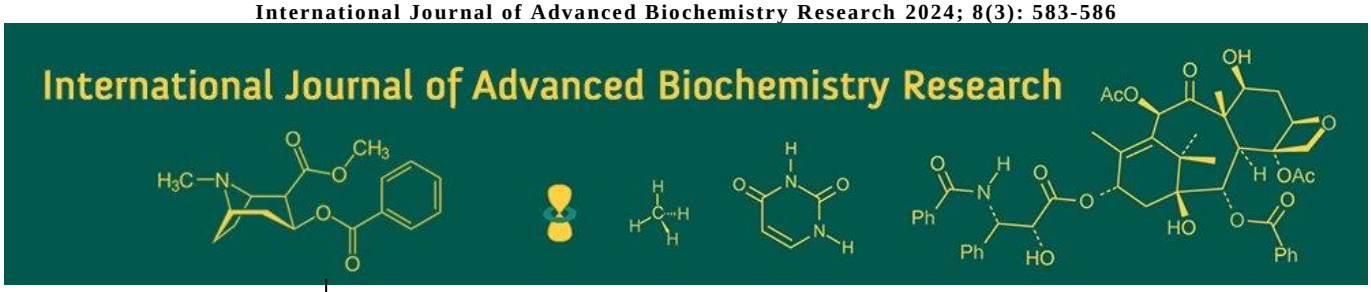

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Effect of seed treatments on storability in onion seeds (*Allium cepa* L.)

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Abstract
An experiment was conducted to study the effect of seed treatments on storability of onion seeds during June 2019 to March 2020 at National Seed Project (Crops), Dharwad, Post Graduate laboratory of the Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad. The seeds were treated with six different fungicides i.e Captan at 2 g/kg of seed, Carboxin + Thiram at 2 g/kg of seed, Carbendazim + Mancozeb at 2 g/kg of seed, Hexaconazole + Zineb at 2 g/kg of seed, Hexaconazole and Tebuconazole (each at 2 ml/kg of seed). Among the treatments, Carbendazim 25% + Mancozeb 50% WS at 2 g kg^{-1} recorded better values of germination and seedling vigor index (70.33% and 659 correspondingly) at the end of nine months of storage. The results of this storage study concluded that seeds treated with Carbendazim 25% + Mancozeb 50% WS at 2 g kg^{-1} fungicide recorded highest seed quality parameters in storage as compared to control.

Keywords: Onion, carbendazim, mancozeb, seed treatment

Introduction
Onion (*Allium cepa* L.) is one of the important vegetables among bulb crops which belongs to the family Amaryllidaceae. It occupies a major position in the world as it is cultivated in majority of the countries and has regular demand for its consumption. Onion is valued mainly for their high carbohydrate, vitamin and mineral contents. In the recent days, the demand for onion is increasing, mainly due to its nutritive and medicinal value such as, antibacterial and antioxidant effects. Good seed is a basic input in vegetable production. Seed producers hold greater responsibility in maintaining genetically pure seeds and to preserve the quality of onion seeds from harvest to next sowing. Onion is an important vegetable crop. Its seed are short lived under ambient conditions (Doijode, 1987) [5].

The seeds are stored after harvest till the next slowing or until further use. The onion seeds are found to be poor storer (Nagaveni, 2005) [10]. Proper seed treatments are needed to maintain the seed quality during storage. The seed deterioration starts right at the field level immediately after the physiological maturity. The seed has to be stored safely so that the viability and vigour is maintained intact. Deterioration of seed during storage is inevitable and leads to different changes at various levels viz, impairment or shift in metabolic activity, compositional changes, decline or change in enzyme activities, phenotypic, cytological changes apart from quantitative losses. Seed deterioration is inevitable and irreversible process but the rate of seed deterioration could be slowed down either by storing the seeds under controlled conditions or with seed treatment chemicals.

Seed treatment with chemicals is found to be more useful in storage for better seed quality up to one year in onion by suppressing the storage pests and fungi (Gupta *et al*., 1989) [7]. Pre-storage seed treatment may reduce the prevalence of seed-borne fungi and protect seeds from the invasion of fungi in storage condition. Fungicides produced significant negative impact on seed-borne fungi and positive impact in maintaining quality during storage (Khan *et al*., 2017) [8].

Material and Methods
The experiment consists of seven treatments viz., T_1: Untreated control, T_2: Captan @ 2 g/kg of seed, T_3: Carboxin + Thiram @ 2 g/kg of seed, T_4: Carbendazim + Mancozeb @ 2 g/kg of

seed, T_5: Hexaconazole @ 2 ml/kg of seed, T_6: Tebuconazole @ 2 ml/kg of seed, T_7: Hexaconazole + Zineb @ 2 ml/kg seed. After proper mixing of seeds as per the treatments, seeds were packed in Aluminum pouch. The design of the experiment adopted was Completely Randomized Design with four replications. Germination test was conducted with four replications of 100 seeds each by adopting between paper method as described by ISTA (Anon., 2011) [2] and Ten normal seedlings selected for measuring shoot, root length and total seedling length. The seedling vigour index was calculated by adopting the method suggested by Abdul Baki and Anderson (1973) [1] and expressed in number.

Results and Discussion

In the present investigation, irrespective of the treatments, the seed quality parameters declined progressively with the increase in storage period. Seed treatment with chemicals had a significant effect on seed quality parameter from the third month of storage up to the end of nine months of storage.

Among the treatments, the seeds treated with Carbendazim 25% + Mancozeb 50% WS at the rate of 2 g/kg seed exhibited superiority in maintaining the seed quality throughout the storage period. The seeds treated with Carbendazim 25% + Mancozeb 50% WS (T_4) gave significantly higher germination percentage when compared to control (T_1) (Table 1). The seeds treated with Carbendazim 25% + Mancozeb 50% WS (T_4) recorded significantly higher values for root length, shoot length and total seedling length indicating the superiority over control in maintaining the seed quality in storage.

The other quality parameters viz., root length, shoot length and total seedling length recorded higher values in seeds treated with Carbendazim 25% + Mancozeb 50% WS (T_4) than compared to untreated control (T_1) (Table 2, Table 3 and Table 4 respectively) recorded at the end of 9th month of storage period Due to the influence of residual systemic action of zinc and manganese present in Carbendazim 25% + Mancozeb 50% WS which contributed in increasing the metabolic activity of enzymes that helped in excess cell division, enlargement and elongation of root length, making root surface to absorb more nutrient from media and also easier for plumule meristem to grow with elongation and enlargement of shoot cells. These are probable reasons for increased germination, root and shoot length. The results are in confirmation with the findings of Seema (2017) [11] in Kabuli chickpea and Anitha *et al.* (2013) [3] in soybean.

Seed treatment with Carbendazim 25% + Mancozeb 50% WS was determined to safeguard the quality of seed due to its antifungal activity and it also recorded the highest in the retainment of seed quality attributes as it is a combination of two fungicides (Carbendazim 25% + Mancozeb 50% WS).The seed treatment options gave a clear indication that treating the seeds with fungicide helped to reduce faster deterioration of seed quality parameters and minimized to progressive rate of multiplication of seed mycoflora during the study. The reduction in seed germination over time could also be linked to the reduction in enzyme activity within the seed and with the reduction in seed germination percentage; there is reduction in all the seed quality parameters (Demirkaya *et al.*, 2010) [4].

The seeds treated with Carbendazim 25% + Mancozeb 50% WS at the rate of 2 g/kg seed (T_4) recorded higher vigour index, while significantly lower seedling vigour index was registered in Control (T_1) at the end of storage period (Table 5).

This can be attributed to the reason that seeds treated with Carbendazim 25% + Mancozeb 50% WS (T_4) recorded highest germination percentage and total seedling length, thus seedling vigour index was high. High germination is an indicator of high vigour and because of that high germination, high seedling vigour index (Table 5) was observed in treated seed with Carbendazim 25% + Mancozeb 50% (T_4) as compared to control. This is in accordance with the findings of Singh *et al.* (1996) [12] and Nagaveni (2005) [10] in onion. A positive and significant correlation was observed between germination percentage and vigour index. Similar findings were observed by Khatun *et al.* (2009) [9].

Table 1: Effect of seed treatment on seed germination (%) in onion seeds during storage period

	Storage period (months)									
Treatments	**Initial**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
T_1	82.67 (65.37*)	80.75 (63.89)	78.67 (62.46)	75.30 (59.97)	73.00 (58.67)	71.33 (57.60)	70.00 (56.97)	68.00 (55.52)	66.67 (54.71)	64.67 (53.50)
T_2	83.00 (65.24)	81.33 (64.13)	79.00 (62.70)	77.33 (61.54)	75.00 (59.97)	72.67 (58.45)	70.67 (57.18)	68.67 (55.93)	67.00 (54.92)	65.00 (53.70)
T_3	84.67 (66.92)	83.50 (65.24)	80.67 (63.89)	79.00 (62.70)	77.67 (61.73)	76.00 (60.42)	73.00 (58.67)	71.00 (57.39)	69.00 (56.14)	67.00 (54.91)
T_4	86.00 (68.00)	85.00 (66.40)	83.33 (65.88)	81.67 (64.62)	79.67 (63.17)	77.67 (61.77)	75.33 (60.19)	73.00 (58.67)	71.67 (57.39)	70.33 (56.97)
T_5	83.67 (66.14)	82.33 (64.62)	79.67 (63.17)	78.33 (62.23)	76.33 (60.86)	74.00 (59.32)	71.33 (57.60)	69.67 (56.59)	67.67 (55.32)	66.00 (54.31)
T_6	83.33 (65.88)	82.00 (64.37)	79.33 (62.93)	77.67 (61.77)	75.67 (60.41)	73.00 (58.67)	71.00 (57.39)	69.00 (56.14)	67.33 (55.12)	65.33 (53.90)
T_7	84.67 (66.40)	83.00 (64.87)	80.33 (63.64)	78.67 (62.46)	77.00 (61.32)	75.00 (59.97)	72.67 (58.45)	70.67 (57.18)	68.67 (55.93)	66.67 (54.71)
Mean	83.90 (66.32)	82.55 (64.83)	79.95 (63.37)	78.24 (62.16)	76.33 (60.86)	74.24 (59.47)	72.05 (58.06)	70.00 (56.76)	68.28 (55.64)	66.42 (54.45)
S.Em±	0.630	0.577	0.563	0.836	0.882	0.756	0.678	0.655	0.678	0.454
C. D. @ (1%)	NS	NS	NS	3.518	3.713	3.182	2.856	2.756	2.856	1.912

Note: *Values in parentheses are arc sine transformed
NS: Non-Significant
T_1: Untreated control
T_2: Captan @ 2 g/kg seeds

T_3: Carboxin + Thiram @2 g/kg seeds
T_4: Carbendazim + Mancozeb @ 2 g/kg seeds
T_5: Hexaconazole @ 2 ml/kg seeds
T_6: Tebuconazole @ 2 ml/kg seeds
T_7: Hexaconazole + Zineb @ 2 g/kg seeds

Table 2: Effect of seed treatment on root length (cm) in onion seeds during storage

	Storage period (months)									
Treatments	**Initial**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
T_1	4.28	4.10	3.92	3.68	3.52	3.47	3.33	3.28	3.12	2.92
T_2	4.37	4.20	4.08	3.81	3.60	3.53	3.48	3.32	3.22	3.02
T_3	4.48	4.45	4.28	4.18	4.03	3.88	3.70	3.55	3.43	3.18
T_4	4.57	4.52	4.42	4.23	4.07	3.97	3.90	3.83	3.65	3.42
T_5	4.43	4.27	4.22	4.10	3.87	3.73	3.65	3.47	3.33	3.12
T_6	4.38	4.23	4.15	4.07	3.68	3.65	3.58	3.43	3.28	3.03
T_7	4.47	4.35	4.25	4.17	4.05	3.80	3.68	3.50	3.37	3.15
Mean	4.43	4.30	4.19	4.04	3.83	3.72	3.62	3.49	3.34	3.12
S.Em±	0.068	0.106	0.103	0.087	0.091	0.056	0.050	0.081	0.064	0.062
C. D. @ (1%)	NS	NS	NS	0.364	0.384	0.237	0.212	0.341	0.268	0.260

NS: Non-Significant
T_1: Untreated control
T_2: Captan @ 2 g/kg seeds
T_3: Carboxin + Thiram @ 3 g/kg seeds
T_4: Carbendazim + Mancozeb @ 2 g/kg seeds
T_5: Hexaconazole @ 2 ml/kg seeds
T_6: Tebuconazole @ 2 ml/kg seeds
T_7: Hexaconazole + Zineb @ 2 g/kg seeds

Table 3: Effect of seed treatment of onion on shoot length (cm) in onion seeds during storage

Treatments	**Initial**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
T_1	7.67	7.28	6.45	6.20	6.07	5.97	5.83	5.62	5.48	5.23
T_2	7.75	7.32	6.48	6.42	6.23	6.03	5.87	5.75	5.55	5.40
T_3	8.05	7.50	7.05	6.75	6.52	6.43	6.25	6.02	5.90	5.77
T_4	8.08	7.70	7.30	7.08	6.78	6.63	6.48	6.27	6.13	5.95
T_5	7.88	7.45	6.87	6.58	6.42	6.30	6.18	5.92	5.70	5.58
T_6	7.77	7.38	6.63	6.38	6.40	6.22	6.15	5.78	5.67	5.53
T_7	8.03	7.48	7.00	6.60	6.48	6.42	6.22	6.00	5.77	5.62
Mean	7.89	7.45	6.83	6.57	6.41	6.29	6.14	5.91	5.74	5.58
S.Em±	0.118	0.169	0.183	0.127	0.102	0.106	0.090	0.100	0.095	0.081
C. D. @ (1%)	NS	NS	NS	0.536	0.431	0.445	0.378	0.423	0.399	0.343

NS: Non-Significant
T_1: Untreated control
T_2: Captan @ 2 g/kg seeds
T_3: Carboxin +Thiram @ 2 g/kg seeds
T_4: Carbendazim + Mancozeb @ 2 g/kg seeds
T_5: Hexaconazole @ 2 ml/kg seeds
T_6: Tebuconazole @ 2 ml/kg seeds
T_7: Hexaconazole + Zineb @ 2 g/kg seeds

Table 4: Effect of seed treatment on Total Seedling Length (cm) in onion seeds during storage

	Storage period (months)									
Treatments	**Initial**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
T_1	11.95	11.38	10.52	9.88	9.58	9.42	9.17	8.90	8.60	8.15
T_2	12.12	11.52	10.57	10.23	9.83	9.57	9.35	9.07	8.77	8.42
T_3	12.47	12.02	11.33	10.93	10.55	10.32	9.95	9.60	9.33	8.95
T_4	12.78	12.22	11.72	11.32	10.85	10.60	10.38	10.10	9.78	9.37
T_5	12.32	11.72	11.08	10.68	10.28	10.03	9.83	9.38	9.03	8.70
T_6	12.15	11.62	10.78	10.45	10.08	9.87	9.73	9.22	8.95	8.57
T_7	12.50	11.83	11.25	10.77	10.50	10.22	9.87	9.50	9.13	8.83
Mean	12.33	11.76	11.04	10.61	10.24	10.00	9.75	9.40	9.09	8.71
S.Em±	0.151	0.255	0.225	0.138	0.152	0.125	0.116	0.152	0.137	0.119
C. D. @ (1%)	NS	NS	NS	0.579	0.640	0.528	0.488	0.638	0.577	0.502

NS: Non-Significant
T_1: Untreated control
T_2: Captan @ 2 g/kg seeds
T_3: Carboxin + Thiram @ 3 g/kg seeds
T_4: Carbendazim +Mancozeb @ 2 g/kg seeds
T_5: Hexaconazole @ 2 ml/kg seeds
T_6: Tebuconazole @ 2 ml/kg seeds
T_7: Hexaconazole + Zineb @ 2 g/kg seeds

Table 5: Effect of seed treatment on Seedling vigour index in onion seeds during storage

Storage period (months)										
Treatments	**Initial**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
T_1	988	918	827	742	700	672	645	605	574	527
T_2	1006	934	835	793	737	695	661	623	587	547
T_3	1061	998	914	864	820	784	726	682	644	600
T_4	1088	1026	961	924	864	823	782	737	700	659
T_5	1031	957	883	837	785	743	701	654	611	574
T_6	1012	945	855	812	763	721	691	636	603	559
T_7	1050	971	904	847	808	766	717	672	627	589
Mean	1034	964	883	832	783	743	703	658	621	579
S.Em+	16.96	24.35	17.37	15.14	14.73	9.1	9.83	11	9.41	6.3
C. D. @ (1%)	NS	NS	NS	64.00	62.00	38.00	41.00	47.00	40.00	27.00

NS: Non-Significant
T_1: Untreated control
T_2: Captan @ 2 g/kg seeds
T_3: Carboxin + Thiram @ 3 g/kg seeds
T_4: Carbendazim + Mancozeb @2 g/kg seeds
T_5: Hexaconazole @ 2 ml/kg seeds
T_6: Tebuconazole @ 2 ml/kg seeds
T_7: Hexaconazole + Zineb @ 2 g/kg seed

Conclusion

Among the treatments, Carbendazim 25% + Mancozeb 50% WS at a rate of 2 g/kg seed emerged as the most effective in maintaining seed quality parameters throughout the storage period. This treatment exhibited superior germination percentage, root length, shoot length, and total seedling length compared to the untreated control and other fungicide treatments. The residual systemic action of zinc and manganese present in Carbendazim 25% + Mancozeb 50% WS likely contributed to increased metabolic activity, enzyme action, and nutrient absorption, ultimately leading to enhanced seed germination and seedling vigor.

The study underscores the importance of proper seed treatments, particularly with fungicides, in preserving seed quality during storage. By reducing the rate of deterioration and suppressing seed-borne fungi, seed treatments can significantly prolong seed viability and vigor, thus ensuring successful germination and crop establishment.

Furthermore, the findings highlight the potential of Carbendazim 25% + Mancozeb 50% WS as an effective seed treatment option for onion seeds. Its antifungal properties and synergistic action of two fungicides make it a promising choice for seed quality maintenance and disease control.

Overall, this research contributes valuable insights into optimizing seed treatment strategies to enhance the storability and performance of onion seeds, ultimately benefiting growers and ensuring a reliable seed supply for sustainable agriculture.

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