Effect of seed treatments and containers on seed viability of Brinjal (*Solanum melongena*)

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ABSTRACT: An experiment was conducted to investigate the influence of fungicides and packaging materials on the longevity of brinjal seed (variety: Hisar Shyamal-8). The seeds were treated with 15 fungicides and were kept in three containers *viz.,* Metal box, Cloth bag and Plastic zipling bag up to 12 months under ambient conditions in seed pathology laboratory of Department of Seed Science & Technology, CCSHAU, Hisar. The samples were drawn at quarterly intervals for ascertaining the seed quality parameters. The seeds treated with carbendazim (2g kg^{-1} seed) and stored in metal-box were found better for maintenance of higher seed quality parameters [germination (71.7%), root length(3.72cm), shoot length(5.93cm), mean seedling dry weight(26.7mg), vigour indices-1&2 (658 & 1912)] 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 brinjal seeds.

Key words: Brinjal, containers, fungicides, seed quality, storage

Brinjal (*Solanum melongena* L.) is commonly known as eggplant and one of the most important vegetable crops being cultivated in India for the last 4000 years. It is harder than other Solanaceous vegetables. The purple colour is due to the presence of anthocyanin pigment, while white fruit lacks this pigment. It is extensively grown in China, India, Bangladesh, Pakistan, and the Philippines. India stands second in the world, next to China and contributes 27.1 per cent of its share in production (FAOSTAT, 2017). The area under brinjal cultivation in India and Haryana is 730 mha and 16.18 mha respectively with production of 12801 Mt and 319 Mt (Saxena *et al.,* 2018).

Deterioration of seed is associated with the aging phenomenon which is defined as an irreversible degradation changes in the quality of seed. Seed is a miracle of life and the carrier of technology from one generation to another. Seed treatment is one of the tools for healthy ecosystem and also the cost effective technique (Sanjeev Kumar, 2012). It is like baby care being with the mother and it ranges from a basic dressing to coating and pelleting (ASF, 2010; Krishna Dubey, 2011). It can improve germination, seedling emergence, stand establishment and plant vigour. Among the seed treatments, seed dressing is most often used, easy and cost-effective technology. Seed treatment with chemicals is a common practice all over the world, as it mitigates the yield losses caused by the pathogens. Aktaruzzaman *et al.* (2010) reported that the storage container also influenced on the quality of okra seeds. For the management of seed-transmitted diseases, storage container and seed treatment is an important measure.

MATERIALS AND METHODS

The present study was carried out on brinjal seed (variety: Hisar Shyamal-8) having seed germination (81 per cent) above Indian Minimum Seed Certification Standards. The

Treatments	Fungicides @ 2 g kg^{-1} seed	Treatments	Fungicides @ 2 g kg^{-1} seed
T_1	Untreated (Control)	T_9	Kitazine 48% EC
T_2	Carbendazim 75% WP	T_{10}	Propineb 70% WP
T_3	Tebuconazole 2 DS	T_{11}	Dimethomorph 50% WP
T_4	Difenoconazole 25% EC	T_{12}	Chlorothalonil 78.2% WP
T_5	Propiconazole 25% EC	T_{13}	Captan 70 % + Hexaconazole 5% WP
T_6	Tricyclazole 75% WP	T_{14}	Carbendazim 12 % + Mancozeb 63 % WP
T_7	Flusilazole 40% EC	*T_{15}	Famoxadone 16.6 % + Cymoxanil 22.1 % SL
T_8	Azoxystrobin 23% SC	T_{16}	Flusilazole 12.5 % + Carbendazim 25 % SE

Systemic fungicides from T_2 to T_{12} and Combi-fungicides from T_{13} to T_{16}* Combi-fungicide T_{15} was used @ 2ml kg^{-1} seed

seeds were treated with fifteen fungicides @ 2 g kg^{-1} seed and kept in the Metal box(C_1), Cloth bag(C_2) and Plastic zipling bag (40 microns)(C_3) under ambient conditions in seed pathology laboratory of Department of Seed Science & Technology, CCSHAU, Hisar. The study was conducted up to twelve months to assess the effect of fungicides and containers on brinjal seed quality parameters.

The brinjal seeds and fungicide were weighed 21g and 0.042g, respectively, wearing gloves using appropriate weighing balance for each treatment. The seeds and fungicides were mixed in beakers and shaked for some time for uniform coating all over the seeds. All the fungicides were in powder formulation except famoxadone 16.6 % + cymoxanil 22.1 % SL, which was measured by micro-pippete and mixed thoroughly. Then, the treated seeds were kept in different containers (metal box, cloth bag and plastic zipling bag) in the laboratory under ambient conditions. The total numbers of treatments were 48 with three replications.

The experiment consisted of two factors (three different packing materials as storage container was used as level factor "C" and the sixteen fungicide treatments were used as level factor "T") were laid out in completely randomized design (CRD). Seeds were taken from each container at quarterly intervals up to twelve months and observations were recorded for seed technological parameters.

Standard germination (%): Four hundred seeds of brinjal 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 7th day and final count was taken on the 14th day and normal seedlings were considered for per cent germination.

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

Ten normal seedlings per replication were selected at random at the time of the final count of standard germination for the shoot and root length (cm) was measured using a measuring scale from the tip of the shoot to the end of the shoot and that of the tip of the radical to its end and the average length was worked out.
Seeds/Seedling dry weight used for a final count of shoot and root length was also assessed for then dry weight (mg) as usual.

Vigour indices: Seedling vigour indices were calculated as per Abdul-Bakiand Anderson (1973).

(a) Seed vigour Index I = Seed germination (%) × Average seedling length (cm)

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

The data obtained from the experiments were analyzed as per standard method (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

During storage, viability and vigour are lost due to many biotic factors like storage pest and other microflora. The insect pest and fungi cause considerable damage and are responsible for deterioration and reduction in storage potential of seed. So, seed treatment with suitable chemicals will reduce the quantitative and qualitative losses besides maintaining quality of the seed for longer period.

Seed treatment and containers had a significant effect on germination percentage from the initial month to the end of 12 months of storage. The germination percentage of seeds was declined progressively with the passage of storage in all the treatments, which may be attributed to the phenomenon of natural ageing and depletion of food reserves and decline in biological activity of seed. The perusal of data in Table 1 indicates that among the treatments, only T_2 (71.7%) and T_4(70.3%) maintained germination above Indian Minimum Seed Certification Standards (IMSCS) (70%) in all three containers up to twelve months. The containers effect was found non-significant. The interaction effect of C_3 with T_2 was found superior in the last quarter of storage. The results are in conformity with the earlier findings of Thippeswamy *et al.,* (2006) in which three fungicides *viz.,*Mancozeb, Carbendazim and Captan at 0.20% concentration showed increased seed germination (95%) in brinjal. In chilli, Bavistin was most effective with (93%) seed germination. This fungicidal treatment was significant over control in which (68%) seed germination was observed (Choudhary *et al.,* 2013). Synthetic fungicide (M-45) at 50% concentration reported to increase seed germination up to 90 per centin Tomato (Vikhe and Reddy, 2015). Flusilazole treatment was found superior for enhancing germination rate (71.8%) in chilli seeds over 12 months of storage period (Kumar and Jakhar, 2019).

There is gradual decrease in shoot and root length with the passage of time. The decline in root and shoot length may be attributed to natural aging induced decline in germination. The damage caused by fungi and toxic metabolites that have hindered the seedling growth. The data depicted in Table 2 reveals thedecreasing trend of shoot length with increasing storage period. The treatment with T_2(5.93cm) proved better and among containers, the C_1 found statistically at par with C_2. Interaction effect of C_2 with T_2 was proved better than others. The results are in close conformity with the earlier findings of Patil *et al.,*

Table1: Effect of seed treatments with fungicides and containers on germination (%) in brinjal seeds

Treatment	3 Months				6 Months				9 Months				12 Months			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
T_1	77.0	76.0	77.0	76.7	72.0	71.0	72.0	71.7	67.0	66.0	67.0	66.7	67.0	68.0	68.0	67.7
T_2	82.7	82.3	82.0	82.3	79.0	79.7	79.0	79.2	74.3	74.0	73.7	74.0	71.0	72.0	72.0	71.7
T_3	79.0	80.0	78.0	79.0	73.0	74.0	76.0	74.3	68.0	68.0	67.0	67.7	65.0	70.0	69.0	68.0
T_4	81.0	79.0	80.0	80.0	76.0	75.0	75.0	75.3	69.0	67.0	68.0	68.0	68.0	69.0	70.0	69.0
T_5	81.7	82.0	82.0	81.9	78.0	77.0	78.0	77.7	73.0	72.0	72.0	72.3	67.0	70.0	70.0	69.0
T_6	79.0	78.0	77.0	78.0	73.0	76.0	74.0	74.3	72.0	70.0	71.0	71.0	71.0	67.0	68.0	68.7
T_7	80.0	77.0	77.0	78.0	75.0	74.0	77.0	75.3	70.0	70.0	69.0	69.7	69.0	68.0	67.0	68.0
T_8	81.0	80.0	80.0	80.3	76.0	72.0	72.0	73.3	71.0	69.0	70.0	70.0	70.0	70.0	71.0	70.3
T_9	80.0	81.0	78.0	79.7	75.0	75.0	74.0	74.7	69.0	71.0	68.0	69.3	68.0	69.0	69.0	68.7
T_{10}	77.0	80.0	79.0	78.7	72.0	76.0	75.0	74.3	70.0	70.0	69.0	69.7	67.0	71.0	70.0	69.3
T_{11}	78.0	81.0	81.0	80.0	74.0	75.0	73.0	74.0	70.0	72.0	73.0	71.7	68.0	67.0	68.0	67.7
T_{12}	78.0	81.0	80.0	79.7	76.0	73.0	76.0	75.0	68.0	69.0	72.0	69.7	67.0	68.0	67.0	67.3
T_{13}	79.0	79.0	79.0	79.0	75.0	78.0	78.0	77.0	67.0	69.0	70.0	68.7	69.0	65.0	68.0	67.3
T_{14}	80.0	78.0	80.0	79.3	74.0	76.0	73.0	74.3	68.0	68.0	71.0	69.0	70.0	66.0	65.0	67.0
T_{15}	77.0	80.0	81.0	79.3	77.0	73.0	75.0	75.0	72.0	70.0	69.0	70.3	70.0	67.0	66.0	67.7
T_{16}	77.0	79.0	77.0	77.7	72.0	75.0	76.0	74.3	71.0	69.0	70.0	70.0	68.0	66.0	67.0	67.0
Mean	79.2	79.6	79.3		74.8	75.0	75.2		70.0	69.6	70.0		68.4	68.3	68.4	
CD (P=0.05)		C	T	C×T		C	T	C×T		C	T	C×T		C	T	C×T
		NS	1.57	2.72		NS	1.47	2.54		NS	1.37	2.37		NS	1.32	2.29

C_1:Metal box C_2:Cloth bag C_3:Plastic zipling bag (40 microns) T_1: Untreated (Control); T_2: Carbendazim 75% WP; T_3: Tebuconazole 2 DS;T_4: Difenoconazole 25% EC; T_5: Propiconazole 25% EC; T_6: Tricyclazole 75% WP; T_7: Flusilazole 40% EC; T_8: Azoxystrobin 23% SC; T_9: Kitazine 48% EC; T_{10}: Propineb 70% WP; T_{11}: Dimethomorph 50% WP; T_{12}: Chlorothalonil 78.2% WP; T_{13}: Captan 70 % + Hexaconazole 5% WP; T_{14}: Carbendazim 12 % + Mancozeb 63 % WP; T_{15}: Famoxadone 16.6 % +Cymoxanil 22.1 % SL; T_{16}: Flusilazole 12.5 % + Carbendazim 25 % SE

Table 2: Effect of seed treatments with fungicides and containers on shoot length (cm) in brinjal seeds

Treatment	3 Months				6 Months				9 Months				12 Months			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
T_1	8.96	9.15	10.41	9.51	9.30	8.65	7.46	8.47	5.95	6.99	5.91	6.28	5.59	4.65	4.61	4.95
T_2	10.70	11.35	11.24	11.10	9.27	9.24	9.29	9.26	7.23	7.36	7.36	7.32	5.96	5.97	5.86	5.93
T_3	8.98	8.27	10.35	9.20	8.15	8.61	7.48	8.08	6.32	6.56	5.47	6.12	4.92	5.02	4.17	4.70
T_4	9.54	9.35	9.68	9.52	8.96	9.06	8.04	8.69	6.60	7.07	6.23	6.63	5.67	5.70	4.93	5.43
T_5	7.66	7.43	7.31	7.47	8.00	8.45	6.16	7.54	4.28	5.48	5.14	4.97	4.08	2.98	3.84	3.63
T_6	9.07	9.44	9.53	9.35	7.99	7.99	7.57	7.85	6.31	7.16	5.87	6.45	5.76	5.67	4.57	5.33
T_7	8.32	7.78	8.15	8.08	8.47	8.50	6.82	7.93	5.99	6.53	4.55	5.69	5.13	4.69	3.25	4.36
T_8	8.49	9.46	9.73	9.23	7.55	8.64	6.99	7.73	6.41	6.47	5.98	6.29	5.07	5.11	4.68	4.95
T_9	9.46	9.12	9.46	9.35	6.18	7.72	7.96	7.29	6.69	6.62	5.35	6.22	5.22	5.39	4.05	4.89
T_{10}	9.77	9.87	9.71	9.78	8.81	8.33	8.31	8.48	6.34	6.29	5.56	6.06	4.89	5.04	4.26	4.73
T_{11}	9.36	10.14	9.95	9.82	8.68	8.19	7.86	8.24	6.12	6.18	5.59	5.96	4.78	4.82	4.29	4.63
T_{12}	9.12	9.16	9.55	9.28	8.15	8.39	7.62	8.05	6.49	5.76	5.97	6.07	4.36	5.19	4.67	4.74
T_{13}	9.52	9.46	8.86	9.28	8.15	8.38	8.02	8.18	6.04	6.05	5.45	5.85	4.65	4.74	4.15	4.51
T_{14}	9.29	9.36	9.66	9.44	6.98	8.24	7.79	7.67	6.57	6.79	4.95	6.10	5.39	5.27	3.65	4.77
T_{15}	8.89	9.44	10.46	9.60	7.84	8.97	7.39	8.07	5.98	5.16	6.42	5.85	3.76	4.68	5.12	4.52
T_{16}	9.18	9.23	10.11	9.51	7.05	8.42	7.68	7.72	6.09	6.04	6.21	6.11	4.64	4.79	4.91	4.78
Mean 'C'	9.15	9.25	9.63		8.10	8.49	7.65		6.21	6.41	5.75		4.99	4.98	4.44	
CD (P=0.05)		C	T	C×T		C	T	C×T		C	T	C×T		C	T	C×T
		0.08	0.18	0.32		0.09	0.20	0.35		0.10	0.23	0.41		0.07	0.17	0.29

C_1:Metal box C_2:Cloth bag C_3:Plastic zipling bag (40 microns)T_1: Untreated (Control); T_2: Carbendazim 75% WP; T_3: Tebuconazole 2 DS;T_4: Difenoconazole 25% EC; T_5: Propiconazole 25% EC; T_6: Tricyclazole 75% WP; T_7: Flusilazole 40% EC; T_8: Azoxystrobin 23% SC; T_9: Kitazine 48% EC; T_{10}: Propineb 70% WP; T_{11}: Dimethomorph 50% WP; T_{12}: Chlorothalonil 78.2% WP; T_{13}: Captan 70 % + Hexaconazole 5% WP; T_{14}: Carbendazim 12 % + Mancozeb 63 % WP; T_{15}: Famoxadone 16.6 % + Cymoxanil 22.1 % SL; T_{16}: Flusilazole 12.5 % + Carbendazim 25 % SE

Table 3: Effect of seed treatments with fungicides and containers on root length (cm) in brinjal seeds

Treatment	3 Months				6 Months				9 Months				12 Months			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
T_1	5.60	4.82	5.72	5.38	4.54	4.71	4.54	4.60	2.70	2.99	3.64	3.11	2.72	3.00	2.51	2.74
T_2	6.58	6.64	6.17	6.46	5.61	5.35	5.16	5.37	4.63	4.91	4.72	4.75	3.76	3.68	3.73	3.72
T_3	5.29	5.58	5.58	5.48	5.19	4.59	5.19	4.99	2.58	3.89	4.36	3.61	2.62	3.16	1.98	2.59
T_4	5.50	5.73	5.62	5.62	4.10	4.72	4.17	4.33	2.60	3.25	3.96	3.27	2.40	3.00	2.31	2.57
T_5	5.94	6.74	5.83	6.17	4.20	4.33	4.23	4.25	3.24	3.59	4.68	3.84	2.46	2.78	2.51	2.58
T_6	5.31	6.16	5.06	5.51	5.10	4.56	5.52	5.06	3.11	2.60	3.61	3.11	2.84	2.98	2.33	2.72
T_7	6.30	6.30	6.55	6.38	4.51	4.24	4.54	4.43	4.27	3.78	3.64	3.90	2.77	2.67	1.84	2.43
T_8	5.67	5.92	5.30	5.63	4.67	4.45	4.70	4.60	4.03	3.64	4.59	4.09	2.93	2.92	2.19	2.68
T_9	5.28	5.91	5.54	5.58	4.46	4.55	4.49	4.50	4.19	3.48	3.79	3.82	2.72	2.94	2.23	2.63
T_{10}	6.04	5.94	5.17	5.72	4.54	4.39	4.57	4.50	3.25	3.47	4.10	3.61	2.67	2.73	3.33	2.91
T_{11}	5.71	5.74	5.54	5.66	4.61	5.12	4.64	4.79	3.22	3.12	4.02	3.45	2.74	3.25	2.19	2.73
T_{12}	5.89	5.99	5.47	5.78	5.24	4.79	5.45	5.16	2.95	2.61	4.02	3.19	2.88	3.11	2.66	2.88
T_{13}	6.12	5.28	5.18	5.53	4.53	4.25	4.60	4.46	3.95	3.81	4.25	4.00	2.83	2.61	2.49	2.64
T_{14}	6.06	4.97	5.49	5.51	4.47	4.90	4.54	4.64	3.89	3.63	2.56	3.36	2.77	3.03	2.71	2.84
T_{15}	5.46	6.04	5.11	5.54	4.65	4.13	4.72	4.50	3.72	4.42	3.30	3.81	2.95	2.43	2.56	2.65
T_{16}	6.15	6.22	5.67	6.01	4.27	4.56	4.34	4.39	5.14	3.74	3.85	4.24	2.54	2.79	2.82	2.72
Mean		5.81	5.87	5.56	4.67	4.60	4.71	3.59	3.56	3.94	2.79	2.94	2.52			
CD (P=0.05)		C	T	C×T		C	T	C×T		C	T	C×T		C	T	C×T
		0.08	0.20	0.35		0.08	0.22	0.39		0.08	0.19	0.33		0.07	0.17	0.30

C_1:Metal box C_2:Cloth bag C_3:Plastic zipling bag (40 microns) T_1: Untreated (Control); T_2: Carbendazim 75% WP; T_3: Tebuconazole 2 DS;T_4: Difenoconazole 25% EC; T_5: Propiconazole 25% EC; T_6: Tricyclazole 75% WP; T_7: Flusilazole 40% EC; T_8: Azoxystrobin 23% SC; T_9: Kitazine 48% EC; T_{10}: Propineb 70% WP; T_{11}: Dimethomorph 50% WP; T_{12}: Chlorothalonil 78.2% WP; T_{13}: Captan 70 % + Hexaconazole 5% WP; T_{14}: Carbendazim 12 % + Mancozeb 63 % WP; T_{15}: Famoxadone 16.6 % + Cymoxanil 22.1 % SL; T_{16}: Flusilazole 12.5 % + Carbendazim 25 % SE

Table 4: Effect of seed treatments with fungicides and containers on seedling dry weight (mg) in brinjal seeds

Treatment	3 Months				6 Months				9 Months				12 Months			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
T_1	40.0	41.0	42.0	41.0	38.0	34.0	37.0	36.3	25.0	24.0	25.0	24.7	21.0	20.0	21.0	20.7
T_2	49.3	51.3	49.7	50.1	40.3	41.3	41.0	40.9	32.3	34.0	34.7	33.7	27.0	26.0	27.0	26.7
T_3	46.0	43.0	46.0	45.0	35.0	36.0	33.0	34.7	27.0	31.0	27.0	28.3	24.0	23.0	24.0	23.7
T_4	42.0	43.0	49.0	44.7	37.0	34.0	34.0	35.0	30.0	29.0	29.0	29.3	23.0	22.0	25.0	23.3
T_5	48.0	49.0	43.0	46.7	41.0	40.0	39.0	40.0	35.0	36.0	33.0	34.7	25.0	24.0	26.0	25.0
T_6	46.0	44.0	42.0	44.0	37.0	38.0	36.0	37.0	33.0	27.0	31.0	30.3	23.0	25.0	23.0	23.7
T_7	43.0	45.0	44.0	44.0	34.0	37.0	38.0	36.3	32.0	30.0	32.0	31.3	26.0	23.0	22.0	23.7
T_8	44.0	47.0	45.0	45.3	35.0	34.0	34.0	34.3	28.0	31.0	30.0	29.7	25.0	24.0	23.0	24.0
T_9	47.0	44.0	43.0	44.7	34.0	35.0	38.0	35.7	31.0	28.0	30.3	29.8	24.0	24.0	25.0	24.3
T_{10}	45.0	43.0	45.7	44.6	37.0	34.0	36.0	35.7	30.0	32.0	28.0	30.0	24.0	25.0	23.0	24.0
T_{11}	44.0	46.0	42.0	44.0	37.7	37.0	35.0	36.6	27.0	33.0	27.0	29.0	23.0	25.0	25.0	23.9
T_{12}	46.0	47.0	47.0	46.7	33.0	39.0	37.0	36.3	29.0	35.0	30.0	31.3	25.0	23.0	24.0	24.0
T_{13}	43.0	42.0	46.0	43.7	34.0	37.0	38.0	36.3	31.0	30.0	34.7	31.9	25.0	25.0	23.0	24.3
T_{14}	43.0	46.0	43.0	44.0	36.0	35.0	37.0	36.0	32.0	27.0	33.0	30.7	24.0	23.0	22.0	23.0
T_{15}	42.0	43.0	44.0	43.0	38.0	36.0	34.0	36.0	30.0	28.0	32.0	30.0	22.0	24.0	24.0	23.3
T_{16}	44.0	45.0	47.0	45.3	34.0	38.0	35.0	35.7	27.0	29.0	28.0	28.0	23.0	22.0	22.0	22.3
Mean	44.5	45.0	44.9		36.3	36.6	36.4		30.0	30.3	30.3		24.0	23.5	23.7	
CD (P=0.05)		C	T	C×T		C	T	C×T		C	T	C×T		C	T	C×T
		NS	1.53	2.65		NS	1.49	2.58		NS	1.05	1.82		NS	0.92	1.10

C_1:Metal boxC_2:Cloth bag C_3:Plastic zipling bag (40 microns) T_1: Untreated (Control); T_2: Carbendazim 75% WP; T_3: Tebuconazole 2 DS;T_4: Difenoconazole 25% EC; T_5: Propiconazole 25% EC; T_6: Tricyclazole 75% WP; T_7: Flusilazole 40% EC; T_8: Azoxystrobin 23% SC; T_9: Kitazine 48% EC; T_{10}: Propineb 70% WP; T_{11}: Dimethomorph 50% WP; T_{12}: Chlorothalonil 78.2% WP; T_{13}: Captan 70 % + Hexaconazole 5% WP; T_{14}: Carbendazim 12 % + Mancozeb 63 % WP; T_{15}: Famoxadone 16.6 % +Cymoxanil 22.1 % SL; T_{16}: Flusilazole 12.5 % + Carbendazim 25 % SE

Table 5: Effect of seed treatments with fungicides and containers on vigour index-I in brinjal seeds

Treatment	3 Months				6 Months				9 Months				12 Months			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
T_1	1,126	1,052	1,235	1,138	997	948	863	936	579	658	640	626	557	520	479	519
T_2	1,430	1,482	1,428	1,447	1,176	1,108	1,141	1,142	882	909	890	894	589	695	690	658
T_3	1,137	1,112	1,230	1,160	974	976	962	971	605	762	658	675	607	572	425	535
T_4	1,223	1,207	1,199	1,210	994	1,033	915	981	662	691	694	682	549	600	506	552
T_5	1,133	1,172	1,105	1,137	951	983	810	915	549	653	706	636	438	402	443	427
T_6	1,146	1,222	1,136	1,168	955	953	968	959	726	683	673	694	634	586	466	562
T_7	1,174	1,075	1,131	1,127	973	942	874	930	718	721	565	668	546	497	341	461
T_8	1,156	1,220	1,210	1,196	928	942	841	904	741	697	739	726	560	561	486	536
T_9	1,189	1,223	1,178	1,196	798	920	921	880	756	716	621	698	540	575	431	516
T_{10}	1,226	1,259	1,190	1,225	961	966	965	964	671	683	666	673	506	552	529	529
T_{11}	1,186	1,275	1,252	1,238	983	998	912	964	654	669	701	675	511	541	445	499
T_{12}	1,181	1,222	1,192	1,198	1,017	962	993	991	642	577	719	646	530	560	489	526
T_{13}	1,241	1,175	1,124	1,180	952	985	984	974	669	680	679	676	516	482	449	482
T_{14}	1,238	1,108	1,207	1,184	848	998	900	915	711	708	533	651	571	550	415	512
T_{15}	1,114	1,228	1,278	1,207	963	956	908	942	698	670	670	680	470	478	511	486
T_{16}	1,185	1,215	1,215	1,205	816	973	913	901	797	674	704	725	489	499	517	501
Mean	1,193	1,203	1,207		955	978	929		691	697	679		538	542	476	
CD (P=0.05)		C	T	C×T		C	T	C×T		C	T	C×T		C	T	C×T
		11.45	30.06	52.06		13.43	31.02	53.72		9.09	21.00	36.38		12.78	29.51	51.12

C_1:Metal box C_2:Cloth bag C_3:Plastic zipling bag (40 microns) T_1: Untreated (Control); T_2: Carbendazim 75% WP; T_3: Tebuconazole 2 DS;T_4: Difenoconazole 25% EC; T_5: Propiconazole 25% EC; T_6: Tricyclazole 75% WP; T_7: Flusilazole 40% EC; T_8: Azoxystrobin 23% SC; T_9: Kitazine 48% EC; T_{10}: Propineb 70% WP; T_{11}: Dimethomorph 50% WP; T_{12}: Chlorothalonil 78.2% WP; T_{13}: Captan 70 % + Hexaconazole 5% WP; T_{14}: Carbendazim 12 % + Mancozeb 63 % WP; T_{15}: Famoxadone 16.6 % + Cymoxanil 22.1 % SL; T_{16}: Flusilazole 12.5 % + Carbendazim 25 % SE

Table 6: Effect of seed treatments with fungicides and containers on vigour index-II in brinjal seeds

Treatment	3 Months				6 Months				9 Months				12 Months			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
T_1	3,093	3,090	3,219	3,134	2,739	2,417	2,667	2,607	1,674	1,583	1,676	1,644	1,409	1,359	1,429	1,399
T_2	4,081	4,228	4,075	4,128	3,187	3,294	3,240	3,240	2,405	2,517	2,554	2,492	1,918	1,873	1,945	1,912
T_3	3,663	3,454	3,572	3,563	2,558	2,667	2,509	2,578	1,835	2,109	1,810	1,918	1,561	1,610	1,657	1,609
T_4	3,416	3,439	3,937	3,597	2,815	2,551	2,551	2,639	2,073	1,946	1,972	1,997	1,565	1,519	1,751	1,612
T_5	3,999	4,049	3,556	3,868	3,201	3,081	3,043	3,108	2,558	2,592	2,376	2,509	1,676	1,680	1,819	1,725
T_6	3,663	3,446	3,263	3,457	2,702	2,889	2,665	2,752	2,377	1,890	2,200	2,156	1,632	1,677	1,565	1,625
T_7	3,454	3,436	3,373	3,421	2,551	2,741	2,929	2,740	2,240	2,101	2,208	2,183	1,797	1,565	1,473	1,612
T_8	3,593	3,729	3,615	3,646	2,661	2,451	2,451	2,521	1,989	2,140	2,101	2,077	1,749	1,679	1,630	1,686
T_9	3,791	3,578	3,384	3,584	2,553	2,626	2,813	2,664	2,139	1,989	2,064	2,064	1,636	1,655	1,726	1,672
T_{10}	3,480	3,426	3,623	3,510	2,667	2,585	2,703	2,651	2,101	2,241	1,933	2,092	1,609	1,774	1,609	1,664
T_{11}	3,460	3,697	3,417	3,524	2,788	2,776	2,558	2,707	1,889	2,377	1,970	2,079	1,563	1,803	1,699	1,688
T_{12}	3,618	3,792	3,776	3,729	2,509	2,850	2,815	2,724	1,973	2,416	2,161	2,183	1,674	1,565	1,608	1,616
T_{13}	3,411	3,345	3,634	3,463	2,551	2,889	2,965	2,801	2,077	2,071	2,428	2,192	1,725	1,624	1,567	1,638
T_{14}	3,468	3,558	3,410	3,479	2,667	2,663	2,702	2,677	2,177	1,835	2,342	2,118	1,680	1,519	1,430	1,543
T_{15}	3,261	3,413	3,610	3,428	2,927	2,629	2,551	2,702	2,161	1,961	2,207	2,110	1,541	1,607	1,583	1,577
T_{16}	3,402	3,540	3,619	3,520	2,451	2,853	2,663	2,655	1,918	2,001	1,959	1,959	1,563	1,451	1,477	1,497
Mean	3,553	3,576	3,568		2,720	2,747	2,739		2,099	2,111	2,123		1,644	1,635	1,623	
CD (P=0.05)		C	T	C×T		C	T	C×T		C	T	C×T		C	T	C×T
		NS	132.86	230.13		NS	164.58	285.07		NS	100.52	174.1		NS	114.78	148.02

C_1:Metal boxC_2:Cloth bag C_3:Plastic zipling bag (40 microns)T_1: Untreated (Control); T_2: Carbendazim 75% WP; T_3: Tebuconazole 2 DS;T_4: Difenoconazole 25% EC; T_5: Propiconazole 25% EC; T_6: Tricyclazole 75% WP; T_7: Flusilazole 40% EC; T_8: Azoxystrobin 23% SC; T_9: Kitazine 48% EC; T_{10}: Propineb 70% WP; T_{11}: Dimethomorph 50% WP; T_{12}: Chlorothalonil 78.2% WP; T_{13}: Captan 70 % + Hexaconazole 5% WP; T_{14}: Carbendazim 12 % + Mancozeb 63 % WP; T_{15}: Famoxadone 16.6 % + Cymoxanil 22.1 % SL; T_{16}: Flusilazole 12.5 % + Carbendazim 25 % SE

(2017) in which Thiram treatment gives (10.91cm) as compared at control (5.73cm) in brinjal. Same trend was followed in case of root length, T_2 (3.72cm) treatment proved better than others and among containers, C_2 proved superior followed by the C1. The interaction effect of the metal box with T_2 was found better than others. These findings were in agreement with the reports of Kavitha *et al.,* (2009) which found that the seed treatment with Captan (3g/kg) + Imidachloprid (2 g/kg) gave highest root (9.35cm) and shoot length (5.47cm) in chilli seeds. Sultana *et al.,* (2015) revealed that the treated seeds stored in plastic container showed longest shoot (20.76cm) and root (11.52cm) length after 4 months of storage.

The significant difference due to seed treatments on seedling dry weight was recorded throughout the storage period. At the end of twelve months of storage period, significantly highest seedling dry weight was recorded in T_2 (26.7mg) treated seeds. It was at par with T_3 (25 mg) treatment. Container's effect was found non-significant in all the four quarters. Interaction effect of the C_1 and C_2 with T_2 was found at par and were better. 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 results are in conformity with the findings of Dheeraj *et al.,* (2018) in which higher seedling dry weight (39.80mg) was obtained in T_{11}-Vitavax+polymer @6ml/kg seed followed T_7- Imidacloprid+ polymer@ 4ml/kg (38.78mg) and lower in T_6 (30.55mg) respectively in tomato seeds. Manoharapaladagu *et al.,* (2017) also observed higher seedling dry weight with T7P2 (40.89mg) treatment as compared to control (35.47mg) in chilli seeds.

In the present study, significantly higher vigour index-I was recorded in T_2 (658) followed by, T_6 (562) at the end of twelve months of storage period. Among containers, cloth bag, and metal box were found statistically at par. The interaction effect of C_2 with T_2 was found better. The fungicide-treated seeds stored in different containers when tested for vigour index-II, treatment T_2 (1912) found superior followed by T5 (1725). The containers effect was found non-significant. Interaction effect of C_3 with T_2 was found better than others. 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 Santoshreddy *et al.,* (2014) in which Combi product fungicides @ 0.2% (Carboxin 37.5% + Thiram 37.5%) proved better vigour index (932.02) as compared to control (351.77) and Chaudhary *et al.,* (2013) who found that among all seed treatments maximum vigour index was found by Bavistin (506) and Thiram (497.95) treated seeds in chilli seeds. kumar *et al.,* (2014) stated that among seed treatments, Bavistin (1%) recorded significantly higher germination percentage (85.70%) and seedling vigour index (887) than the other treatments ($ZnSO_4$, $MnSO_4$, DAP and control) followed by arappu leaf powder (250g/ kg) at the end of12 months of storage period.

CONCLUSION

Seed quality attributes of brinjal seeds were not significantly influenced by seed treatments and packing materials during storage period. Among the various fungicide treatments, Carbendazim @ 2g/kg treatment was found highly effective when treated seeds were stored in metal box. Among the packaging materials the metal box was found superior than the others because of protection from unfavorable ambient conditions. This study also reveals that Carbendazim seed treatment maintains excellent seed health and seed quality during the storage period of 12 months, which directly enhances the viability of seeds by safe guarding seed deterioration from mycoflora.

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