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Effectiveness of provenance, container and seed treatment on seed viability and longevity for long term conservation in drumstick (*Moringa oleifera* Lam. (syn. *M. ptreygosperma* Gaertn.)

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Abstract

Moriga has gained importance recently due to its medicinal and nutritional properties in plants parts and seeds. Seeds are used for propagation and are found to lose its viability rapidly and unable to store seeds for long term storage. A study was conducted to know the effect of storage provenances, containers and storage conditions on seed longevity and viability of drumstick seeds for long term ambient storage circumstances. Being low volume high value medicinal crop moisture impervious and moisture proof containers need to be identified for longer term storage. Storage conditions and containers had a greater impact on seed deterioration during storage period. Drumstick seeds lost its complete viability after 34 months of storage. At 24 months of storage seeds packed in aluminum foil pouch, treated with captaf (2g/kg) and stored in Southern dry zone has preserved minimum seed certification germination standards (70%) compared to other treatments. The vigour index (2730) and field emergence (60%) was also higher stating that, moisture proof containers are better for long term storage upto 24 months. Among provenances, Southern dry zone of Karnataka (minimum 14 ^{0}C & maximum 35 ^{0}C) has maintained the seed quality parameters at higher range at the end of long storage period.

Keywords: longevity, storage, germination, provenance

Introduction

Moringa oleifera Lam. (syn. *M.* p*treygosperma* Gaertn.) is a commonly known woody tree belongs to the family Moringaceae. It is native to Western and sub Himalayan tracts of India, Pakistan, Asia Minor, Africa and Arabia and well established after introduction to Philippines, Cambodia, Central America, North and South America and the Caribbean Islands. This wide distribution is due to the adoptability for humid tropics or hot dry lands, less fertile soil and slightly tolerant to drought. Moringa is popular as drumstick in India and horse-radish tree in other parts of the world.

It is a back yard tree commonly seen in villages and considered as an important nutritive vegetable in southern parts of India, where leaves, flowers and immature pods are used [Anwar *et al.*, 2005] [1] as food and medicine [Lalas and Tsaknis, 2002] [9].

Moringa is highly cross pollinated (Ramesh *et al.*, 2014) [15] crop and propagated commercially though seeds. Studies have been reported better germination from fresh seeds when compared to old seeds. In contrast, studies have also reported lower germination percentages on fresh seed than on seeds stored for a period of three months (Croft *et al.*, 2012) [4]. The study has also opined that drumstick seed germination varies with duration of storage, storage temperature and moisture content (Croft *et al.*, 2012) [4].

Knowledge on the seed longevity has practical application in germplasam conservation and handling of leftover/ carry over seeds. Seed quality is known to deteriorate during storage and rate of deterioration depends on initial seed quality, seed moisture and storage conditions (Christina *et al.*, 1994) [3].

Seeds when exposed to air containing water vapor, seed moisture content equilibrates in relation to the relative humidity (RH) of the air surrounding the seeds and decreases seed longevity (Moravec *et al.*, 2008) [10]. Maintenance of seed viability is particularly challenging in tropical environments where stored seeds are often exposed to hot, humid air (Ellis, 1988) [6]. Hence, knowing optimal conditions for storage of seeds for longer period is of research and commercial importance. The aim of this study was to know the effect of different storage conditions on seed longevity of drumstick seeds and to study the relation between environmental factors for bulk storage of quality seeds.

Materials and Methods

Freshly harvested seeds of drumstick variety Bhagya (KDM-01 grown in University of Horticultural Sciences, Bagalkote, Karnataka (16.1635° N, 75.6172° E) were used and stored at different agro climatic zones *viz*., C1: Northern dry zone (16.1635° N, 75.6172° E) and C2: Southern dry zone of Karnataka (13.1770° N, 78.2020° E), India. Before storage seeds were treated with Captaf (2g/kg) and packed in three different storage containers *viz*., A1: HDPE bag, A2:400 guage polythene bag and A3: Alluminium foil. Seeds stored under ambient room temperature conditions until seeds complete lose its viability. Observations on the seed moisture content germination (%), seed moisture content (%), field emergence(%), seedling dry weight (mg) and seedling vigour index were recorded on every three months (ISTA, 2013) [8] and until the germination drops below the minimum seed certifications standards. The experimental data thus obtained were statistically analyzed as per Sundararaj *et al*. (1972) [17].

Results and Discussion:

In the present study initial 99 per cent germination gradually declined to 69 per cent during storage period of 34 months. Irrespective of the treatments drumstick seeds took 34 months for complete loss of viability. The slow decline in germination during storage is due to adverse storage environmental factors resulting in depletion of food reserves, reduced physiological activity and ageing process as reported by (Vijaya & Bhaskaran, 2018) [18]. Seeds stored in aluminum foil treated with captaf and stored in Southern dry zone has recorded higher seed longevity at 24 months and maintained 70 per cent germination and in accordance with minimum seed certification standards (fig 1). Whereas, seeds stored in Northern dry zone has lost minimum seed germination standards at 20 months of storage. Southern dry zone climate was favourable having temperature ranging from minimum 14 ^{0}C and maximum 35^{0}C during storage studies (fig 5a). The storage temperature of Northern dry zone is observed to be minimum 14^{0}C and maximum 40^{0}C. This wide range fluctuations of temperature may have lead to speed up the adverse actions of physiological activities in the seeds. Seeds stored in alluminium foil has maintained superior quality (65% germination) at 24 months of storage irrespective of storage provenances. However, seeds stored in 400 guage polythene bag germination (63%) results are *on par* with the alluminium foil storage. The interaction effect of packing material, seed treatment and storage provenance has resulted in significant results for germination. Seeds packed in alluminium foil treated with captaf and stored in southern dry zone has maintained MSCS recording 75 per cent germination after 24 months of storage. The drumstick seeds has maintained minimum certification standards of 70 per cent germination at 24 months of storage when stored in Southern dry zone. The storage environment conditions plays a major role in maintaining seed viability. Similar results has been reported in groundnut (Basavaraj *et al*., 2018) [2] and soybean (Sharma *et al*., 1998 & Nivedita, 2013) [16, 13].

The reduction in germination of seeds during storage has been related to seed moisture content (Fig 2). The seed composition is one of the factors which influence the moisture content during storage. The seed moisture initially during storage was 8.0 per cent and it tends to increase as the storage period advances to 34 months. At the end of the storage studies of 34 months, the seed moisture content has increased to 12-14% irrespective of the container and provenance and resulted in lower germination. Increased moisture content has resulted in increased electrical conductivity of seed leachates and melonaldehyde contents for seed stored and depicted maximum deterioration in drumstick (Irfan *et al.*, 2020) [7]. The increased moisture content above 8.0 per cent has shown negative impact on germination during storage.

Seedling dry weight also has been significantly influenced by packaging, seed treatment and storage environment in drumstick. However, significantly reduce seedling dry weight was recorded after 18 months of storage (Table 1). At initial stage of storage seedling dry weight 61.05 mg has been reduced to 32.67 mg at 34 months of storage in aluminum foil, treated with captaf when stored in Southern dry zone. Irrespective of the treatments the seedling dry weight has declined from initial storage months to end of the storage period. Seed physiological activities will be declined as seed naturally aging affected enzyme activities for energy release and formation of new cells.

The performance of seeds after storage in field emergence is far behind compared to the results of germination test. Economically viable field emergence was recorded till 18 months of storage after which it declined at faster rate compared to germination results (Fig 3). However, at 24 months of storage seeds packed in aluminum foil treated with captaf and stored in southern dry zone has recorded higher field emergence (60%) and least was recorded in HDPE bag untreated and stored in northern dry zone (28%). The wide variation in the storage temperature and relative humidity has pessimistic effect on the seed vigour and field emergence. Southern dry zone has recorded narrow range of fluctuation in temperature (maximum 35^{0}C and minimum 14^{0}C) during the study while, in Northern dry zone maximum temperature recorded was 39^{0}C and minimum 14.6^{0}C. Seeds being sensitive to the temperatures prevailing in storage provenance may fasten deterioration compared to cool temperatures (Dick *et al*., 1990 and Mubvuma *et al*., 2013) [5, 11]

Seedling vigour index has also followed the results of germination and seedling dry weight (Fig 4). During initial days of storage and up to six months of storage, non significant results were reported for seedling vigour index among treatments. However, later there was gradual decrease in seedling vigour index during storage up to 24 months. After 24 months of storage there was quick decline on the seedling vigour index. At the end of 24 months of storage higher seedling vigour index was recorded in aluminum foil (2730). Seeds stored in Southern dry zone has recorded higher vigour (3103) compared to other treatments. Among the interactions of treatments seeds packed in alluminium foil treated with captaf and stored in southern dry zone has recorded higher vigour index (4199). These results are in comparison with Naphade & Sagare (1983) [12] in sunflower, Prem Kumar *et al* (2018) [14] in soybean .

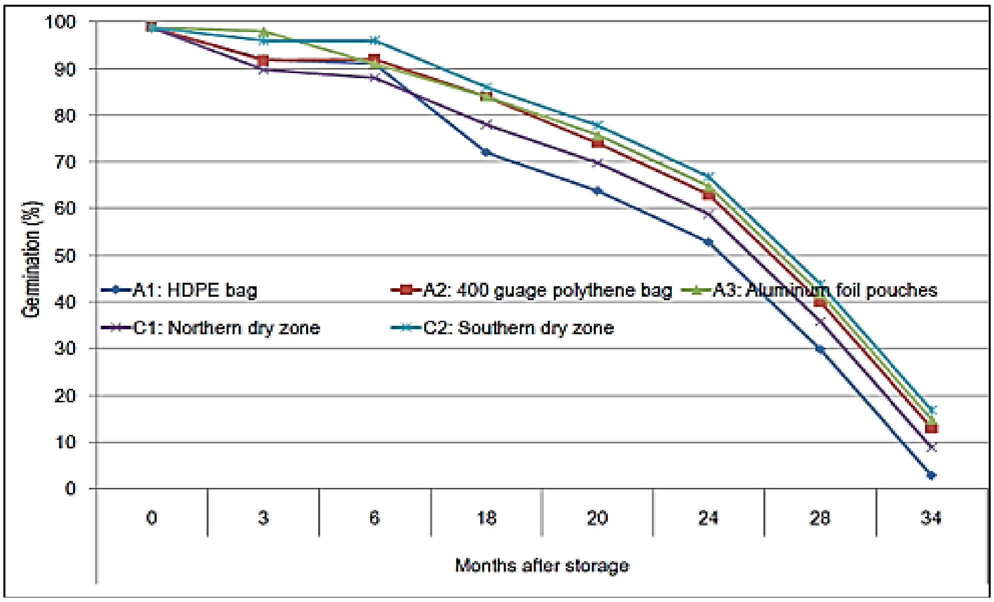

Fig 1: Influence of provenance and containers on germination (%) during long term storage in drumstick seeds cv. Bhagya.

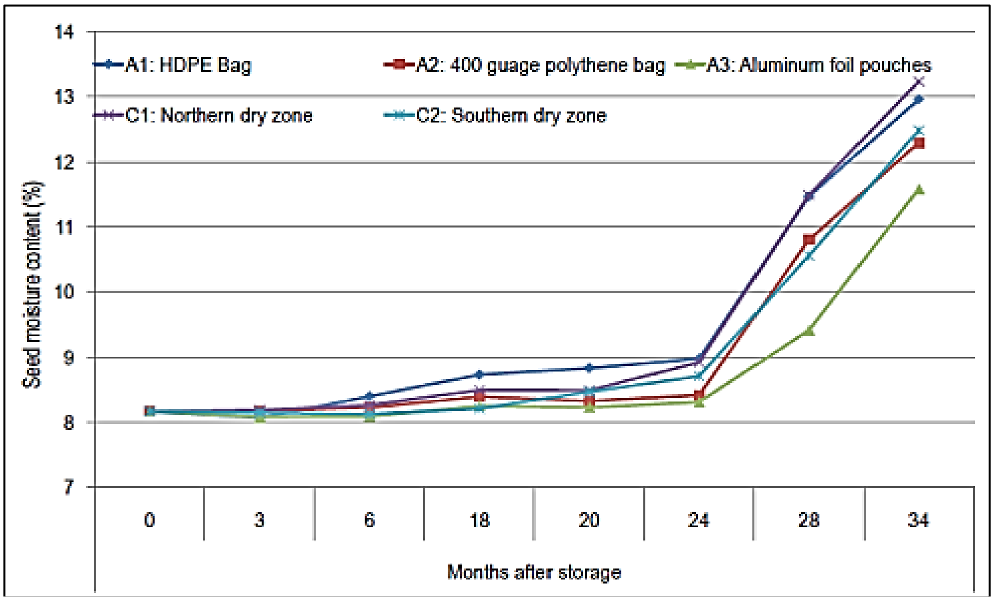

Fig 2: Influence of provenance and containers on seed moisture content (%) during long term storage in drumstick seeds cv. Bhagya.

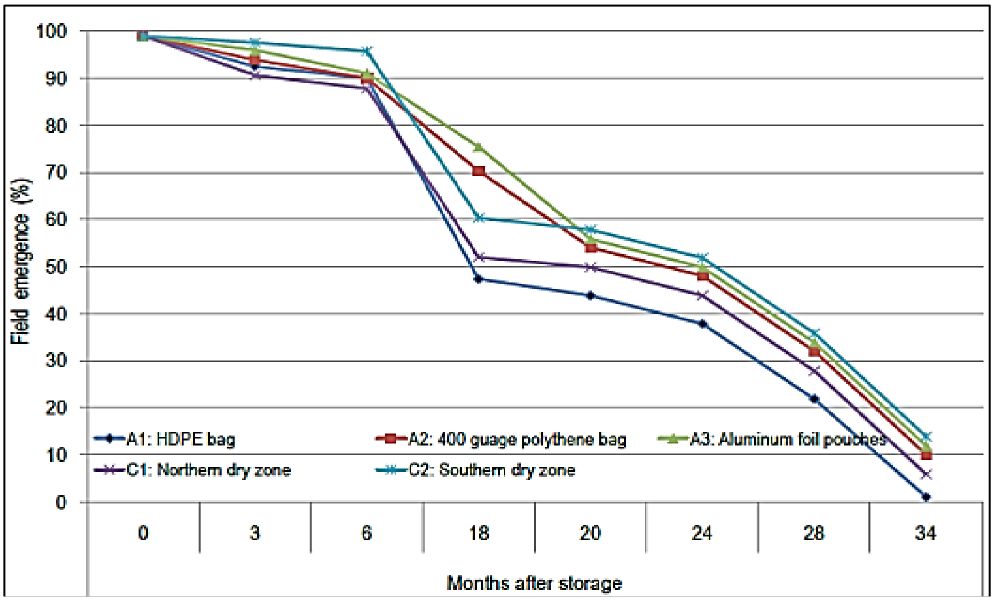

Fig 3: Influence of provenance and containers on field emergence (%) during long term storage in drumstick seeds cv. Bhagya.

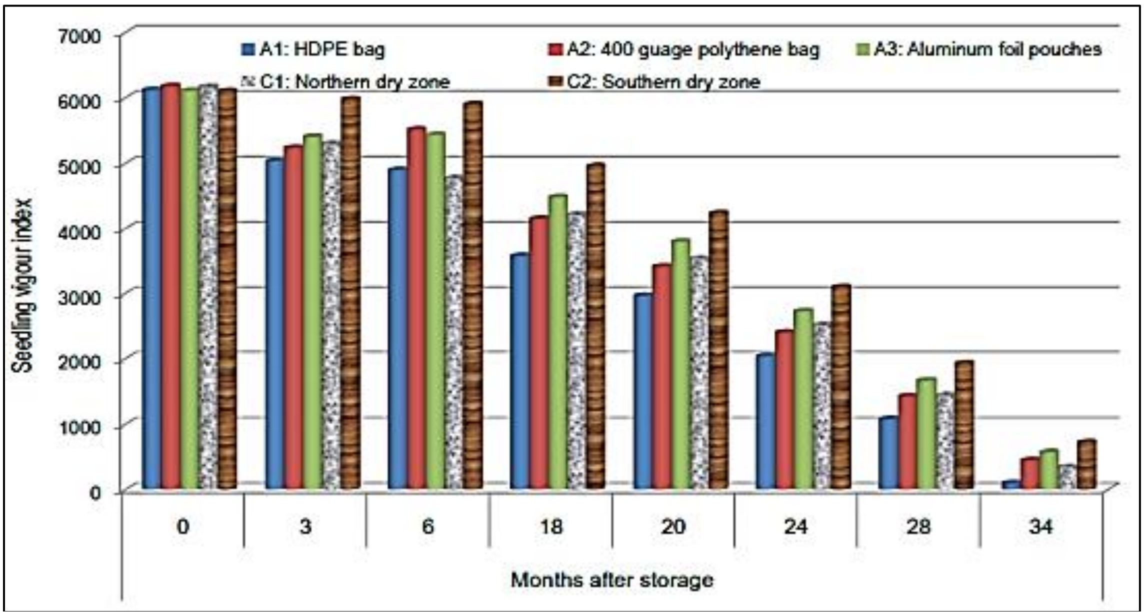

Fig 4: Influence of provenance and containers on seedling vigour index during long term storage in drumstick seeds cv. Bhagya.

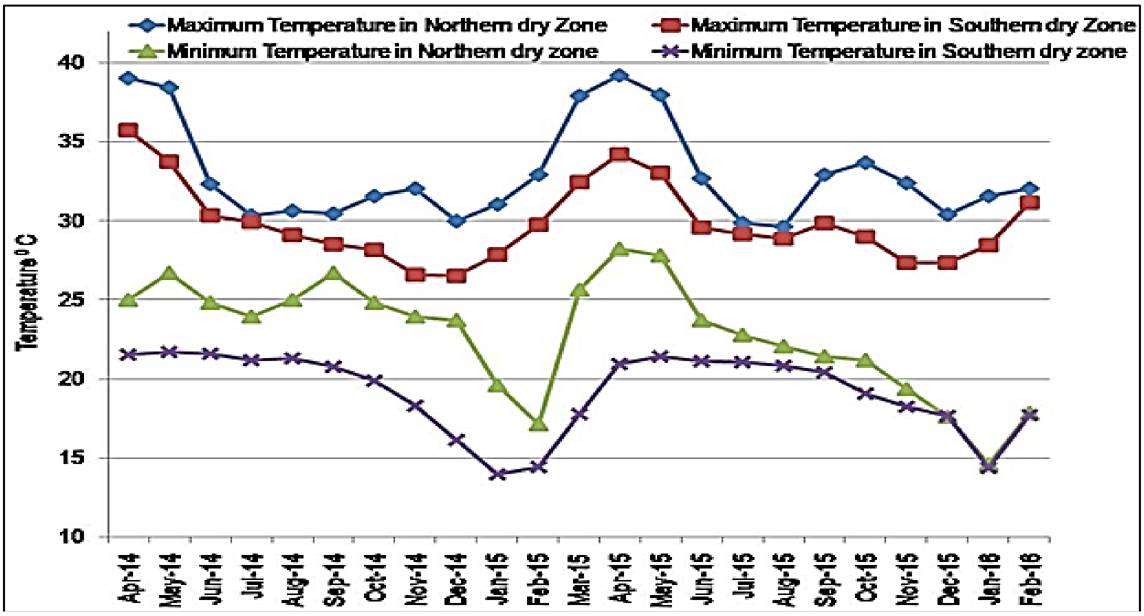

Fig 5a: Maximum and minimum temperature (^{0}C) recorded in the provenances of Karnataka for long term storage of drumstick seeds

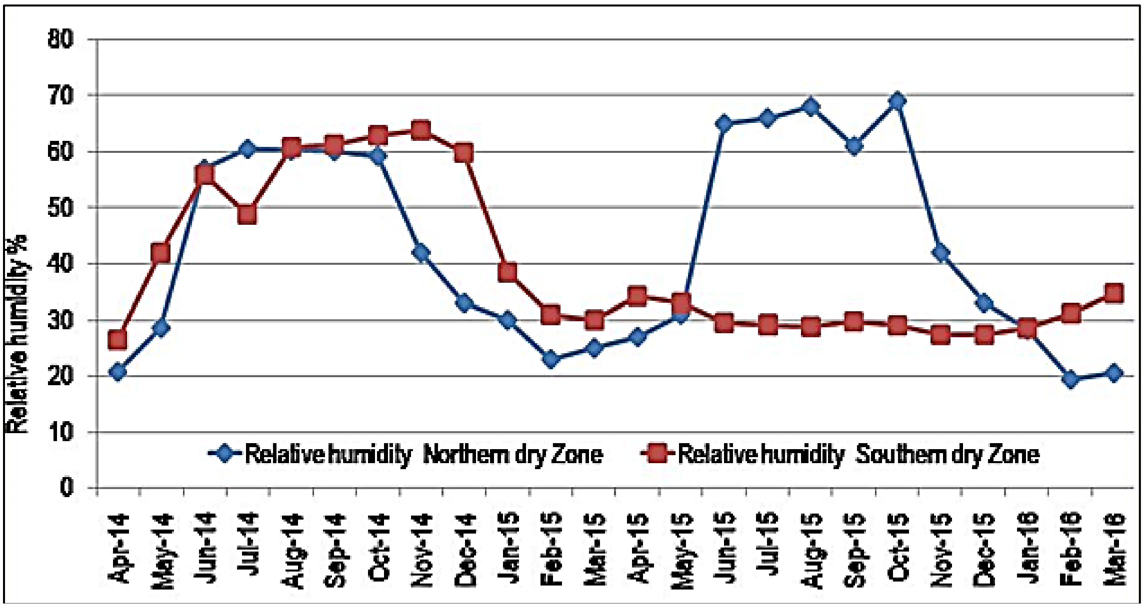

Fig 5b: Relative humidity (%) recorded in the provenances of Karnataka for long term storage of drumstick seeds

Table 1: Influence of container, provenance and seed treatment on seedling dry weight (mg) during long term storage in drumstick var. Bhagya (KDM-1)

Treatments	Months after storage							
	0	3	6	18	20	24	28	34
A1: HDPE bag	62.04	54.71	53.83	49.74	46.45	38.52	36.14	34.90
A2: 400 gauge polythene bag	62.44	57.04	59.92	49.38	46.09	38.16	35.78	34.54
A3: Aluminum foil pouches	61.76	55.12	59.70	53.35	50.07	42.13	39.75	38.52
CD (1%)	NS	NS	NS	2.382	2.174	2.982	3.832	3.175
B1: Untreated	62.4	54.7	55.9	50.8	47.5	39.5	37.2	35.9
B2: Captaf	61.8	56.6	59.8	56.9	53.6	45.7	43.3	42.0
CD (1%)	NS	NS	3.925	3.947	3.836	4.398	4.284	4.836
C1: Northern dry zone	62.39	58.97	54.18	53.97	50.69	42.75	40.37	39.14
C2: Southern dry zone	61.77	62.25	61.46	57.67	54.38	46.45	44.07	42.83
CD (1%)	NS	NS	2.937	2.933	2.782	2.614	2.761	2.591
A1B1	60.84	55.32	55.15	50.15	46.87	38.93	36.55	35.32
A1B2	63.24	54.08	52.51	49.33	46.04	38.11	35.73	34.49
A2B1	62.59	57.17	61.35	46.98	43.69	35.76	33.38	32.14
A2B2	62.31	56.90	58.49	51.78	48.49	40.56	38.18	36.94
A3B1	61.97	57.16	55.84	53.14	48.89	45.18	38.96	35.41
A3B2	61.54	61.48	56.58	51.20	47.92	45.78	42.18	39.84
CD (1%)	NS	6.874	6.123	7.821	6.824	6.431	6.872	6.126
A1C1	62.19	48.98	48.07	51.60	48.32	40.38	38.00	36.77
A1C2	61.88	60.42	59.58	47.88	44.59	36.66	34.28	33.04
A2C1	62.83	51.11	57.68	51.88	48.59	40.66	38.28	37.04
A2C2	62.07	62.96	62.16	46.88	43.59	35.66	33.28	32.04
A3C1	62.17	46.83	56.77	58.47	55.18	47.25	44.87	43.63
A3C2	61.34	63.38	62.63	48.25	44.97	37.03	34.65	33.42
CD (1%)	NS	NS	8.284	8.552	8.721	8.239	8.215	8.438
B1C1	62.09	49.96	57.52	53.68	50.39	42.46	40.08	38.84
B1C2	61.51	63.14	62.02	48.08	44.80	36.87	34.48	33.25
B1C1	62.71	47.99	50.83	54.28	51.00	43.07	40.68	39.45
B2C2	62.03	61.37	60.90	47.25	43.97	36.03	33.65	32.42
CD (1%)	NS	NS	7.548	8.286	8.614	8.783	8.263	8.925
A1B1C1	60.91	58.41	57.64	51.55	48.27	40.33	37.95	30.49
A1B1C2	60.76	62.38	60.72	48.75	45.47	37.53	35.15	33.92
A1B2C1	63.47	59.78	56.48	51.65	48.37	40.43	38.05	29.15
A1B2C2	63.00	58.47	58.45	56.12	54.00	52.78	41.85	30.74
A2B1C1	63.06	51.08	60.23	47.45	44.17	36.23	33.85	31.49
A2B1C2	62.11	63.27	62.47	46.50	43.22	35.28	32.90	32.49
A2B2C1	62.60	51.15	55.14	56.30	53.02	45.08	32.18	30.49
A2B2C2	62.01	62.65	61.85	57.42	53.48	46.81	43.25	32.42
A3B1C1	62.29	60.54	59.14	54.19	52.18	48.22	36.21	30.49
A3B1C2	61.63	63.77	62.87	49.00	45.72	37.78	35.40	34.17
A3B2C1	62.04	43.12	50.77	54.90	51.62	43.68	42.98	30.78
A3B2C2	61.05	63.00	62.40	57.40	56.84	56.14	42.01	32.67
CD (1%)	NS	NS	10.325	10.754	10.723	10.571	10.562	10.129
CV%	2.111	3.045	4.115	5.394	4.32	4.87	5.32	5.71

Conclusion

Loss of seed viability and deterioration is a uncontrolled and natural physiological process and cannot be stopped but the rate of deterioration can be reduced by modification in storage conditions. The seed viability and vigour of drumstick has declined during storage period which was affected by storage provenance temperature and seed treatments. As the storage period increases the seed quality parameters has declined after 6 months of storage. Seeds stored in aluminum foil treated with captaf and stored in Southern dry zone has performed well compared to others for long term storage and maintained the minimum seed certification standards of 70 per cent germination. The results of this experiment have opined that apart from container, storage provenance has a significant role in maintaining seed viability during long term storage.

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