiment was conducted during April 2021-Sep 2022 at NSP, Seed unit, UAS, Dharwad. The experimental design was Factorial completely randomised design having 3 replications and 2 factors *i.e.* storage conditions like ambient and cold storage and storage containers (cloth bag, high density polythene bag (HDPE), polythene bag, aluminum laminated bag, vacuum packed bag) and stored for 18 months of period and seed quality parameters like Speed of germination, Mean seedling length and mean germination time were evaluated. Arka kalyan variety was selected for the study. The seed is obtained from university of horticultural sciences, Bagalkot. The readings were taken on bimonthly basis.

2.1 Speed of germination

Hundred seeds of four replications were kept for germination on paper medium. The number of seeds germinated was recorded daily up to the day of final count. The speed of germination was calculated by using the formula suggested by Maguire (1962) [9].

$$\text{Speed of germination} = \frac{G_1}{D_1} + \frac{G_2}{D_2} + \ldots\ldots\ldots + \frac{G_n}{D_n}$$

Where,

G_1, G_2, --- G_n are the number of seeds germinated on D_1, D_2, --- D_n day

2.2 Mean seedling length (cm)

Ten normal seedlings were randomly selected from each treatment and replication and then carefully separated from the wet paper towel of the germination test. The total length of the seedling was measured from tip of primary root to tip of primary leaf by using a measuring scale. The mean of ten seedlings from each treatment in each replication was calculated and is expressed in centimetres (Anon., 2010) [3].

2.3 Mean germination time (MGT, days)

Seeds were put for germination by following between paper method by placing 100 seeds. The numbers of seeds germinated were recorded on daily basis. The mean germination time was calculated by following the formula as suggested by Azimi *et al.* (2013) [4].

$$\text{Mean germination time} = \frac{(n1 \times d1) + (n2 \times d2) + \ldots\ldots}{\text{Total number of seeds germinated}}$$

Where,

n: number of seeds germinated on each day

d: number of days

3. Results and Discussion

3.1 Speed of germination

Results of speed of germination is given in the table 1. Initially the speed of germination was 47.37, as the storage period progressed the speed of germination got decreased from 45.77 in second month to 35.37 at 18 th month of storage period. As the storage period progressed the speed of germination got decreased in all the months of storage period irrespective of the storage condition and storage container but in case of vacuum packed container which is stored in cold storage (S_2P_5) environment there was seen a less decrease in speed of germination compared to other treatments. Then it is followed by vacuum packed bag stored in ambient storage (S_1P_5). The speed of germination is zero in case of S_1P_1 because there was no germination at the end of 18 th month of storage period.

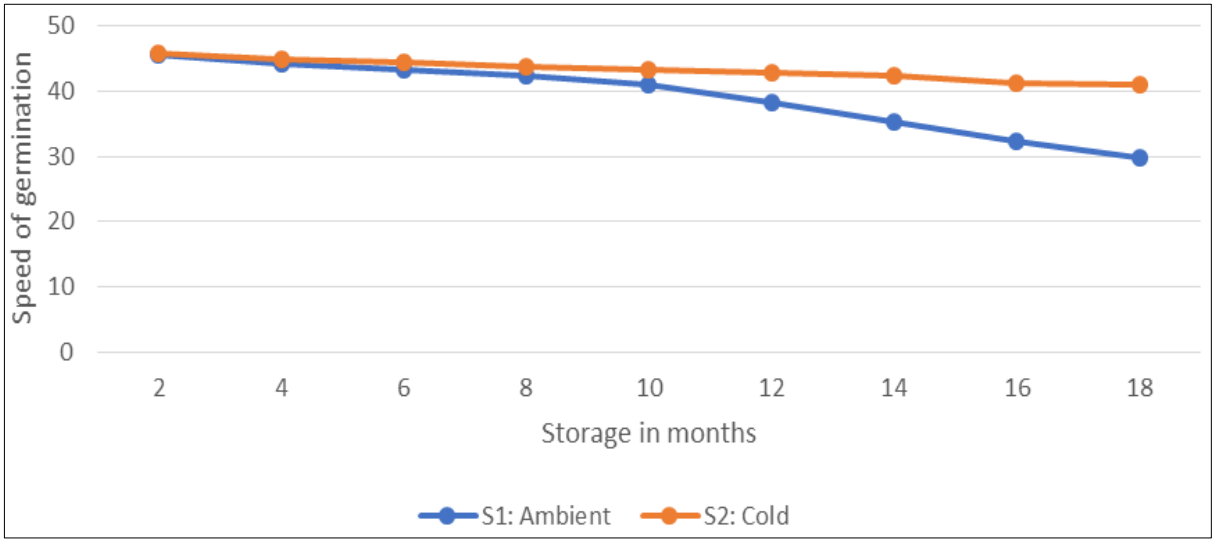

Fig 1: Effect of storage conditions on speed of germination in onion seed during storage

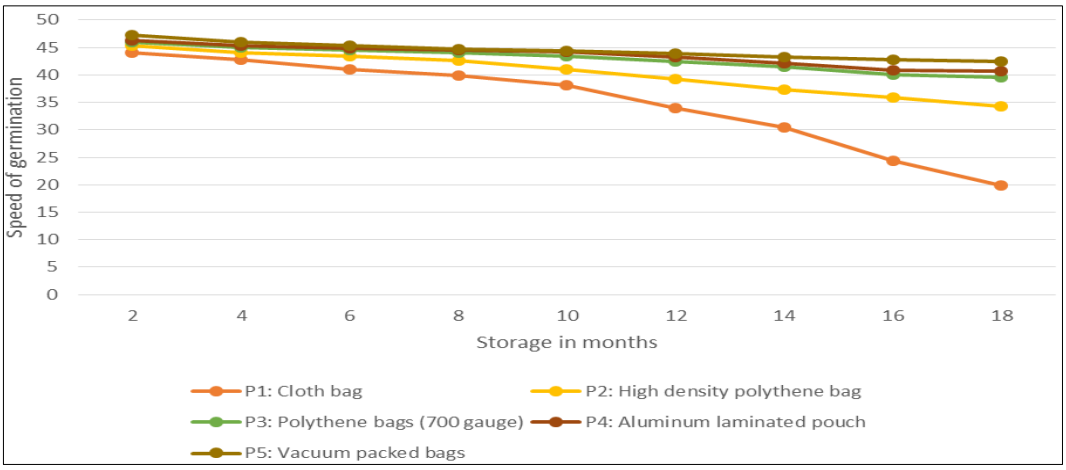

Fig 2: Effect of packaging materials on speed of germination in onion seeds during storage

Table 1: Influence of packaging material and storage conditions on Speed of germination during storage in onion seeds

Treatments	Storage (Months)								
	2	4	6	8	10	12	14	16	18
Storage conditions (S)									
S_1: Ambient	45.57	44.31	43.23	42.50	41.08	38.18	35.41	32.25	29.73
S_2: Cold	45.96	44.98	44.45	43.84	43.41	42.97	42.42	41.34	40.99
S.Em (±)	0.12	0.17	0.21	0.15	0.13	0.09	0.13	0.09	0.08
C. D. (1%)	0.58	0.71	0.88	0.66	0.56	0.39	0.56	0.39	0.34
Packaging materials (P)									
P_1: Cloth bag	44.07	42.76	40.99	39.94	38.17	33.92	30.45	24.37	19.82
P_2: High density polythene bag	45.28	44.11	43.46	42.68	40.94	39.29	37.30	35.91	34.31
P_3: Polythene bags (700 gauge)	46.02	44.98	44.54	44.07	43.50	42.46	41.42	40.07	39.60
P_4: Aluminum laminated pouch	46.28	45.41	44.93	44.49	44.15	43.28	42.16	40.86	40.68
P_5: Vacuum packed bags	47.19	45.97	45.28	44.67	44.46	43.93	43.24	42.76	42.42
S.Em (±)	0.20	0.27	0.33	0.25	0.21	0.15	0.21	0.15	0.12
C. D. (1%)	0.84	1.13	1.39	1.05	0.89	0.62	0.89	0.62	0.53
Interaction (SXP)									
S_1P_1	43.81	42.07	39.04	37.30	34.53	26.37	20.13	8.68	0.00
S_1P_2	45.20	43.64	42.77	42.34	39.39	36.61	32.97	31.14	28.37
S_1P_3	45.98	44.85	44.33	43.90	43.29	41.64	40.43	39.21	38.60
S_1P_4	46.24	45.28	44.85	44.42	43.98	42.68	41.21	40.08	39.99
S_1P_5	46.67	45.72	45.20	44.59	44.24	43.64	42.34	42.16	41.73
S_2P_1	44.33	43.46	42.94	42.60	41.81	41.47	40.77	40.08	39.65
S_2P_2	45.37	44.59	44.16	43.03	42.51	41.99	41.64	40.69	40.25
S_2P_3	46.07	45.11	44.76	44.24	43.72	43.29	42.42	40.95	40.60
S_2P_4	46.33	45.54	45.02	44.57	44.33	43.90	43.12	41.64	41.38
S_2P_5	47.71	46.24	45.37	44.76	44.68	44.24	44.16	43.38	43.12
Mean	45.77	44.65	43.84	43.17	42.25	40.58	38.92	36.80	35.37
S. Em (±)	0.28	0.38	0.47	0.35	0.30	0.21	0.30	0.21	0.18
C. D. (1%)	1.19	1.60	1.97	1.49	1.27	0.88	1.26	0.88	0.76
C.V (%)	1.08	1.49	1.87	1.44	1.25	0.91	1.35	1.00	0.90

S1: Ambient storage, **S2:** Cold storage, **P1:** Cloth bag, **P2:** High density polythene bag, **P3:** Polythene bags (700 gauge), **P4:** Aluminum laminated pouch, **P5:** Vacuum packed bags (Initial=47.37)

Table 2: Influence of packaging material and storage conditions on Mean seedling length (cm) during storage in onion seeds

Treatments	Storage (Months)								
	2	4	6	8	10	12	14	16	18
Storage conditions (S)									
S_1: Ambient	19.52	19.16	18.33	17.65	17.43	17.00	16.61	16.30	13.08
S_2: Cold	19.62	19.31	18.48	17.91	17.62	17.16	16.80	16.56	16.32
S. Em (±)	0.12	0.10	0.15	0.13	0.15	0.12	0.13	0.01	0.008
C. D. (1%)	0.51	0.43	0.66	0.58	0.64	0.53	0.55	0.06	0.03
Packaging materials (P)									
P_1: Cloth bag	19.06	18.76	17.95	17.21	16.90	16.56	16.16	15.73	8.01
P_2: High density polythene bag	19.40	19.18	18.34	17.60	17.45	16.95	16.64	16.40	16.22
P_3: Polythene bags (700 gauge)	19.71	19.30	18.44	17.78	17.62	17.15	16.77	16.52	16.31
P_4: Aluminum laminated pouch	19.80	19.39	18.58	17.93	17.77	17.28	16.89	16.69	16.42

P_5: Vacuum packed bags	19.87	19.55	18.72	18.08	17.90	17.48	17.07	16.83	16.54
S.Em (±)	0.19	0.16	0.25	0.22	0.24	0.20	0.21	0.02	0.01
C. D. (1%)	0.81	0.68	1.04	0.91	1.02	0.85	0.87	0.10	0.05
Interaction (SXP)									
S_1P_1	18.90	18.52	17.73	17.06	16.62	16.36	15.87	15.25	0.00
S_1P_2	19.38	19.16	18.32	17.52	17.37	16.90	16.60	16.37	16.19
S_1P_3	19.68	19.26	18.41	17.75	17.58	17.08	16.70	16.47	16.29
S_1P_4	19.80	19.38	18.54	17.91	17.74	17.28	16.91	16.66	16.40
S_1P_5	19.85	19.53	18.66	18.04	17.87	17.42	17.00	16.77	16.52
S_2P_1	19.23	19.01	18.19	17.37	17.19	16.77	16.47	16.22	16.03
S_2P_2	19.42	19.22	18.37	17.69	17.53	17.02	16.68	16.43	16.25
S_2P_3	19.75	19.34	18.47	17.82	17.67	17.22	16.85	16.57	16.34
S_2P_4	19.81	19.41	18.62	17.96	17.80	17.30	16.89	16.72	16.44
S_2P_5	19.91	19.58	18.79	18.13	17.93	17.54	17.15	16.89	16.58
Mean	19.57	19.24	18.41	17.72	17.53	17.09	16.71	16.44	14.70
S. Em (±)	0.27	0.23	0.35	0.31	0.34	0.28	0.29	0.03	0.01
C. D. (1%)	1.15	0.96	1.47	1.29	1.45	1.20	1.24	0.14	0.07
C.V (%)	2.45	2.08	3.33	3.05	3.44	2.92	3.09	0.37	0.21

S1: Ambient storage, **S2:** Cold storage, **P1:** Cloth bag, **P2:** High density polythene bag, **P3:** Polythene bags (700 gauge), **P4:** Aluminum laminated pouch, **P5:** Vacuum packed bags (Initial= 20.07 cm)

Table 3: Influence of packaging material and storage conditions on Mean germination time (Days) during storage in onion seeds

Treatments	**Storage (Months)**								
	2	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**
Storage conditions (S)									
S_1: Ambient	1.26	1.35	1.38	1.45	1.51	1.58	1.60	1.65	1.33
S_2: Cold	1.11	1.20	1.26	1.33	1.40	1.51	1.53	1.56	1.52
S. Em (±)	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.03	0.03
C. D. (1%)	0.10	0.16	0.13	0.16	0.20	0.18	0.16	0.15	0.13
Packaging materials (P)									
P_1: Cloth bag	1.33	1.41	1.45	1.54	1.62	1.70	1.70	1.75	0.83
P_2: High density polythene bag	1.29	1.37	1.41	1.45	1.45	1.54	1.58	1.62	1.70
P_3: Polythene bags (700 gauge)	1.25	1.37	1.37	1.45	1.54	1.66	1.62	1.66	1.56
P_4: Aluminum laminated pouch	1.16	1.25	1.37	1.45	1.54	1.62	1.62	1.58	1.58
P_5: Vacuum packed bags	0.91	0.95	1.00	1.04	1.12	1.20	1.29	1.41	1.45
S. Em (±)	0.04	0.06	0.05	0.06	0.07	0.06	0.06	0.05	0.05
C. D. (1%)	0.16	0.25	0.21	0.25	0.31	0.28	0.26	0.24	0.21
Interaction (SXP)									
S_1P_1	1.42	1.50	1.50	1.58	1.67	1.75	1.75	1.83	0.00
S_1P_2	1.33	1.42	1.50	1.50	1.50	1.58	1.58	1.67	1.92
S_1P_3	1.33	1.42	1.42	1.50	1.58	1.67	1.67	1.67	1.57
S_1P_4	1.25	1.33	1.42	1.50	1.58	1.58	1.58	1.58	1.67
S_1P_5	1.00	1.08	1.08	1.17	1.25	1.33	1.42	1.50	1.50
S_2P_1	1.25	1.33	1.42	1.50	1.58	1.67	1.67	1.67	1.67
S_2P_2	1.25	1.33	1.33	1.42	1.42	1.50	1.58	1.58	1.50
S_2P_3	1.17	1.33	1.33	1.42	1.50	1.67	1.58	1.67	1.57
S_2P_4	1.08	1.17	1.33	1.42	1.50	1.67	1.67	1.58	1.50
S_2P_5	0.83	0.83	0.92	0.92	1.00	1.08	1.17	1.33	1.40
Mean	1.19	1.28	1.33	1.39	1.46	1.55	1.57	1.61	1.43
S. Em (±)	0.05	0.08	0.07	0.08	0.10	0.09	0.09	0.08	0.07
C. D. (1%)	0.23	0.36	0.30	0.36	0.45	0.40	0.37	0.35	0.30
C.V (%)	8.27	11.76	9.66	10.91	12.88	10.81	10.04	9.09	8.78

S1: Ambient storage, **S2:** Cold storage, **P1:** Cloth bag, **P2:** High density polythene bag, **P3:** Polythene bags (700 gauge), **P4:** Aluminum laminated pouch, **P5:** Vacuum packed bags (Initial=0.75 Days)

3.2 Mean seedling length (cm)

Result of mean seedling length is given in the table 2. Initially the mean seedling length was 20.07, as the storage period progressed the mean seedling length got decreased from 19.57 cm in second month to 14.70 at 18 th month of storage period. As the storage period progressed the mean seedling length got decreased in all the months of storage period irrespective of the storage condition and storage container but in case of vacuum packed container which is stored in cold storage (S_2P_5) environment there was seen a less decrease compared to other treatments (16.58 cm). Then it is followed by vacuum packed bag stored in ambient storage S_1P_5 (16.52 cm). The speed of germination is zero in case of S_1P_1 because there was no germination at the end of 18 th month of storage period.

3.3 Mean germination time (MGT, days)

Result of mean germination time is given in the table 3. Initially the mean germination time was 0.75 days, as the storage period progressed the mean germination time got increased from 1.19 days in second month to 1.43 days at 18 th month of storage period. As the storage period progressed the mean germination time got increased in all the months of

storage period irrespective of the storage condition and storage container but in case of vacuum packed container which is stored in cold storage (S_2P_5) environment there was seen a less decrease compared to other treatments (1.40 days). Then it is followed by vacuum packed bag stored in ambient storage S_1P_5 (1.50 days). The mean germination time is zero in case of S_1P_1 because there was no germination at the end of 18 th month of storage period.

As the storage progressed the deterioration occurs due to high respiration rate increased due to high moisture content. As the storage period advances the vigour of seed declines due to catabolic activity going on in the seed and thus the seed though viable, yet fails to emerge. Decline in seed vigour depends on storage condition that is temperature, relative humidity and seed moisture contents. High temperature, relative humidity and moisture in the storage environment appear to be principle factors involved in deterioration of seed quality. Speed of germination decreases as the storage prolongs due to high metabolic activity, high respiration, production of reactive oxygen species and high electrolyte leachates from the seed surface. The variation in speed of germination among the storage materials implies that this might be due to differences in temperature, RH, and moisture content that each storage material has. These findings are in accordance to Cabrera and Lansakara (2002) [5]. But in cold storage there will be reduced metabolic activity like reduced lipid peroxidation resulted in enhanced antioxidant activity which protects seeds from deterioration. Alhamdan *et al.*, (2011) [1] reported that seeds of onion stored at 5 °C had the highest speed of germination. Mean seedling length of the seed decreases as the storage period progressed because of the reduction in the availability of food materials in the seed to grow and dry matter of seed is also decreased with less mean seedling length. Similar findings were reported by Balesevic-Tubic *et al.*, (2010) [10] in oil seed crops, khalequzzaman *et al.*, (2012) [12] in French bean, Basavegowda *et al.*, (2013) [11] in chickpea, Patel *et al.*, (2017) [13] in onion. Mean germination time in days increased 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.

4. Conclusion:

It is concluded that speed of germination and mean seedling length was highest in treatment S_2P_5 compared to all other treatments at end of storage period (18 months) which is useful for farmers, as they germinate and emerge within less time and favours early harvesting. Lowest mean germination time was recorded in S_2P_5 as this also favours early harvesting.

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