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Influence of Fungicides and Containers on Seed Storability of Onion (*Allium cepa* L.)

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ABSTRACT

The present study was carried out in the Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar to evaluate the effect of different fungicide treatments and containers on seed storability of onion seed. The onion seeds (variety: Hisar Onion-4) were treated with seven fungicides @ 2g kg^{-1} seed (carbendazim, difeconazole, carboxin, thiram, metalxyl, captan, carboxin+thiram) along with control and were kept in two containers (cloth bag and plastic zipling bag) for ambient storage. All the treatments were evaluated for seed quality parameters up to nine months at ambient conditions (germination, shoot length, root length, seedling dry weight, vigour indices (I and II), electrical conductivity, seed mycoflora, emergence index and seedling establishment) at a regular interval of three months. All the parameters were found decreasing except electrical conductivity and seed mycoflora which was increasing with the passage of storage time. The seeds treated with carboxin + thiram and kept in plastic zipling bag recorded higher seed quality parameters.

Keywords Onion, Seed quality, Fungicides, Containers, Storage.

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INTRODUCTION

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 family *Alliaceae.* It was originated in Central Asia. India is second largest producer of onion after China as it produces 23.28 million tons of onion from 1.29 million hectare (Anonymous 2019). Seed is the basic and vital input in agricultural production3 Onion seeds are short lived under ambient conditions and show orthodox storage behavior. They have poor storage capacity and lose viability within a year.

Deterioration of the stored seed is natural phenomena and seeds tend to lose viability even under ideal storage conditions (Shanon 2013). As the con-

trolled conditions involve huge cost, seed treatments remains the best alternative approach to maintain the seed quality. Seed treatments provides protection during the critical germination and stand establishment stages when seed and emerging seedlings are unable to protect themselves against evasive pathogens and pests. Serving as the first line of defence, seed treatments can improve germination, seedling emergence, stand establishment and plant vigour. As a result of this early-season performance, plants treated with seed treatments have an edge over untreated plants when it comes to realizing yield, quality and profit potential. The seeds are stored after harvest till the next sowing or until further use.

Every seed is a potential harbor of a wide variety of mycoflora containing both pathogenic and saprophytic microorganisms, both externally and internally (Utobo *et al.* 2011). During storage, number of biotic and abiotic factors influences the storage potential of seeds and results in gradual deterioration and ultimately death of the seeds (Kumar *et al*.2014). Seed containers or packaging materials are considered as one of the most important factors influencing longevity of seeds in storage in many field crops, in general. Sharma *et al.* (2015) reported that lack of awareness to seed treatment at farmer's level is one of the limiting factors in disease management. The information on prolonging the shelf life of onion seeds under storage is very limited. Therefore, the present study entitled "Influence of Fungicidesm and Containers on Seed Storability of onion (*Allium cepa* L.)" was carried out.

MATERIALS AND METHODS

The present study was carried out on onion seed (Hisar Onion-4) harvested in May 2018 having germination (81 %) above Indian Minimum Seed Certification Standards. The seeds were treated with various fungicides @ 2 g kg^{-1} seed (T_1: Carbendazim 75% WP, T_2: Difeconazole 25% EC, T_3: Carboxin 75% WP, T_4: Thiram 75 % WS, T_5: Metalaxyl 35% WS, T_6: Captan 50 % WP, T_7: Carboxin 37.5 % + Thiram 25 % WP and T_8: Untreated (Control)) and were kept in containers (C_1: Cloth bag, C_2: Plastic zipling bag (40 µm) under ambient conditions in seed pathology laboratory of Department of Seed Science and Technology, CCS HAU, Hisar.

The onion seeds and fungicide were weighed 21g and 0.042 g, wearing gloves, using appro priate weighing balance for each treatment. The seeds and fungicides were mixed in beakers and shacked for some time for uniform coating of fungicides 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 24 with three replications.

The experiment consisted of two factors (two different packing materials as storage container were used as level factor "C" and the seven fungicide 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 (ISTA 2011). 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 according as per Abdul-Baki and Anderson 1973.

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

Table 1. Effect of various seed treatment with fungicides and containers on germination (%) in onion seed. C_1: Cloth bag C_2: Plastic zipling bag T_1 Carbendazim 75% WP, T_2 Difenoconazole 25% EC, T_3 Carboxin 75% WP; T_4 Thiram 75% WP, T_5 Metalaxyl 35% WS, T_6 Captan 50 % WP, T_7 Carboxin 37.5 % + Thiram 37.5 % WS, T_8 Untreated (Control).

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	75.67	76.33	76.00	72.67	73.33	73.00	66.67	67.33	67.00
T_2	74.00	74.67	74.33	71.33	72.00	71.67	66.33	67.00	66.67
T_3	74.67	75.33	75.00	71.00	71.67	71.33	67.00	67.33	67.17
T_4	76.00	77.00	76.50	73.00	73.67	73.33	67.67	68.67	68.17
T_5	73.67	74.33	74.00	72.33	73.00	72.67	66.00	66.67	66.33
T_6	74.00	74.67	74.33	71.33	72.33	71.83	65.00	65.33	65.17
T_7	77.33	78.33	77.83	73.33	74.33	73.83	68.67	69.33	69.00
T_8	73.00	73.67	73.33	70.33	71.00	70.67	63.00	64.00	63.50
Mean	74.79	75.54		71.92	72.67		66.29	66.96	
CD (p=0.05)	C	T	(C×T)	C	T	(C×T)	C	T	(C×T)
	0.603	1.206	NS	0.621	1.241	NS	0.615	1.23	NS

Electrical conductivity of the seed leachates was measured as per ISTA (1999).

Seed health test was conducted by blotter method as recommended by ISTA (Anon 1999).

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 (1962).

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 (Panse and Sukhatme1985).

RESULTS AND DISCUSSION

The seed possess maximum germination and vigour at the time of physiological maturity and there after 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

Table 2. Effect of various seed treatments with fungicides and containers on root length (cm) in onion seed. C_1: Cloth bag C_2: Plastic zipling bag T_1 Carbendazim 75% WP, T_2 Difenoconazole 25% EC; T_3 Carboxin 75% WP, T_4 Thiram 75% WP, T_5 Metalaxyl 35% WS, T_6 Captan 50 %WP, T_7 Carboxin 37.5 % + Thiram 37.5 % WS, T_8 Untreated (Control).

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	3.40	3.47	3.43	3.27	3.47	3.37	3.20	3.40	3.30
T_2	3.60	3.83	3.72	3.47	3.50	3.48	3.43	3.43	3.43
T_3	4.30	4.40	4.35	4.03	4.17	4.10	4.00	4.13	4.07
T_4	4.43	4.57	4.50	4.17	4.17	4.28	4.10	4.13	4.20
T_5	3.57	3.77	3.67	3.53	3.47	3.50	3.50	3.37	3.43
T_6	4.37	4.40	4.38	4.20	4.37	4.28	4.10	4.27	4.18
T_7	4.43	4.80	4.62	4.30	4.60	4.45	4.27	4.50	4.38
T_8	3.10	3.20	3.15	3.00	3.10	3.05	3.00	3.10	3.05
Mean	3.90	4.05		3.75	3.85		3.70	3.79	
CD (p=0.05)	C	T	(C×T)	C	T	(C×T)	C	T	(C×T)
	0.101	0.202	NS	0.105	0.21	NS	0.133	0.265	NS

Table 3. Effect of various seed treatments with fungicides and containers on shoot length (cm) in onion seed. C_1: Cloth bag C_2: Plastic zipling bag T_1 Carbendazim 75% WP, T_2 Difenoconazole 25% EC; T_3 Carboxin75%WP, T_4 Thiram 75% WP, T_5 Metalaxyl 35% WS, T_6 Captan 50 % WP, T_7 Carboxin 37.5 % + Thiram 37.5 % WS, T_8 Untreated (Control).

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	5.60	5.63	5.62	5.53	5.60	5.57	5.43	5.53	5.48
T_2	5.67	5.77	5.72	5.57	5.67	5.62	5.47	5.60	5.53
T_3	6.17	6.40	6.28	6.07	6.30	6.18	5.97	6.27	6.12
T_4	6.27	6.33	6.35	6.17	6.27	6.25	6.25	6.17	6.24
T_5	5.67	5.73	5.70	5.57	5.63	5.60	5.43	5.57	5.50
T_6	6.27	6.37	6.32	6.17	6.30	6.23	6.07	6.33	6.20
T_7	6.53	6.70	6.62	6.43	6.60	6.52	6.33	6.50	6.42
T_8	5.10	5.23	5.17	5.03	5.10	5.07	5.03	5.17	5.10
Mean	5.91	6.02		5.82	5.93		5.72	5.89	
CD (p=0.05)	C	T	(C × T)	C	T	(C × T)	C	T	(C × T)
	0.101	0.202	NS	0.105	0.21	NS	0.133	0.265	NS

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_7 (69%) recorded higher germination percentage and at par with T_4 treatment (68.17%). Among the containers, plastic zipling bag showed better performance. Interaction effect of containers with fungicides was found non-significant. The similar results were reported in the past by Chaudhary *et al.* (2013) in chilli and Sultana *et al*. (2016) in okra.

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_7 (4.38 cm) treatment which was at par with T_4 (4.20 cm), T_6 (4.18 cm) and T_3 (4.07 cm) treatments. Plastic zipling bag proved better among containers and interaction effect was non-significant. The results were in accordance with the findings of Kumar *et al.* (2020), Patil *et al.* (2017) brinjal. Same trend (Table 3) was followed in case of shoot length, T_7 (6.42 cm) treatment proved better than others followed by T_4 (6.24 cm) and T_6 (6.20 cm) and among containers, plastic zipling bag was

Table 4. Effect of various seed treatments with fungicides and containers on seedling dry weight (mg) in onion seed. C_1: Cloth bag C_2: Plastic zipling bag T_1 Carbendazim 75% WP, T_2 Difenoconazole 25% EC; T_3 Carboxin 75% WP, T_4 Thiram 75% WP, T_5 Metalaxyl 35%WS, T_6 Captan 50 % WP, T_7 Carboxin 37.5 % + Thiram 37.5 % WS, T_8 Untreated (Control).

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	7.63	7.80	7.72	7.23	7.55	7.39	6.80	6.90	6.85
T_2	7.30	7.43	7.37	7.00	7.17	7.08	6.70	6.80	6.75
T_3	7.13	7.30	7.22	6.97	7.03	7.00	6.73	6.80	6.77
T_4	7.42	7.52	7.47	7.17	7.32	7.24	6.87	6.97	6.92
T_5	7.17	7.33	7.25	6.90	7.03	6.97	6.60	6.73	6.67
T_6	7.30	7.50	7.40	7.03	7.13	7.08	6.53	6.83	6.68
T_7	7.90	8.00	7.95	7.57	7.70	7.63	6.87	7.03	6.95
T_8	6.37	6.57	6.47	6.07	6.23	6.15	5.93	6.03	5.98
Mean	7.28	7.43		6.99	7.15		6.63	6.76	
CD (p=0.05)	C	T	(C X T)	C	T	(C X T)	C	T	(C X T)
	0.123	0.245	NS	0.111	0.223	NS	0.083	0.165	NS

Table 5. Effect of various seed treatments with fungicides and containers on vigour index-I in onion seed. C_1: Cloth bag C_2: Plastic zipling bag T_1 Carbendazim 75% WP, T_2 Difenoconazole 25% EC; T_3 Carboxin 75% WP, T_4 Thiram 75% WP, T5 Metalaxyl 35% WS, T_6 Captan 50 %WP, T_7 Carboxin 37.5 % + Thiram 37.5 % WS, T_8 Untreated (Control).

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	681.0	694.3	687.7	639.7	664.7	652.2	575.7	601.3	588.5
T_2	685.7	716.7	701.2	644.7	660.0	652.3	590.7	605.0	597.8
T_3	781.7	814.0	797.8	717.0	750.3	733.7	668.0	700.3	684.2
T_4	788.3	810.3	799.3	754.3	769.0	761.7	686.0	707.3	696.7
T_5	683.3	731.7	707.5	658.0	664.3	661.2	589.7	595.7	592.7
T_6	787.3	804.0	795.7	739.7	771.7	755.7	661.0	692.3	676.7
T_7	848.0	901.0	874.5	787.7	832.7	810.2	728.0	762.7	745.3
T_8	630.3	651.0	640.7	590.7	613.3	602.0	516.7	537.3	527.0
Mean	735.7	765.4		691.5	715.8		627.0	650.3	
CD (p=0.05)	C	T	(C × T)	C	T	(C × T)	C	T	(C × T)
	13.662	27.324	NS	11.626	23.252	NS	11.029	22.05	NS

superior. The interaction effect was non-significant. These findings were in agreement with the reports of Kumar and Jakhar (2019), Kavitha *et al*. (2009) in chilli and Sultana *et al.* (2015) in okra.

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, significantly highest seedling dry weight was recorded in T_2 (26.7 mg) followed by T_4 (6.92 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 root and shoot length. The results are in conformity with the findings of Dheeraj *et al.* (2018) in tomato, Manoharapaladagu *et al*. (2017) in chilli and Kumar *et al.* (2020) in brinjal.

In the present study, significantly higher vigour index-I was recorded in T_7 (745.30) followed by, T_4 (696.70) at the end of nine months of storage period (Table 5). The fungicide-treated seeds stored in different containers when tested for vigour index-II, treatment T_7 (479.60) found superior followed by T_4 (461.30) 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

Table 6. Effect of various seed treatments with fungicides and containers on vigour index-II in onion seed. C_1: Cloth bag C_2: Plastic zipling bag T_1 Carbendazim 75% WP; T_2 Difenoconazole 25% EC; T_3 Carboxin 75% WP; T_4 Thiram 75% WP; T_5 Metalaxyl 35% WS; T_6 Captan 50 %WP; T_7 Carboxin 37.5 % + Thiram 37.5 % WS; T_8 Untreated (Control).

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	577.6	595.4	586.5	525.7	553.7	539.7	453.3	464.6	459.0
T_2	540.5	555.0	547.7	499.3	516.1	507.7	444.4	455.6	450.0
T_3	553.8	566.3	560.0	508.9	524.4	516.6	460.0	469.1	464.5
T_4	525.5	542.7	534.1	508.5	518.1	513.3	455.6	467.0	461.3
T_5	530.3	564.4	547.3	499.1	513.5	506.3	435.5	448.7	442.1
T_6	540.4	559.9	550.2	501.7	515.9	508.8	424.6	446.5	435.6
T_7	610.9	626.7	618.8	554.7	572.4	563.6	471.6	487.6	479.6
T_8	464.7	483.8	474.2	426.7	442.4	434.6	373.7	386.1	379.9
Mean	542.9	561.8		503.1	519.6		439.9	453.2	
CD (p=0.05)	C	T	(C × T)	C	T	(C × T)	C	T	(C × T)
	10.343	20.686	NS	8.858	17.716	NS	6.081	12.162	NS

Table 7. Effect of various seed treatments with fungicides and containers on EC (µS/cm/g) in onion seed. C_1: Cloth bag C_2: Plastic zipling bag T_1 Carbendazim 75% WP; T_2 Difenoconazole 25% EC; T_3 Carboxin75%WP; T_4 Thiram 75% WP; T_5 Metalaxyl 35% WS; T_6 Captan 50 % WP; T_7 Carboxin 37.5 % + Thiram 37.5 % WS; T_8 Untreated (Control).

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	0.383	0.360	0.372	0.400	0.383	0.392	0.430	0.407	0.418
T_2	0.350	0.323	0.337	0.373	0.350	0.362	0.427	0.383	0.405
T_3	0.403	0.383	0.393	0.420	0.403	0.412	0.467	0.433	0.450
T_4	0.327	0.317	0.322	0.343	0.327	0.335	0.370	0.377	0.373
T_5	0.400	0.400	0.400	0.413	0.400	0.407	0.440	0.430	0.435
T_6	0.347	0.327	0.337	0.363	0.347	0.355	0.403	0.360	0.382
T_7	0.307	0.300	0.303	0.333	0.307	0.320	0.367	0.350	0.358
T_8	0.490	0.487	0.488	0.530	0.503	0.517	0.590	0.580	0.585
Mean	0.376	0.362		0.397	0.378		0.437	0.415	
CD	C	T	(C × T)	C	T	(C × T)	C	T	(C × T)
(p=0.05)	0.01	0.019	NS	0.014	0.028	NS	0.012	0.023	NS

work found similarity with the earlier findings of Santoshreddy *et al.* (2014); Chaudhary *et al.* (2013) in chilli and kumar *et al*. (2014) in brinjal.

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 (585 µS/ cm/g) electrical conductivity after nine months of storage was recorded in T_8 (control) while minimum (0.358 µS/cm/g) was recorded in T_7 followed by T_4 (0.373 µS/ cm/g).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 (Namvar *et al*. 2013). The loss of membrane integrity due to damage of phospholipids leads to increased membrane permeability and release of electrolytes, aminoacids and enzymes from cells (Zamani *et al*. 2010). Results were in conformity with the earlier findings of Kumari *et al.* (2014) in fenugreek and Kumar *et al.* (2019) in chilli and brinjal.

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 minimum seed mycoflora (0.538 %) was recorded in

Table 8. Mycoflora average (%) in onion seed treated with fungicides kept in different storage container. C_1: Cloth bag C_2: Plastic zipling bag T_1 Carbendazim 75% WP; T_2 Difenoconazole 25% EC; T_3 Carboxin75%WP; T_4 Thiram 75% WP; T_5 Metalaxyl 35%WS; T_6 Captan 50 %WP; T_7 Carboxin 37.5 % + Thiram 37.5 % WS; T_8 Untreated (Control).

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	0.443	0.300	0.372	0.557	0.413	0.485	0.703	0.550	0.627
T_2	0.490	0.313	0.402	0.593	0.420	0.507	0.723	0.600	0.662
T_3	0.513	0.313	0.413	0.613	0.427	0.520	0.773	0.610	0.692
T_4	0.420	0.207	0.313	0.520	0.327	0.423	0.680	0.470	0.575
T_5	0.517	0.267	0.392	0.650	0.390	0.520	0.790	0.550	0.670
T_6	0.427	0.303	0.365	0.550	0.463	0.507	0.693	0.607	0.650
T_7	0.340	0.217	0.278	0.473	0.287	0.380	0.670	0.407	0.538
T_8	0.817	0.597	0.707	1.093	0.680	0.887	1.353	0.790	1.072
Mean	0.496	0.315		0.631	0.426		0.798	0.573	
CD	C	T	(C × T)	C	T	(C × T)	C	T	(C × T)
(p=0.05)	0.01	0.02	0.028	0.02	0.04	0.056	0.012	0.024	0.034

Table 9. Effect of various seed treatments with fungicides and containers on emergence index in onion seed. C_1: Cloth bag C_2: Plastic zipling bag T_1 Carbendazim 75% WP; T_2 Difenoconazole 25% EC; T_3 Carboxin75%WP; T_4 Thiram 75% WP; T_5 Metalaxyl 35%WS; T_6 Captan 50 %WP; T_7 Carboxin 37.5 % + Thiram 37.5 % WS; T_8 Untreated (Control).

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	8.6	8.7	8.7	7.6	7.7	7.6	6.3	6.5	6.4
T_2	8.6	8.5	8.5	7.3	7.5	7.4	6.2	6.4	6.3
T_3	8.5	8.6	8.6	7.5	7.6	7.6	6.3	6.5	6.4
T_4	8.3	8.7	8.5	7.6	7.7	7.7	6.3	6.5	6.4
T_5	8.5	8.6	8.5	7.5	7.6	7.5	5.9	6.0	6.0
T_6	8.4	8.4	8.4	7.4	7.4	7.4	6.1	6.4	6.3
T_7	8.8	8.9	8.8	7.8	7.8	7.8	6.6	6.8	6.7
T_8	8.2	8.2	8.2	7.2	7.2	7.2	5.6	6.0	5.8
Mean	8.5	8.6		7.5	7.6		6.2	6.4	
CD (p=0.05)	C	T	(C × T)	C	T	(C × T)	C	T	(C × T)
	0.058	0.117	0.165	0.058	0.117	NS	0.059	0.118	NS

T_7 treatment in both containers at the end of storage period of 9 months. The maximum seed mycoflora (1.072%) was recorded in T_8 (control). Plascticzipling bag was significantly superior over cloth bag. The better interaction effect was noticed in $T_7 \times C_2$ (0.407 %). The results are in accordance with the earlier findings of Ram *et al.* (2021) in sorghum.

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_7 (6.7) at the end of storage period. The minimum speed of emergence (5.8) was recorded in T_8 (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 Sashibaskar *et al.* (2012) in tomato.

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_7 (56.70 %) 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 Kumar *et al.* (2020) in okra.

Table 10. Effect of various seed treatments with fungicides and containers on seedling establishment (%) in onion seed. C_1: Cloth bag C_2: Plastic zipling bag T_1 Carbendazim 75% WP; T_2 Difenoconazole 25% EC; T_3 Carboxin75%WP; T_4 Thiram 75% WP; T_5 Metalaxyl 35%WS; T_6 Captan 50 % WP; T_7 Carboxin 37.5 % + Thiram 37.5 % WS; T_8 Untreated (Control).

Treatments	3 Month			6 Month			9 Month		
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	72.3	72.7	72.5	62.3	63.0	62.7	54.3	55.0	54.7
T_2	72.3	72.3	72.3	62.3	63.0	62.7	54.0	54.3	54.2
T_3	70.7	71.3	71.0	61.0	61.3	61.2	53.0	53.7	53.3
T_4	72.0	73.0	72.5	62.7	63.0	62.8	55.3	55.7	55.5
T_5	71.7	72.3	72.0	61.7	62.7	62.2	53.3	54.3	53.8
T_6	72.3	72.7	72.5	62.0	62.7	62.3	53.7	54.7	54.2
T_7	73.7	74.3	74.0	63.7	63.7	63.7	56.3	57.0	56.7
T_8	69.0	69.3	69.2	59.0	59.3	59.2	51.7	52.0	51.8
Mean	71.8	72.3		61.8	62.3		54.0	54.6	
CD (p=0.05)	C	T	(C × T)	C	T	(C × T)	C	T	(C × T)
	NS	1.037	NS	NS	1.078	NS	0.504	1.009	NS

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 was increasing. The germination percentage falls below IMSCS (70%) after 9 months of storage. The treatment with combi-fungicide (carboxin + thiram) 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 carboxin+thiram maintains viability, vigour and seed health for longer period of time in case of onion seeds.

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