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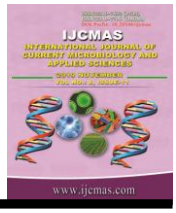

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Effect of Seed Priming on Standard Germination and Electrical Conductivity in Marigold Seeds

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A B S T R A C T

Marigold is one of the important annual flowers grown for commercial purpose all over the world. Non availability of high quality seeds of marigold is one of the major constraints in its cultivation. Priming of Marigold seeds plays crucial role in its germination and electrical conductivity, Hence a laboratory study was carried out to investigate the influence of various priming treatments on standard germination and electrical conductivity of French marigold seeds. This study was carried out on marigold seeds of four lines and nine treatments. Seeds treated with 0.5% KNO_3 exhibited significantly highest germination (83.00%) during 0 month storage. In 2, 4, 6, 8 and 10 months storage duration, significantly maximum germination percentage was observed in T_4 (81.33%, 75.33%, 69.33%, 60.91% and 44.25%) respectively. Maximum germination percentage was recorded in G-4 (83.55%) which was followed by G-1 (79.33%) and G-3 (76.22%) during 0 month storage. In 2, 4, 6, 8 and 10 months storage duration, significantly maximum germination percentage was observed in G-4 (81.741%, 74.44%, 65.92%, 55.96% and 43.96%) respectively. The highest electrical conductivity was recorded in T_0 (0.499ds/cm/seed) during 0 month storage. In 2, 4, 6, 8 and 10 months storage duration, significantly maximum electrical conductivity was observed in T_0 (0.604 ds/cm/seed, 0.634 ds/cm/seed, 0.688 ds/cm/seed, 0.735 ds/cm/seed and 0.786ds/cm/seed) respectively. Maximum electrical conductivity was recorded in G-2(0.373ds/cm/seed) which was followed by G-3 (0.299ds/cm/seed) and G-1 (0.283 ds/cm/seed) during 0 month storage. In 2, 4, 6, 8 and 10 months storage duration, significantly maximum electrical conductivity was observed in G-2 (0.477 ds/cm/seed, 0.496 ds/cm/seed, 0.534 ds/cm/seed, 0.573 ds/cm/seed and 0.607ds/cm/seed) respectively.

Introduction

Floriculture is a branch of horticulture concerned with the cultivation of commercial flowers and ornamental plants for gardens and for floristy. Flowers have been considered as the symbol of grace and elegance and a feast for our eyes. Floriculture is the art and knowledge of growing flowers to perfection. In India, floriculture is not getting the priority it deserves, though it has a great role to play. It is an intensive type of agriculture and the

income per acre is much higher than any other agricultural product if it is done in a scientific way. Flowers symbolize purity, beauty, peace, love, and passion.

Marigold (*Tagetes patula L.*), a member of family compositae is an important loose flower crop cultivated in India. It is native to Mexico and commonly called as Jafri and Gaindi. In India, it is mainly grown for commercial purposes in the states of Karnataka, Maharashtra, Haryana, Madhya Pradesh, Gujarat, Andhra Pradesh and Odisha. The marigold is also grown as trap crop to control pest activity. Poultry industry is extensively using marigold petals as a natural source of xanthophylls pigment. Thus, cultivation of marigold gaining popularity day by day in agriculture business owing to its commercial usage.

Marigold seeds exhibit a rapid decline in vigour and viability under ambient conditions of storage from April to October in Northern plains (Rao *et al.*, 2003). Non availability of high quality seeds of marigold is one of the major constraints in its cultivation. Seed possesses maximum vigour at the time of physiological maturity, thereafter in viability and vigour of seed decline gradually.

Thus, the preparation of seed with high vigour is essential to improve seed storability and seedling establishment which ultimately enhance the productivity under wide range of field conditions. Little information has been reported on seedling development of marigold subsequent to priming. Priming treatments have been reported to offer promising means for maintaining the quality of different crop species. Improved seed invigouration techniques are being used in many parts of world to reduce the germination time, synchronize germination, improve germination rate and increase seedling stand (Khan 1992, Lee and Kim, 2000). Various treatments involving hydration-dehydration or pre sowing treatments with different chemicals – $CaCl_2$ and KNO_3 for increasing the storage of seeds life have been found beneficial. Therefore, a laboratory study was carried out to assess the influence of various priming treatments on germination and electrical conductivity of French marigold seeds.

Materials and Methods

A good quality seed is an essential requirement for obtaining higher yields per unit area. To assess the seed quality during storage this research was conducted in laboratory of Seed Science and Technology department, CCS Haryana Agricultural University. The research was planned to determine the ageing, priming and enzyme activity on seed quality parameters of marigold seeds under natural and artificial aged conditions. An effort was made to assess effect of priming treatments on seed quality during storage and the effect of accelerated ageing on primed seed genotypes during storage.

The seed material for the present investigation was collected from Horticulture farm, Department of Horticulture CCS Haryana Agricultural University Hisar. The study was carried out on marigold seeds of four lines which were harvested during April. The harvested seeds of different lines (MGH208, MGH205, MGH207 and Hissar Jafri) were designated as Genotype-1; Genotype-2; Genotype-3; and Genotype-4, respectively.

Treatments

The seeds of various genotypes (G-1, G-2, G-3 and G-4) were harvested in 16th April and after processing the seeds were primed and observations were recorded at two months interval upto February (2017).

T_0 - Untreated (control)

T_1 – Hydration (Soaking for 6 h) and dehydration at room temperature

T_2 – 2% $CaCl_2$ (Soaking for 6 h) and dehydration at room temperature.

T_3 – 4% $CaCl_2$ (Soaking for 6 h) and dehydration at room temperature.

T_4 – 0.5% KNO_3 (Soaking for 6 h) and dehydration at room temperature.

T_5 – 1% KNO_3 (Soaking for 6 h) and dehydration at room temperature.

T_6 – 2% Mannitol (Soaking for 6 h) and dehydration at room temperature.

T_7 – – 4% Mannitol (Soaking for 6 h) and dehydration at room temperature.

T_8 – – 6% Mannitol (Soaking for 6 h) and dehydration at room temperature.

Method of application of priming treatments

Sufficient number of seeds from different seed genotypes were placed over filter-paper soaked in solution of the desired treatment in a beaker and kept it at room temperature.

The seeds were allowed to imbibe solution for 6 h in all the treatments. After the completion of treatment period, the seeds were dehydrated at room temperature.

Standard germination test (%)

Fifty seeds of each lot replicated thrice were placed on sufficiently in petri plates and placed in seed germinator at 20°C temperature with 80-85 per cent relative humidity. The final count of germinated seeds was taken on 10th day and normal seedlings were expressed as percent germination of total seeds.

Electrical conductivity test (EC) (ds/cm/seed)

Twenty normal and uninjured seeds were soaked in separate beakers each containing 50 ml of distilled water. Seeds were immersed completely in water and beakers were covered with foil. Thereafter, these samples were placed in germinator at 20°C for 24 hours in dark. The electrical conductivity of seed leachates was measured by conductivity bridge meter (ISTA, 1999).

Results and Discussion

Standard germination test (%)

The various priming treatments had significant effect on the germination percentage in marigold (Table 1). Maximum germination percentage was recorded in G-4(83.556%) which was followed by G-1 (79.33%) and G-3 (76.222%) during 0 month storage. In 2, 4, 6, 8 and 10 months storage duration, significantly maximum germination percentage was observed in G-4 (81.741%, 74.444%, 65.926%, 55.963% and 43.963%) respectively. The highest germination percentage was recorded in T_4 (83.00%) during 0 month storage. In 2, 4, 6, 8 and 10 months storage duration, significantly maximum germination percentage was observed in T_4 (81.333%, 75.333%, 69.33%, 60.917% and 44.250%) respectively.

The germination percentage observed in T_4 and G-4 interaction (89.00%) was non significant in 0 month storage. In 2, 4, 6, 8 and 10 months storage duration, significantly maximum germination percentage was observed in T_4 and G-4 interaction (87.00%, 80.667%, 74.667%, 68.00% and 50.33%) respectively

Electrical conductivity test (EC) (ds/cm/seed)

The various priming treatments had significant effect on the electrical conductivity in marigold (Table 2). Maximum electrical conductivity was recorded in G-2(0.373ds/cm/seed) which was followed by G-3 (0.299ds/cm/seed) and G-1 (0.283 ds/cm/seed) during 0 month storage. In 2, 4, 6, 8 and 10 months storage duration, significantly maximum electrical conductivity was observed in G-2 (0.477 ds/cm/seed, 0.496 ds/cm/seed, 0.534 ds/cm/seed, 0.573 ds/cm/seed and 0.607ds/cm/seed) respectively. The highest electrical conductivity was recorded in T_0 (0.499ds/cm/seed) during 0 month storage. In 2, 4, 6, 8 and 10 months storage duration, significantly maximum electrical conductivity was observed in T_0 (0.604 ds/cm/seed, 0.634 ds/cm/seed, 0.688 ds/cm/seed, 0.735 ds/cm/seed and 0.786ds/cm/seed) respectively.

The highest electrical conductivity was observed in $\mathbf{T_0}$ and G-2 interaction (0.570 ds/cm/seed) during 0 month storage. In 2, 4, 6, 8 and 10 months storage duration, significantly maximum electrical conductivity was observed in $T_0$and G-2 interaction (0.670 ds/cm/seed, 0.687ds/cm/seed, 0.720 ds/cm/seed, 0.750ds/cm/seed and 0.783ds/cm/seed) respectively

Standard germination

Effect of priming treatments on standard germination of marigold seeds has been recorded in the Table 1. At 0 month storage period treatment T_4 (0.5% KNO_3) and genotype G-4 was highly significant compared to all other treatments and genotypes. For 2, 4, 6, 8and 10 month storage, T_4 and G-4 produced maximum germination percentage. The positive effect of KNO_3 might be due to its role in influencing the permeability of membranes, which ultimately leads to activation of enzymes involved in protein synthesis, carbohydrate metabolism. These results are in line with Nawaz *et al.,* (2011) in tomato seeds, Afzal *et al.,* (2009) in marigold seeds, Abdollahi *et al.,* (2012) in *canola* seeds and Yam *et al.,* (2015) in Chinese cabbage seeds.

Electrical conductivity

Electrical conductivity in the marigold seed of different priming treatment for 0 month storage was found highest in the treatment T_0 (control) compared to all other treatments. Among different genotypes G-2 was highly significant as compared to other genotypes as presented in the Table 2. Similar results were observed over the other storage duration. This might be due to destructive changes in cellular membrane system resulting in more leakage of organic solutes (free sugars, fatty acids and amino acids). Damage to membrane system could be repaired and protected against such changes by invigouration treatments with KNO_3 as evidenced by low electrical conductivity of seed leachates, which presumably have extended the viability of seeds. The differential EC values recorded among the seed treatments indicate the nature and extent of membrane protection offered, which may not be the same for all seed priming treatments, thus resulting in difference EC values.

Fresh seeds were tested for various vigour and viability parameters in a completely randomized design with three replications.

The statistical analysis of data for various parameters was carried out according to the standard procedure. The results obtained during the investigation are summarized as below:

Table.1 Effect of priming treatments on germination of marigold seeds

Storage duration	Seed genotypes	Germination percentage (%)									Mean (%)
		Priming treatments									
In months		T_0	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T8	
0	G-1	82.000	79.333	80.000	80.333	87.000	82.000	77.000	74.000	72.333	79.333
	G-2	77.000	73.000	72.000	73.000	75.000	73.000	72.000	69.000	69.000	72.556
	G-3	79.000	76.000	75.000	78.000	81.000	76.000	74.000	71.000	76.000	76.222
	G-4	87.000	82.000	82.000	85.000	89.000	87.000	82.000	79.000	79.000	83.556
Mean		81.250	77.583	77.250	79.083	83.000	79.500	76.250	73.250	74.083	
2	G-1	80.000	77.333	78.333	77.000	85.667	80.333	75.000	72.667	70.333	77.407
	G-2	75.000	71.000	70.333	71.667	73.333	71.000	70.000	67.000	67.667	70.778
	G-3	77.667	74.667	73.000	76.333	79.333	74.333	72.000	69.667	74.333	74.593
	G-4	85.000	80.000	80.000	83.000	87.000	85.333	80.000	77.667	77.667	81.741
Mean		79.417	75.750	75.417	77.000	81.333	77.750	74.250	71.750	72.500	
4	G-1	72.000	66.000	70.667	73.000	77.000	74.000	70.000	65.667	65.000	70.370
	G-2	63.000	63.667	65.000	64.333	70.000	65.333	65.000	59.667	63.000	64.333
	G-3	65.333	64.667	65.000	69.667	73.667	68.333	66.000	62.000	65.333	66.667
	G-4	76.667	70.333	74.333	76.333	80.667	77.333	73.000	72.000	69.333	74.444
Mean		69.250	66.167	68.750	70.833	75.333	71.250	68.500	64.833	65.667	
6	G-1	62.667	60.000	62.333	66.667	69.000	65.000	60.667	57.000	57.333	62.296
	G-2	56.000	52.000	55.667	56.000	62.000	55.667	53.333	49.667	52.000	54.704
	G-3	59.000	58.000	48.333	63.667	71.667	62.333	59.667	53.000	55.667	59.037
	G-4	66.000	61.333	64.333	68.667	74.667	68.667	66.333	62.333	61.000	65.926
Mean		60.917	57.833	57.667	63.750	69.333	62.917	60.000	55.500	56.500	
8	G-1	49.333	46.333	55.000	58.667	59.667	56.333	45.333	41.333	46.000	50.889
	G-2	44.333	40.333	40.333	41.667	54.333	48.667	40.667	36.000	34.667	42.333
	G-3	49.000	44.000	43.000	54.333	61.667	50.000	42.000	39.667	36.000	46.630
	G-4	53.333	50.000	57.333	60.000	68.000	57.333	57.667	50.333	49.667	55.963
Mean		49.000	45.167	48.917	53.667	60.917	53.083	46.417	41.833	41.583	
10	G1	38.667	38.333	39.333	45.333	46.333	43.000	41.000	38.000	36.000	40.667
	G-2	33.333	31.667	33.667	36.000	36.333	34.333	33.333	32.333	31.667	33.630
	G-3	34.333	32.333	39.667	40.667	44.000	39.333	38.000	36.000	34.667	37.667
	G-4	41.333	39.667	44.333	47.333	50.333	49.333	44.667	40.333	38.333	43.963
Mean		36.917	35.500	39.250	42.333	44.250	41.500	39.250	36.667	35.167	
C.D. at 5% Seed											
Genotype =1.464		Genotype=0.734						Genotype=0.617			
Treatment= 2.196		Treatments=0.101						Treatments=0.925			
Genotype X Treatments =NS		Genotype X Treatments =2.203						Genotype X Treatments=1.850			
Genotype =0.662		Genotype=0.879						Genotype=0.866 Treatment = 1.993			
Treatments=1.318		Treatments =1.299						Genotype X Treatments =2.985			
Genotype X Treatments =2.636		Genotype X Treatments =2.598									

Table.2 Effect of priming treatments on Electrical conductivity of marigold seeds

Storage duration	Seed genotype	Electrical conductivity (ds/cm/seed)									Mean
		Priming treatments									
In months		T_0	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T8	
0	G-1	0.434	0.280	0.330	0.360	0.240	0.270	0.230	0.200	0.200	0.283
	G-2	0.570	0.330	0.470	0.440	0.330	0.310	0.310	0.310	0.290	0.373
	G-3	0.510	0.300	0.320	0.320	0.300	0.300	0.170	0.370	0.100	0.299
	G-4	0.480	0.360	0.350	0.377	0.270	0.250	0.220	0.210	0.210	0.303
Mean		0.499	0.318	0.368	0.374	0.285	0.283	0.233	0.273	0.200	
2	G-1	0.545	0.387	0.430	0.457	0.353	0.377	0.307	0.307	0.303	0.385
	G-2	0.670	0.440	0.573	0.557	0.433	0.417	0.417	0.407	0.380	0.477
	G-3	0.613	0.303	0.413	0.427	0.403	0.407	0.287	0.270	0.203	0.370
	G-4	0.587	0.350	0.453	0.480	0.370	0.357	0.330	0.307	0.307	0.393
Mean		0.604	0.370	0.468	0.480	0.390	0.389	0.335	0.323	0.298	
4	G-1	0.620	0.420	0.463	0.487	0.373	0.407	0.330	0.313	0.337	0.417
	G-2	0.687	0.470	0.600	0.587	0.480	0.457	0.430	0.410	0.347	0.496
	G-3	0.610	0.330	0.450	0.470	0.430	0.430	0.323	0.313	0.330	0.410
	G-4	0.620	0.390	0.480	0.520	0.390	0.370	0.353	0.330	0.330	0.420
Mean		0.634	0.403	0.498	0.516	0.418	0.416	0.359	0.342	0.336	
6	G-1	0.680	0.440	0.500	0.510	0.410	0.430	0.380	0.340	0.343	0.448
	G-2	0.720	0.517	0.620	0.640	0.503	0.490	0.480	0.450	0.390	0.534
	G-3	0.650	0.373	0.490	0.490	0.450	0.453	0.353	0.350	0.320	0.437
	G-4	0.703	0.470	0.510	0.510	0.410	0.400	0.390	0.370	0.350	0.457
Mean		0.688	0.450	0.530	0.538	0.443	0.443	0.401	0.378	0.351	
8	G-1	0.710	0.470	0.530	0.560	0.460	0.473	0.410	0.380	0.370	0.485
	G-2	0.750	0.490	0.670	0.710	0.513	0.530	0.543	0.520	0.430	0.573
	G-3	0.690	0.390	0.520	0.570	0.477	0.460	0.390	0.390	0.353	0.471
	G-4	0.790	0.500	0.550	0.600	0.490	0.473	0.430	0.410	0.390	0.515
Mean		0.735	0.463	0.567	0.610	0.485	0.484	0.443	0.425	0.386	
10	G-1	0.750	0.490	0.560	0.593	0.480	0.490	0.430	0.410	0.400	0.511
	G-2	0.783	0.507	0.690	0.733	0.590	0.570	0.573	0.550	0.467	0.607
	G-3	0.730	0.427	0.550	0.610	0.500	0.490	0.413	0.420	0.390	0.503
	G-4	0.880	0.590	0.610	0.670	0.530	0.523	0.490	0.473	0.450	0.580
Mean		0.786	0.503	0.603	0.652	0.525	0.518	0.477	0.463	0.427	
C.D. at 5% Genotype =0.012 Treatment = 0.018 Genotype X Treatments =0.035		Genotype=0.005 Treatments=0.008 Genotype X Treatments =0.016						Genotype=0.005 Treatments =0.008 Genotype X Treatments=0.016			
Genotype =0.007 Treatment = 0.011 Genotype X Treatments =0.022		Genotype=0.010 Treatments=0.015 Genotype X Treatments =0.030						Genotype=0.009 Treatments =0.014 Genotype X Treatments =0.028			

Seeds were primed with various priming treatments *viz.*, 0.5 and 2% KNO_3, 2 and 4% $CaCl_2$, 2, 4 and 6% Mannitol, control and dehydration. Treatment T_4 (0.5% KNO_3) exhibited higher germination as compared to other treatments and Seed genotype-4 was found to be performing significantly better germination than rest of genotypes and The highest electrical conductivity was observed in T_0 and G-2 interaction

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