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INFLUENCE OF SEED TREATMENT CHEMICALS AND CONTAINERS ON SEED QUALITY OF MARIGOLD DURING STORAGE

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ABSTRACT

Studies were conducted to know the effect of seed treatment and containers on seed quality of marigold during storage. Result from the study indicated that seed treated with chlorax and stored in double layer polythene bag recorded higher seed quality parameters *viz*., significantly higher germination (49.25% and 38.81%), root length (4.13 cmand 3.30 cm), shoot length (3.51 cm and 3.90 cm), vigour index (376 and 281), germination rate index (11.31 and 11.04) and field emergence (43.25% and 33.44) with lowest electrical conductivity of seed leachate (1.292 dSm^{-1} and 1.856 dSm^{-1}), respectively of marigold at the end of storage. With the advance in the storage period, an increase in moisture, seed health and electrical conductivity of seed were observed. Therefore, these treatments can be used for storage of marigold seeds in order to maintain viability.

INTRODUCTION

Marigold (*Tagetes spp.*) is widely used for beautification and as landscape plants due to its ideal height and attractive colour. It is ideal for rockeries, edging, hanging baskets and in window boxes. The species is grown around field crops to control pest activity (Tereschuk *et al*., 1997). Poultry industry is extensively using marigold petals as a natural source of xanthophylls pigments to strengthen yellow colour of egg yolk. The oil of marigold species is highly used in high quality perfumes and also carotenoid pigments are used in food industry. Further, *Tagetes* oil, mainly from *T. minuta*, is used in perfumery and as a uavoring constituent (Aruna singh *et al*., 2013). Thus it has considerable impact on ecology. Caroteniod pigments have beneficial role for treatment of skin tumor, dermatological diseases and cancer in human being. Thus, cultivation of marigold as an alternative crop is gaining popularity day by day in agriculture business due to the commercial use of carotenoids in pharmaceutical and poultry industries.

Seed being a biological or living entity, deterioration in its quality is inevitable, irreversible and inexorable. It occurs with advance in ageing, which is common for all the living organisms. In storage, number of biotic and abiotic factors influence storage potential of seeds and results in gradual seed deterioration and ultimately death of the seeds. However, the rate of seed deterioration could be slowed down by certain seed treatments with fungicides, insecticides and storing them in suitable moisture impervious containers (Doijode, 1988).

In view of the previous work done by different authors like Punitha (1996) in vegetable seeds, Pham Long Giang and Rame Gowda (2007) in paddy and Hemashree *et al*. (2011) in cotton, it can be assumed that seed treatment with chemicals and stored in moisture proof containers can proved to maintain higher seed quality during storage.

The present study was planned with the hypothesis that marigold seed exhibit orthodox storage behavior and susceptible to pest damage, store fairly well under ambient conditions. Seed drying is beneficial in maintaining high viability during storage. The lowering the seed moisture and treat the seed with seed treatment chemicals then stored these seeds in moisture proof containers preserve viability for longer period. To best of our knowledge, limited work has been reported regarding storage of marigold seeds. Therefore, this study was planned and executed with the objective to know the influence of seed treatment chemicals and containers on seed quality of marigold during storage.

MATERIALS AND METHODS

The storage experiment was conducted for a period of ten months under ambient condition in the laboratory of department of Seed Science and Technology, college of Agriculture, Dharwad 580 005. The seed material of marigold variety Orange double was obtained from the Floriculture Unit, in the Department of Horticulture, University of Agricultural Sciences, Dharwad. The experiment consisted of 12 treatment combinations with two factors *viz*. containers: Cloth bag (**C_1**), single layer polythene bag (400 guage) (**C_2**) and double layer polythene bag (400 guage each) (**C_3**); seed treatment chemicals as second factor: control (T_0), thiram @ 2 g per kg of seed (T_1), neem leaf extract @ 5 mL per kg of seed (T_2) and calcium oxychloride ($CaOCl_2$) @ 4 gm/kg seeds (T_3).

The seeds were treated with thiram at the rate of 2 g per kg of seed, Neem leaf extract @ 5 ml per kg of seed and Calcium oxychloride ($CaOCl_2$) @ 4 gm/kg seeds, After mixing, the required amount of seeds (20 g/packet) were packed in cloth bag, 400 guage single and double layer polythene packet and immediately heat sealed. Experiment was laid out in complete randomized design with factorial concept in four replications. Seed samples were drawn subsequently at bimonthly intervals and tested for the following seed quality parameters (Hemashree *et al*., 2011).

The seed moisture content was calculated and expressed in per cent by using the standard procedure (ISTA, 2006).

Germination per cent was determined as per ISTA rules for seed testing. The seeds were placed in rolled paper towels. Hundred seeds of four replications were tested at a constant temperature of 25°C. The number of normal seedlings were evaluated on 14th day and per cent germination was expressed on normal seedling basis (ISTA, 2006).

From the standard germination test, ten normal seedlings were selected at random in each replication on final count. The shoot length was measured from collar region to the point of attachment of cotyledons and root length from the collar region to the tip of the primary root, sum of shoot and root length constitute the seedling length and mean was calculated and expressed in centimeters. Seedling vigour index was computed by adopting the formula as suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

Seedling vigour index-I = Germination (%) x Mean seedling length (cm)

Seed germination test was conducted as described above daily germination counts were recorded and the only seeds with 3-5 mm radical were considered. The speed of germination was calculated by using formula suggested by Maguire (1962)

$$\text{Speed of germination} = \frac{\text{No. of seeds germinated}}{\text{Days to first count}} + \ldots + \frac{\text{No. of seeds germinated}}{\text{Days to final count}}$$

Field emergence was calculated by sowing one hundred seeds from each treatment in four replications in the field. The emergence counts were made on 14th day after sowing and expressed in per cent (ISTA, 2006).

To measure the electrical conductivity of the seed leachate four replicates of one hundred seeds were taken, washed with distilled water and soaked in 50 ml distilled water for 6 hours. The electrical conductivity of the seed leachate was measured in a digital conductivity meter (Type MCD- 287) with a cell constant of the electrode being one. The electrical conductivity of seed leachate was expressed in dSm^{-1}(ISTA, 2006). The

Table 1: Effect of seed treatment chemicals, containers and their interactions on moisture content (%) and electrical conductivity (dSm^{-1}) of marigold seeds during storage

Treatments	Storage period									
	Moisture content (%)					Electrical conductivity (dSm^{-1})				
	2	4	6	8	10	2	4	6	8	10
Containers										
C_1	7.96	7.67	7.45	7.40	7.69	0.888	1.178	1.518	2.250	3.616
C_2	7.97	7.96	7.99	8.02	8.02	0.706	0.831	1.082	1.470	2.848
C_3	7.99	7.99	7.99	8.01	8.01	0.507	0.606	0.722	0.925	1.856
S.Em±	0.003	0.004	0.004	0.003	0.003	0.007	0.014	0.004	0.008	0.002
CD (1 %)	0.013	0.015	0.014	0.013	0.012	0.028	0.053	0.010	0.030	0.007
Chemicals										
T_0	7.96	7.82	7.83	7.78	7.93	0.769	1.003	1.228	1.671	3.021
T_1	7.96	7.87	7.83	7.78	7.88	0.687	0.797	1.126	1.474	2.576
T_2	8.01	7.86	7.75	7.91	7.86	0.716	0.953	1.142	1.684	2.679
T_3	7.97	7.93	7.83	7.77	7.96	0.629	0.733	0.932	1.363	2.332
S.Em±	0.004	0.005	0.004	0.004	0.004	0.008	0.004	0.005	0.010	0.002
CD (1%)	0.015	0.018	0.016	0.015	0.014	0.032	0.010	0.010	0.040	0.008
C×T Interaction										
C_1T_0	7.93	7.51	7.47	7.29	7.76	0.941	1.443	1.773	2.604	4.363
C_1C_1	7.92	7.66	7.50	7.32	7.61	0.898	0.996	1.436	2.261	3.628
C_1C_2	8.07	7.68	7.31	7.639	7.54	0.923	1.345	1.676	2.116	3.152
C_1C_3	7.93	7.84	7.50	7.32	7.86	0.790	0.927	1.186	2.017	3.321
C_2C_0	7.97	7.96	7.99	8.02	8.02	0.743	0.913	1.099	1.412	2.580
C_2C_1	7.96	7.97	8.01	8.01	8.01	0.698	0.798	1.235	1.892	2.421
C_2C_2	7.99	7.98	7.97	8.03	8.03	0.715	0.886	1.025	1.397	2.554
C_2C_3	8.01	7.97	7.99	8.02	8.02	0.668	0.728	0.968	1.180	2.382
C_3C_0	8.00	7.99	8.00	8.01	8.02	0.623	0.653	0.412	0.997	2.121
C_3C_1	8.01	8.01	8.01	8.02	7.99	0.465	0.596	0.708	0.898	1.989
C_3C_2	8.00	7.99	8.01	8.02	8.02	0.510	0.629	0.724	0.910	1.023
C_3C_3	7.99	8.01	7.99	8.00	8.01	0.430	0.545	0.643	0.893	1.292
Mean	7.98	7.87	7.81	7.81	7.91	0.700	0.872	1.107	1.546	2.652
S.Em±	0.007	0.008	0.007	0.007	0.006	0.015	0.008	0.010	0.018	0.004
CD (1%)	0.025	0.031	0.028	0.027	0.025	0.056	0.030	0.040	0.070	0.014

Table 2: Effect of seed treatment chemicals, containers and their interactions on germination (%) and field emergence (%) of marigold seeds during storage

Treatments	Storage period (months)									
	Germination (%)					Field emergence (%)				
	2	4	6	8	10	2	4	6	8	10
Containers										
C_1	70.06	65.31	49	40.18	23.25	64.69	61.12	45	36.25	17.81
C_2	71.12	65.87	57.18	48.62	32.75	66.13	61.69	53.31	44.38	26.63
C_3	73	67.87	61.18	52.62	38.81	68.25	64.44	56.56	48	33.44
S.Em±	0.18	0.23	0.33	0.28	0.48	0.238	0.201	0.259	0.309	0.195
CD (1 %)	0.71	0.88	1.27	1.08	1.86	0.917	0.775	1.001	1.190	0.754
Chemicals										
T_0	70.16	64.08	52.83	42.91	28.16	64.75	60	48.92	39.08	22.58
T_1	71.66	66.75	54.66	46.75	30.75	66.83	63.17	50.42	42.58	24.42
T_2	71.5	64.16	52.91	45.33	29.66	66.33	62	48.92	40.75	24.17
T_3	72.25	70.41	62.75	53.58	38.16	67.5	64.5	58.25	49.08	32.67
S.Em±	0.21	0.26	0.38	0.32	0.56	0.275	0.232	0.300	0.356	0.226
CD (1%)	0.81	1.01	1.47	1.25	2.15	1.059	0.895	1.156	1.374	0.870
C×T Interaction										
C_1T_0	69	63.25	46.75	37.25	20.25	63.5	58.25	42.25	33.75	14.75
C_1C_1	71.25	66.5	48.25	39.75	22.25	65.5	62.5	44.75	35.25	16.25
C_1C_2	69.25	64.25	49.25	41	24.25	64.25	61.25	45.25	37.75	18.75
C_1C_3	70.25	67.25	51.75	42.75	26.75	65.5	62.5	44.75	35.25	16.25
C_2C_0	70	64.5	55.25	45.25	30.5	64.75	60.5	51.75	41.75	24.5
C_2C_1	72.5	65	56.5	48.25	32.75	67.75	62.5	52.25	44.75	25.5
C_2C_2	71	63.75	53.25	45.75	29.25	66.5	61.25	49.75	44.75	25.5
C_2C_3	71	70.25	63.75	55.25	38.5	65.5	62.5	59.5	50.75	33.25
C_3C_0	71.5	64.5	56.5	46.25	33.75	66	61.25	52.75	41.75	28.5
C_3C_1	72.75	68.75	59.25	52.25	36.75	68.5	64.5	54.75	47.75	31.5
C_3C_2	72.25	64.5	56.25	49.25	35.5	67	63.5	51.75	44.25	30.5
C_3C_3	75.5	73.25	72.75	62.75	49.25	71.5	68.5	67.5	58.25	43.25
Mean	71.39	66.35	55.79	47.14	31.68	66.35	62.42	51.63	42.88	25.96
S.Em±	0.37	0.45	0.66	0.56	0.97	0.475	0.402	0.519	0.617	0.391
CD (1%)	1.41	1.75	2.55	2.16	3.72	1.834	1.551	2.002	2.381	1.508

data obtained from the experiments were statistically analyzed as per Snedecor and Cochran, 1967.

RESULTS AND DISCUSSION

Effect of seed treatment chemicals on seed quality during storage

Some physiological and biochemical changes leading to seed deterioration have been related to increased activity of enzymes (catalase. peroxidase, etc.), lipid autooxidation (Basu and Rudrapal, 1980) and accumulation of toxic metabolites, free radical damage, decreased protein synthesis breakdown in mechanism of triggering germination. reduced respiration, change in polar lipids, decreased contents of glyco and phospholipids, ultra structural damage to cell and its organelles, accumulation of cytotoxic and mutagenic compounds etc. During storage, viability and vigour are least due to many biotic factors like storage pests and other microflora. The insect and fungi cause considerable damage and will be responsible for deterioration and reduction in storage potential of seed. So seed treatment with chemicals will reduce the qualitative and quantitative losses besides maintaining the quality of seed for longer period.

Among the chemical treatments, chlorax seed treatment recorded higher germination percentage (38.16%), field emergence (32.67%), shoot length (3.09 cm), root length (3.84 cm), seedling dry weight (3.03 mg), vigour index (269) and germination rate index (10.54) with lowest electrical conductivity of seed leachate (2.332 dSm^{-1}) at the end of 10^{th} month storage period compared to thiram and neem leaf extract (Table 2, 3 and 4). However, moisture content in seed did not vary due to chemical treatments during storage period. This may be related to beneficial effects of Chlorax. That resulted in reducing physiological deterioration by stabilizing unsaturated fatty acid components of lipoprotein moiety of cellular membrane and possibly reduced lipid peroxidation and free radical formation and thus helped in maintenance of cellular membrane integrity (Basu, 1993). Similar results of higher germination and field emergence with chlorax were obtained by Rudrapal and Basu (1981) in mustard, Punitha (1996) in vegetable seeds, Malarkodi and Dharmalingam (1999) in cotton. Higher shoot and root length and vigour index was reported with chlorax treatment by Rajavelu (1996) in sunflower, Bandopadhyay and Basu (1996) in groundnut and Punitha (1996) in vegetable seeds.

Effect of containers on seed quality during storage

Among the containers, moisture content of marigold seed remained unchanged or slight fluctuations were noticed in double layer polythene bag and single layer polythene bag which may be due to moisture proof packing whereas seed moisture content fluctuated in cloth bag responding to the fluctuating relative humidity of the atmosphere due to its

Table 3: Effect of seed treatment chemicals, containers and their interactions on root length (cm) and shoot length (cm) of marigold seeds during storage

Treatments	Storage period Root length (cm)					Shoot length (cm)				
	2	4	6	8	10	2	4	6	8	10
Containers										
C_1	5.97	5.26	4.82	4.11	3.34	5.11	4.39	4.03	3.34	2.56
C_2	6.09	5.54	5.10	4.65	3.62	5.18	4.55	4.22	3.76	2.74
C_3	6.19	5.63	5.27	4.88	3.90	5.26	4.80	4.57	4.15	3.30
S.Em±	0.008	0.006	0.038	0.007	0.004	0.007	0.009	0.004	0.004	0.004
CD (1 %)	0.029	0.022	0.145	0.028	0.016	0.029	0.036	0.016	0.015	0.017
Chemicals										
T_0	6.01	5.31	4.82	4.29	3.38	5.08	4.42	4.05	3.52	2.60
T_1	6.11	5.50	5.19	4.63	3.68	5.22	4.61	4.34	3.81	2.97
T_2	6.09	5.47	5.00	4.52	3.60	5.21	4.57	4.24	3.73	2.80
T_3	6.12	5.62	5.23	4.75	3.84	5.22	4.72	4.45	3.94	3.09
S.Em±	0.009	0.007	0.044	0.008	0.005	0.009	0.011	0.005	0.004	0.005
CD (1%)	0.034	0.026	0.168	0.032	0.018	0.033	0.014	0.018	0.017	0.020
C×T Interaction										
C_1T_0	5.89	5.02	4.59	3.88	3.11	5.08	4.28	3.89	3.18	2.31
C_1C_1	5.98	5.32	4.90	4.21	3.44	5.16	4.43	4.08	3.38	2.62
C_1C_2	5.87	5.19	4.76	4.04	3.25	5.12	4.32	3.99	3.32	2.54
C_1C_3	6.03	5.49	5.02	4.32	3.56	5.07	4.53	4.16	3.46	2.70
C_2C_0	5.98	5.39	4.86	4.33	3.36	5.04	4.30	3.95	3.42	2.45
C_2C_1	6.12	5.58	5.39	4.88	3.70	5.22	4.64	4.32	3.91	2.85
C_2C_2	6.09	5.53	4.85	4.60	3.60	5.17	4.50	4.10	3.60	2.60
C_2C_3	6.15	5.65	5.28	4.88	3.82	5.27	4.76	4.51	4.11	3.05
C_3C_0	6.16	5.51	5.02	4.65	3.67	5.12	4.68	4.32	3.95	2.97
C_3C_1	6.20	5.70	5.38	4.92	3.92	5.32	4.87	4.64	4.24	3.44
C_3C_2	6.17	5.59	5.29	4.89	3.89	5.29	4.75	4.62	4.16	3.26
C_3C_3	6.22	5.70	5.39	5.05	4.13	5.32	4.89	4.69	4.27	3.51
Mean	6.08	5.47	5.06	4.55	3.62	5.18	4.58	4.27	3.75	2.86
S.Em±	0.015	0.012	0.075	0.015	0.008	0.015	0.018	0.008	0.008	0.009
CD (1%)	0.059	0.045	0.316	0.056	0.032	0.058	0.017	0.032	0.029	0.034

pervious nature. The results are in conformity with the findings of Anuradha and Agarwal (1989) in tomato and Jagadish *et al*. (1994) in onion.

Among the containers, germination percentage and field emergence was influenced throughout the storage period. However, the per cent reduction in germination and field emergence was lower in double layer polythene bag (48.47% and 36.75 %) followed by single layer polythene bag (55.78% and 50.75%) and it was highest in cloth bag (Table 2). Similarly reduction in shoot and root length, seedling dry weight and vigour index, germination rate index was lower in double layer polythene bag followed by single layer polythene bag and it was greater in cloth bag (Table 3 and 4). This could be attributed to slower rate of deterioration in double layer Polythene bag due to impervious nature of polythene layer with maintenance of low moisture content. Whereas, in cloth bag seed moisture fluctuated with the change in ambient relative humidity. Such rapid loss of viability in cloth bag due to decrease in metabolic processes and the products of metabolism were sources for developing microflora was reported by Likhatchev *et al*. (1984). These results are in conformity with Vijaykumar *et al*. (1991) in onion, Verma *et al*. (1991) in tomato, Jagadhish *et al*. (1994) in onion and Dhyani *et al*. (1991) in pepper.

The electrical conductivity of seed leachate was lower in double layer polythene bag (1.856 dSm^{-1}) followed by single layer polythene bag (2.848 dSm^{-1}) at the end of the storage period (Table 1). This might be due to lower seed metabolites leaching from seed because of higher membrane integrity. This is because of constant relative humidity maintained inside the packet and vapour proofing nature of package. Electrical conductivity of the seed leachate was highest in cloth bag (3.616 dSm^{-1}) at the end of 10^{th} month. This could be attributed to the fluctuating seed moisture content with changes in the atmosphere humidity led to the loss of cell membrane integrity, increased leachate from seed (Hydecker, 1972).

Interaction effect

Interaction of chemical treatment and container also influenced the seed quality parameters of marigold. Significantly higher seed quality parameters viz., germination percentage, field emergence shoot and root length, seedling dry weight, vigour index and germination rate index with lowest electrical conductivity of seed leachate at the end of 10^{th} month storage period was observed in seed treated with chlorax and stored in double layer polythene bag followed by thiram treated seed stored in double layer polythene bag at the end of 10^{th} month. While it was lowest in seed stored in cloth bag without treatment (Table 1, 2, 3 and 4).

Retention of higher germination in chlorax treated seed stored in double layer polythene bag, may be due to impervious nature of polythene bag and might have acted as better moisture barrier and chlorax might have stabililized unsaturated fatty acid components of lipid membranes

Table 4: Effect of seed treatment chemicals, containers and their interactions on seedling vigour index and germination rate index of marigold seeds during storage

Treatment	Storage period(months) Seedling vigour index					Germination rate index				
	2	4	6	8	10	2	4	6	8	10
Containers										
C_1	776	630	432	299	140	16.73	15.26	13.52	11.75	8.07
C_2	800	664	534	404	209	17.20	16.17	14.73	13.37	10.34
C_3	835	706	603	477	281	17.58	16.44	15.22	13.81	11.04
S.Em±	2.17	2.48	2.34	4.15	2.45	0.048	0.023	0.023	0.027	0.023
CD (1 %)	8.36	9.58	9.04	16.01	9.46	0.186	0.089	0.089	0.104	0.090
Chemicals										
T_0	778	621	468	337	171	16.85	15.62	13.88	12.21	9.12
T_1	811	666	507	388	200	17.29	16.04	14.73	13.39	9.99
T_2	807	648	506	385	191	17.27	15.80	14.25	12.67	9.59
T_3	818	731	611	463	269	17.27	16.36	15.09	13.64	10.54
S.Em±	2.50	2.87	2.71	4.79	2.83	0.056	0.027	0.27	0.031	0.027
CD (1%)	9.65	11.06	10.44	18.48	10.92	0.215	0.103	0.103	0.120	0.104
C×T Interaction										
C_1T_0	757	589	389	263	114	16.23	14.28	12.03	10.97	7.68
C_1C_1	793	632	422	289	132	17.02	15.95	14.35	12.31	8.37
C_1C_2	774	626	443	312	147	16.89	14.81	13.21	11.24	7.83
C_1C_3	780	674	475	333	167	17.04	16.01	14.48	12.46	8.98
C_2C_0	771	623	487	350	177	16.79	16.16	14.38	12.59	9.40
C_2C_1	822	652	518	398	203	17.34	16.19	14.96	14.16	9.93
C_2C_2	797	649	506	395	192	17.26	15.97	14.53	13.98	10.68
C_2C_3	811	731	624	497	265	17.39	16.34	15.03	13.98	11.34
C_3C_0	807	652	527	398	224	17.53	16.43	15.23	13.08	10.88
C_3C_1	832	717	594	480	264	17.59	16.39	15.02	14.01	11.02
C_3C_2	837	666	557	446	260	17.57	16.21	14.89	13.88	10.93
C_3C_3	862	788	733	583	376	17.63	16.73	15.75	14.28	11.31
Mean	804	667	523	393	210	17.17	15.96	14.49	12.98	9.81
S.Em±	4.33	4.97	4.69	8.30	4.91	0.096	0.046	0.046	0.054	0.047
CD (1%)	16.71	19.16	18.07	32.02	18.92	0.372	0.178	0.178	0.207	0.181

rendering it not susceptible to lipid peroxidation due to its anti physiological (Mandal and Basu, 1986), antimicrobial (Mahra and Thind 1994) and insecticidal property (Chitra, 1995, Vasantha, 1995 and Arumugam, 1997).

The present study revealed that, with the advance in the storage period, irrespective of containers and seed treatment chemicals and their interactions all the seed quality parameters were gradually decreased. This might be due to ageing phenomenon and due to the depletion of food reserves and decline in synthetic activity (Shakuntala *et al*., 2012)

Finally, it can be concluded based on above discussion, seeds treated with chlorax and stored in double layer polythene bag retained seed germination and seedling vigour more than 10 months of storage period under ambient conditions of Dharwad and these treatments can be used for storage of marigold seeds in order to maintain viability.

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