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Influence of Plant Oils and Containers on Seed Storability of *Alllium Cepa* L.

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ABSTRACT: An experiment was conducted to investigate the influence of plant oils and packaging materials on the longevity of onion seed (variety: Hisar Onion-4). The seeds were coated with eight plant oils seed and were kept in two containers viz., Cloth bag and Plastic zipling bag up to nine months under ambient conditions in Seed Pathology laboratory of Department of Seed Science & Technology, CCSHAU, Hisar. The samples were drawn at three month intervals for ascertaining the seed quality parameters. The seeds coated with neem oil (5 ml kg^{-1} seed) and stored in plastic zipling bag were found better for the maintenance of higher seed quality parameters [germination (66.33%), root length (3.27cm), shoot length (5.47cm), mean seedling dry weight (26.7mg), vigour indices1 & II (579.4 & 1912), electrical conductivity (0.483 µS/cm/seed), mycoflora (0.643%), emergence index (6.33) and seedling establishment (54.17%)] during study period. The study suggested that the use of appropriate packaging material and seed treatment could be useful to prolong the storage life and seed health of onion seeds.

Keywords: Onion, containers, plant oils, seed quality, storage

Onion (*Allium cepa* L.) is the most important commercial crop grown all over the world and consumed in various forms. It is a condiment cum bulb vegetable which belongs to the family *Alliaceae*. The pungency in onion is due to volatile oil *Allyl propyl disulfide*. India is second largest producer of onion after China as it produces 23.28 mt of onion from 1.29 mha. Major onion producing states in India are Maharashtra (8.47mt) and Madhya Pradesh (3.72mt) [1].

Seed is the basic and vital input in agriculture. Onion seeds are short lived under ambient conditions and show orthodox storage behavior which losses viability within a year. The deterioration of stored seed is a natural phenomenon and seeds tend to lose viability even under ideal storage conditions due to ageing [2]. During storage, number of biotic and abiotic factors influences the storage potential of seeds which results in gradual deterioration and ultimately death of the seeds [3]. Every seed is a potential harbour of a wide variety of mycoflora containing both pathogenic and saprophytic microorganisms, both externally and internally [4]. As the controlled conditions involve huge cost, seed treatments remain the best alternative approach to maintain the seed quality.

In any seed production programme, storage of seeds from harvest to next planting season is of prime importance. Sharma [5] reported that lack of awareness to seed treatment at farmer's level is one of the limiting factors in disease management. It is well known fact that the choice of materials for seed treatment, containers selected for storing the seeds and storage environment exert a positive effect on the viability and vigour of seeds in storage.

Seed treatment with fungicides is an ordinary practice for controlling the pathogens. The indiscriminate use of fungicides has lead to residual toxicity, induced resistance and environmental pollution. On the other side, biological agents like plant products provides advantage of natural, inexpensive and eco-friendly. Plant oils like neem or karanj are reported to give maximum protection against seed mycoflora by suppressing the activity and growth of pathogens [6]. These oils also have growth promoting effect through increased seedling vigour. The information on prolonging the shelf life of onion seeds under storage is very limited. Therefore, the present study entitled 'Influence of plant oils and containers on seed storability of *Allium cepa* L.' was carried out.

MATERIAL AND METHODS

The present study was carried out during 2019-20 on onion seed (Hisar Onion-4) harvested in May 2018 having

germination (81 per cent) above Indian Minimum Seed Certification Standards. The seeds were treated with plant oils @ 5ml kg^{-1} seed (T_1: Castor oil, T_2:Neem oil, T_3: Aonla oil, T_4: Til oil, T_5:Linseed oil, T_6: Karanj oil, T_7: Akhrot oil, T_8: Ajwain oil and T_9: Untreated (control) and were kept in two containers [C_1: Cloth bag, C_2: Plastic zipling bag (40 µm)] under ambient conditions in Seed Pathology laboratory of Department of Seed Science & Technology, CCS HAU, Hisar.

The onion seeds and oils were weighed 40g and 0.2ml respectively wearing gloves, using appropriate weighing balance for each treatment. The seeds and oils were mixed in beakers and shaked for some time for uniform coating of oil all over the seeds. Then, the treated seeds were kept in different containers (cloth bag and plastic zipling bag) in the laboratory under ambient conditions. The total number of treatments was 27 with three replications.

The experiment consisted of two factors (two different packing materials as storage container were used as level factor "C" and the eight oil treatments along with control were used as level factor "T") were laid out in completely randomized design (CRD) as well as in randomized block design (RBD). Seeds were taken from each of the different containers at three months interval up to nine months and observations were recorded on seed technological parameters.

Standard germination test (%): Four hundred seeds of each treatment were placed in three replications in between the germination paper and placed in germinators at 25±1°C [7]. The germination was checked on first count after 6th day and final count on 14th day and normal seedlings were considered for per cent germination.

$$\text{Seed germination (\%)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds placed for germination}} \times 100$$

Ten normal seedlings per replication were selected after final count and were measured for root and shoot lengths as usual. After measuring root and shoot lengths, seedlings were dried in hot air oven for 24 h at 80±1°C and were weighed.

Seedling vigour indices were calculated as per method of Abdul-Baki and Anderson [8].

Seed Vigour Index-I = Seed germination (%) × Average seedling length (cm)

Seed vigour Index-II = Seed germination (%) × Average dry seedling weight (mg)

Electrical conductivity of the seed leachates was measured as per ISTA [9].

Seed health test was conducted by blotter method as recommended by ISTA [10].

Three replications of one hundred seeds each were sown at three, six and nine months in factorial randomized block design, in Research Farm of Department of Seed Science and Technology for calculating following parameters.

Emergence index was calculated by method as described by Maguire [11].

The seedling establishment was determined by counting the total number of seedlings on 15th day.

The data recorded from the experiments were statistically analyzed as per method suggested [12].

RESULTS AND DISCUSSION

The seed possess maximum germination and vigour at the time of physiological maturity and thereafter starts declining. Seed ageing is a continuous process and it can't be stopped but the rate of deterioration can be minimized by management of storage conditions and by seed treatments.

The seed germination declined progressively with the passage of storage in all the treatments which may be attributed to the phenomena of natural ageing and was recorded below Indian Minimum Seed Certification Standards (70%) in both the storage containers at the end of storage period of nine months. The data presented in table 1 indicates that among the treatments, T_2 (66.33%) recorded higher germination percentage and at par with T_5 treatment (65.67%) and T_3 (65.50 %) and the lowest was recorded in T_9 treatment (63.50%). Among the containers, plastic zipling bag was significantly better. Interaction effect of containers with fungicides was found non-significant. The similar results were reported in the past by [13] in chilli seeds and [14] in chickpea seeds.

There is gradual decrease in shoot and root length of seedlings with the passage of storage time. The decline in root and shoot length may be attributed to natural ageing induced decline in germination. The damage caused by fungi and toxic metabolites that have hindered the seedling growth. The perusal of data indicated in table 2 showed the maximum root length was recorded in T_2 (3.27 cm) treatment closely followed by T_3 (3.23 cm) and T_5 (3.22 cm) treatments. Containers and interaction effect was found non-significant. Similar trend was followed in

Table 1. Effect of various seed treatment with plant oils (5 ml/kg seed) and containers on germination (%) in onion seed

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	74.33	74.67	74.50	71.33	72.00	71.67	63.67	64.33	64.00
T_2	74.67	75.67	75.17	71.00	71.67	71.33	66.00	66.67	66.33
T_3	73.67	74.33	74.00	72.33	73.00	72.67	65.33	65.67	65.50
T_4	73.33	73.67	73.50	71.67	72.33	72.00	64.67	65.33	65.00
T_5	74.00	74.67	74.33	71.33	72.33	71.83	65.00	66.33	65.67
T_6	73.67	74.67	74.17	72.00	73.00	72.50	64.33	64.67	64.50
T_7	73.33	74.00	73.67	71.67	72.33	72.00	64.33	65.00	64.67
T_8	74.33	74.67	74.50	72.00	72.67	72.33	64.00	65.00	64.50
T_9	73.00	73.67	73.33	70.33	71.00	70.67	63.00	64.00	63.50
Mean	74.00	74.63		71.63	72.37		64.70	65.43	
CD (P=0.05)	C	T	(C X T)	C	T	(C X T)	C	T	(C X T)
	0.433	0.968	NS	0.541	1.21	NS	0.515	1.151	NS

C_1: Cloth bag C_2: Plastic zipling bag

T_1: Castor oil; T_2: Neem oil; T_3: Aonla oil; T_4: Til oil; T_5: Linseed oil; T_6: Karanj oil; T_7: Akhrot oil; T_8: Ajwain oil; T_9: Untreated (Control)

Table 2. Effect of various seed treatment with plant oils (5 ml/kg seed) and containers on root length (cm) in onion seeds

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	3.33	3.40	3.37	3.27	3.33	3.30	3.13	3.20	3.17
T_2	3.40	3.40	3.40	3.33	3.40	3.37	3.27	3.27	3.27
T_3	3.33	3.33	3.33	3.23	3.33	3.28	3.23	3.23	3.23
T_4	3.33	3.33	3.33	3.33	3.33	3.33	3.10	3.23	3.17
T_5	3.33	3.40	3.37	3.33	3.33	3.33	3.20	3.23	3.22
T_6	3.20	3.20	3.20	3.20	3.20	3.20	3.10	3.20	3.15
T_7	3.17	3.23	3.20	3.17	3.17	3.17	3.17	3.17	3.17
T_8	3.10	3.17	3.13	3.10	3.10	3.10	3.20	3.10	3.15
T_9	3.10	3.20	3.15	3.00	3.10	3.05	3.00	3.10	3.05
Mean	3.27	3.313		3.223	3.277		3.16	3.213	
CD (P=0.05)	C	T	(C X T)	C	T	(C X T)	C	T	(C X T)
	NS	0.115	NS	NS	0.121	NS	NS	0.111	NS

case of shoot length, T_2 treatment recorded significantly higher shoot length (5.47 cm) and among containers, plastic zipling bag was superior. The interaction effect was non-significant. The results were in accordance with the findings of [13] in brinjal and [15] *shisham* seeds.

The significant difference due to seed treatments on seedling dry weight was recorded throughout the storage period (Table 4). At the end of nine months of storage period, highest seedling dry weight was recorded in T_2 (6.68 mg) followed by T_1 (6.63 mg). Plastic zipling bag again proved better than the cloth bag. Interaction effect was non-significant. This gradual decline in seedling dry weight may be attributed to natural ageing, which resulted in seed deterioration of seed, decreases in the germination percentage and root and shoot length. The study was in accordance with that of [16] in soybean seeds.

In the present study, significantly higher vigour index-I was recorded in T_2 (579.40) treatment at the end of nine months of storage period (Table 5). The plant oil-treated seeds stored in two containers when tested for vigour index-II, treatment T_2 (443.40) found significantly superior as illustrated in table 6. Among containers, plastic zipling bag was superior. The interaction effect was non-significant. Gradual decline in seedling vigour index was noticed due to age induced decline in germination, decrease in dry matter accumulation in seedling and decrease in seedling length. The work found similarity with the earlier findings of [17] in mungbean seeds, [18] in cotton seeds and [19] in sorghum seeds.

Table 3. Effect of various seed treatment with plant oils (5ml/kg seed) and containers on shoot length (cm) in onion seeds

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	5.43	5.53	5.48	5.33	5.43	5.38	5.23	5.33	5.28
T_2	5.50	5.53	5.52	5.50	5.50	5.50	5.43	5.50	5.47
T_3	5.40	5.57	5.48	5.33	5.40	5.37	5.23	5.33	5.28
T_4	5.40	5.43	5.42	5.33	5.40	5.37	5.33	5.33	5.33
T_5	5.30	5.40	5.35	5.23	5.30	5.27	5.13	5.23	5.18
T_6	5.23	5.27	5.25	5.17	5.23	5.20	5.13	5.17	5.15
T_7	5.30	5.33	5.32	5.23	5.30	5.27	5.23	5.23	5.23
T_8	5.33	5.43	5.38	5.33	5.33	5.33	5.23	5.33	5.28
T_9	5.10	5.23	5.17	5.03	5.10	5.07	5.03	5.17	5.10
Mean	5.36	5.44		5.30	5.36		5.24	5.32	
CD (P=0.05)	C	T	(C X T)	C	T	(C X T)	C	T	(C X T)
	0.064	0.143	NS	NS	0.139	NS	0.055	0.124	NS

Table 4. Effect of various seed treatment with plant oils (5ml/kg) and containers on seedling dry weight (mg) in onion seeds

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	7.30	7.43	7.37	6.97	7.30	7.13	6.57	6.70	6.63
T_2	7.42	7.60	7.51	7.17	7.42	7.29	6.60	6.77	6.68
T_3	7.27	7.38	7.33	7.13	7.30	7.22	6.50	6.67	6.58
T_4	7.17	7.33	7.25	6.90	7.17	7.03	6.50	6.67	6.58
T_5	7.27	7.50	7.38	7.03	7.27	7.15	6.47	6.60	6.53
T_6	7.30	7.52	7.41	7.10	7.30	7.20	6.50	6.60	6.55
T_7	7.20	7.42	7.31	6.97	7.20	7.08	6.50	6.60	6.55
T_8	7.13	7.30	7.22	7.00	7.13	7.07	6.47	6.67	6.57
T_9	6.37	6.57	6.47	6.07	6.23	6.15	5.93	6.03	5.98
Mean	7.21	7.39		6.96	7.19		6.48	6.62	
CD (P=0.05)	C	T	(C X T)	C	T	(C X T)	C	T	(C X T)
	0.106	0.238	NS	0.083	0.186	NS	0.062	0.139	NS

C_1: Cloth bag C_2: Plastic zipling bag

T_1: Castor oil; T_2: Neem oil; T_3: Aonla oil; T_4: Til oil; T_5: Linseed oil; T_6: Karanj oil; T_7: Akhrot oil; T_8: Ajwain oil; T_9: Untreated (Control)

Table 5. Effect of various seed treatment with plant oils (5ml/kg) and containers on vigour index I in onion seeds

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	651.6	667.0	659.3	613.5	631.2	622.3	532.6	549.0	540.8
T_2	652.2	673.5	662.8	627.2	637.8	632.5	574.3	584.4	579.4
T_3	655.6	664.0	659.8	619.6	637.5	628.6	553.1	562.5	557.8
T_4	640.4	645.7	643.0	621.1	631.8	626.5	545.4	559.7	552.6
T_5	639.0	657.1	648.1	611.2	624.5	617.8	541.7	561.6	551.7
T_6	621.3	632.1	626.7	602.5	615.6	609.1	529.6	541.0	535.3
T_7	620.9	633.9	627.4	602.0	612.5	607.3	540.4	546.0	543.2
T_8	626.9	642.1	634.5	607.0	612.9	610.0	539.7	548.2	544.0
T_9	598.5	621.2	609.9	565.0	582.2	573.6	506.1	529.0	517.6
Mean	638.8	653.1		610.9	625.1		543.9	558.3	
CD (P=0.05)	C	T	(C X T)	C	T	(C X T)	C	T	(C X T)
	7.833	17.515	NS	8.208	18.354	NS	6.596	14.749	NS

Table 6. Effect of various seed treatment with plant oils (5ml/kg) and containers on vigour index-II in onion seeds

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	542.6	555.0	548.8	497.0	525.7	511.3	418.0	431.1	424.5
T_2	553.9	575.1	564.5	508.9	531.5	520.2	435.7	451.1	443.4
T_3	535.4	548.7	542.0	516.0	532.9	524.5	424.7	437.8	431.2
T_4	525.6	540.3	532.9	494.5	518.5	506.5	420.3	435.7	428.0
T_5	537.9	559.9	548.9	501.7	525.7	513.7	420.4	437.8	429.1
T_6	537.7	561.2	549.5	511.2	533.0	522.1	418.1	426.8	422.5
T_7	527.9	548.8	538.4	499.4	521.0	510.2	418.1	429.0	423.6
T_8	530.2	544.9	537.6	504.0	518.3	511.2	413.8	433.4	423.6
T_9	464.7	483.8	474.2	426.7	442.4	434.6	373.7	386.1	379.9
Mean	533.3	551.3		498.5	520.3		419.6	433.3	
CD (P=0.05)	C	T	(C X T)	C	T	(C X T)	C	T	(C X T)
	8.252	18.451	NS	8.026	17.947	NS	5.256	11.752	NS

Table 7. Effect of various seed treatment with plant oils (5ml/kg) and containers on electrical conductivity (µS/cm/seed) in onion seeds

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	0.467	0.447	0.457	0.497	0.480	0.488	0.540	0.527	0.533
T_2	0.420	0.410	0.415	0.467	0.443	0.455	0.497	0.470	0.483
T_3	0.437	0.423	0.430	0.473	0.463	0.468	0.533	0.520	0.527
T_4	0.443	0.430	0.437	0.503	0.463	0.483	0.503	0.497	0.500
T_5	0.457	0.440	0.448	0.490	0.473	0.482	0.523	0.513	0.518
T_6	0.450	0.443	0.447	0.480	0.477	0.478	0.510	0.507	0.508
T_7	0.437	0.427	0.432	0.463	0.453	0.458	0.520	0.513	0.517
T_8	0.460	0.443	0.452	0.473	0.470	0.472	0.523	0.503	0.513
T_9	0.490	0.487	0.488	0.530	0.503	0.517	0.590	0.580	0.585
Mean	0.446	0.433		0.478	0.461		0.517	0.504	
CD (P=0.05)	C	T	(C X T)	C	T	(C X T)	C	T	(C X T)
	NS	0.021	NS	NS	0.053	NS	NS	0.04	NS

C_1: Cloth bag C_2: Plastic zipling bag

T_1: Castor oil; T_2: Neem oil; T_3: Aonla oil; T_4: Til oil; T_5: Linseed oil; T_6: Karanj oil; T_7: Akhrot oil; T_8: Ajwain oil; T_9: Untreated (Control)

The change of electrical conductivity is commonly used as an indicator for testing the integrity of plasma membrane. Electrical conductivity (µS/cm/g) of seed leachates increased significantly after ageing in all the treatments (Table 7). The maximum (0.585 µS/ cm/g) electrical conductivity after nine months of storage was recorded in T_9 (control) while significantly minimum in T_2 treatment (0.483 µS/cm/g). Containers and interaction effect was non-significant. The better performance was may be due to the seed treatment which may have increased the cell membrane stability and decreased the leakage of solutes from the seeds which ultimately lead to intact seed coat [20]. The loss of membrane integrity due to damage of phospholipids leads to increased membrane permeability and release of electrolytes, aminoacids and enzymes from cells [21]. Results were in conformity with the earlier findings of [13] in brinjal seeds.

Fungi are one of the most important factors which effect seeds during storage and reduce the seed viability in a short span. The data depicted in table 8 shows that the seed mycoflora was increased as the storage time progressed in all the treatments. The significant minimum seed mycoflora (0.643 %) was recorded in T_2 treatment in both containers at the end of storage period of nine months. The maximum seed mycoflora (1.072%) was recorded in T_9 treatment (control). Plastic zipling bag was significantly superior over cloth bag. The better interaction effect was noticed in T_2xC_2 (0.563 %). The results are also supported by studies of [22] in sorghum seeds, [13] in brinjal seeds and [23] in rice seeds.

Table 8. Mycoflora percentage in onion seed treated with plant oil (5ml/kg) kept in different storage containers

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	0.490	0.350	0.420	0.593	0.430	0.512	0.737	0.600	0.668
T_2	0.467	0.333	0.400	0.563	0.427	0.495	0.723	0.563	0.643
T_3	0.477	0.340	0.408	0.573	0.433	0.503	0.763	0.570	0.667
T_4	0.517	0.367	0.442	0.650	0.453	0.552	0.790	0.567	0.678
T_5	0.480	0.340	0.410	0.567	0.463	0.515	0.747	0.607	0.677
T_6	0.483	0.350	0.417	0.573	0.440	0.507	0.770	0.570	0.670
T_7	0.513	0.340	0.427	0.583	0.463	0.523	0.790	0.607	0.698
T_8	0.480	0.367	0.423	0.603	0.430	0.517	0.753	0.570	0.662
T_9	0.817	0.597	0.707	1.093	0.680	0.887	1.353	0.790	1.072
Mean	0.517	0.368		0.636	0.463		0.813	0.599	
CD (P=0.05)	C	T	(C X T)	C	T	(C X T)	C	T	(C X T)
	0.006	0.014	0.02	0.016	0.035	0.05	0.009	0.021	0.03

Table 9. Effect of various seed treatment with plant oils (5ml/kg) and containers on emergence index in onion seeds

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	8.33	8.37	8.35	7.30	7.37	7.33	6.17	6.27	6.22
T_2	8.50	8.60	8.55	7.47	7.60	7.53	6.30	6.37	6.33
T_3	8.43	8.47	8.45	7.47	7.47	7.47	6.20	6.30	6.25
T_4	8.40	8.43	8.42	7.40	7.43	7.42	6.17	6.27	6.22
T_5	8.37	8.40	8.38	7.30	7.40	7.35	6.10	6.20	6.15
T_6	8.40	8.43	8.42	7.33	7.43	7.38	6.20	6.30	6.25
T_7	8.37	8.40	8.38	7.30	7.40	7.35	6.17	6.23	6.20
T_8	8.37	8.43	8.40	7.33	7.43	7.38	6.10	6.17	6.13
T_9	8.17	8.23	8.20	7.13	7.23	7.18	5.60	6.00	5.80
Mean	8.4	8.5		7.4	7.4		6.1	6.3	
CD (P=0.05)	C	T	(C X T)	C	T	(C X T)	C	T	(C X T)
	0.041	0.091	NS	0.045	0.101	NS	0.055	0.122	NS

The data presented in table 9 showed that speed of emergence was slower as the storage time augmented in all the treatments. This might be due to decrease in seed vigour with the process of advancement in ageing. The maximum speed of emergence was observed in T_2 treatment (6.33) closely followed by T_4 and T_6 treatment (6.25) at the end of storage period while the minimum (5.80) was recorded in T_9 (control). The seeds kept in plastic zipling bag recorded higher speed of emergence over the cloth bag. The interaction effect was non-significant. These findings were in agreement with the reports of [24] in tomato seeds.

The perusal of data indicated in table 10 revealed that seedling establishment rate was declined as the storage period progressed in all the treatments. The decline in seedling establishment rate may be attributed to decrease in potential of seed during storage. The maximum seedling establishment was observed in T_2 treatment (54.17 %) at the end of storage period. Among containers, plastic zipling bag was better. The interaction effect was non-significant during the storage period. Results found similarity with [25] in okra seeds.

CONCLUSION

Deterioration of the stored seeds is natural phenomena and seeds tend to lose viability even under ideal storage conditions. Onion seeds are short lived. In the present study all the seed quality attributes were found decreasing except electrical conductivity and seed mycoflora which were increasing. The germination percentage falls below

Table 10. Effect of various seed treatment with plant oils (5ml/kg) and containers on seedling establishment (%) in onion seeds

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	71.67	72.00	71.83	61.67	62.00	61.83	53.33	53.67	53.50
T_2	72.00	72.33	72.17	62.00	62.33	62.17	54.00	54.33	54.17
T_3	70.67	71.00	70.83	60.67	61.00	60.83	53.00	53.33	53.17
T_4	71.67	72.00	71.83	61.67	62.00	61.83	53.00	53.67	53.33
T_5	71.00	71.33	71.17	61.00	61.33	61.17	53.33	54.00	53.67
T_6	71.33	71.67	71.50	61.33	61.67	61.50	52.67	53.00	52.83
T_7	71.67	72.00	71.83	61.67	62.00	61.83	52.33	52.67	52.50
T_8	70.67	71.00	70.83	60.67	61.00	60.83	53.33	53.67	53.50
T_9	69.00	69.33	69.17	59.00	59.33	59.17	51.67	52.00	51.83
Mean	71.20	71.57		61.53	61.57		53.10	53.53	
CD (P=0.05)	C	T	(C X T)	C	T	(C X T)	C	T	(C X T)
	NS	0.968	NS	NS	1.731	NS	NS	1.09	NS

C_1: Cloth bag C_2: Plastic zipling bag

T_1: Castor oil; T_2: Neem oil; T_3: Aonla oil; T_4: Til oil; T_5: Linseed oil; T_6: Karanj oil; T_7: Akhrot oil; T_8: Ajwain oil; T_9: Untreated (Control)

IMSCS (70%) after 9 months of storage. The treatment with neem oil (5 ml kg^{-1} seed) proved superior over all other treatments. Among containers, plastic zipling bag showed better performance as compared to cloth bag. The study also states that seed treatment with neem oil maintains viability, vigour and seed health for longer period of time in case of onion seeds.

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