



Effect of different sources of nutrient on relative storability of coriander (*Coriandrum sativum*) seed

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ABSTRACT

Accelerated aging is one of the most useful tests used for the estimation of relative storability of different seed lots. In the present study, coriander seed viability and vigour of coriander seed was estimated by putting different seed lots under various period of accelerated ageing, i.e. 24, 48, 72, 96 and 120 hours at 40±1°C at 100% relative humidity during two consecutive years, i.e. 2017 and 2018. The study was carried out on the seeds produced under eighteen treatment combinations of organic manures (Farmyard manure and vermicompost), bio-fertilizers (*Azotobacter* and phosphate solubilizing bacteria) and inorganic fertilizers. Experimental results revealed that the co-inoculation of *Azotobacter* and PSB along with application of 100% recommended dose of nitrogen through vermicompost (VC) recorded significantly higher standard germination (%), seedling length (cm), seedling dry weight (mg), vigour index-I and vigour index-II at every stage of accelerated ageing. The electrical conductivity recorded was also minimum under this treatment which was due to cell membrane stability and decreased leakage of solutes from the seeds.

Key words: Accelerated ageing, Relative Storability, Seed quality, Vermicompost

Coriander (*Coriandrum sativum* L.), a member of Umbelliferae family, also known as Chinese parsley, *cilantro* or *dhania* is one of the earliest herbaceous annual spices used by mankind (Luayza *et al.* 1996). The oleoresin extracted from coriander seed is used for flavouring beverage, pickles and sweets. It is also used for curing bleeding piles, rheumatism, neurologin, ciphalgia and locally in eye infection (Agarwal *et al.* 1991). The biochemical and medicinal properties shows the importance of this spice crop.

Coriander crop responds well to the application of both manures and inorganic fertilizers (Singh 2015). Not any single source of nutrient is capable of supplying all essential plant nutrients in adequate amount and balanced proportion. The management practices using organic manures and biofertilizers result in agricultural sustainability by improving physical, chemical and biological properties of soils with resulting in increased yield and essential oil content of medicinal plants (Darzi *et al.* 2007).

Seed viability and vigour decrease during prolonged storage condition due to aging. Higher germination percentage is normally achieved immediately after harvesting and gradually decreases with increase in storage period. Aging of seed could be judged by various parameters

like delay in germination and emergence, slow growth and increasing susceptibility to environmental stresses (Walters 1998). Using high quality seed improved performance by producing healthy seedlings which has higher seedling growth and uniform germination (Ghasemi-Golezani *et al.* 1996). High temperature, ambient relative humidity, and seed moisture content are the main factors influencing seed storability (Abdul-Baki 1980). This ageing test of seed vigour can give better indications of probable field emergence for vegetable crop seeds than germination and growth tests. Accelerated ageing though initially proposed as a method to evaluate seed storability, this test is a rapid, low-cost, simple and convenient germination testing method (Siadat *et al.* 2012).

Meanwhile, the process of deterioration under accelerated ageing conditions is essentially similar to those under normal conditions where we can predict the rate of deterioration of the seeds through the accelerated ageing test so that the relative storability of the seeds can be estimated (Goel *et al.* 2002). Therefore, the aim of the present study was to investigate the effect of integrated nutrient management on the germination and vigour of coriander seeds under various period of accelerated aging.

MATERIALS AND METHODS

The present investigation was carried out at Research Farm of CCS Haryana Agricultural University, Hisar, Haryana during 2016–17 to 2017–18. Coriander cultivar Hisar Bhoomi was sown in the second week of November

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in the net plot of 4.0 m × 2.4 m during both seasons. The seeds were treated with *Azotobacter* @10 ml/kg seed and PSB @10 ml/kg seed uniformly before sowing. Well decomposed farmyard manure having nitrogen content (0.50% N and 0.48% N) and vermicompost (1.0% N and 1.03% N) obtained from Department of Agronomy, CCS HAU, Hisar during 2016–17 and 2017–18, respectively were incorporated into the soil before sowing to fulfill the recommended dose of nitrogen (60 kg/ha). All the fertilizers were applied in a single dose at the time of sowing.

The seeds were sown in 18 treatment combinations, viz. T₁ {100% Recommended dose of nitrogen (RDN) through inorganic sources + *Azotobacter* + Phosphate solubilising bacteria (PSB)}, T₂ {75% RDN (Inorganic) + *Azotobacter* + PSB}, T₃ {100% RDN through FYM + *Azotobacter* + PSB}, T₄ {75% RDN through FYM + *Azotobacter* + PSB}, T₅ {100% RDN through vermicompost (VC) + *Azotobacter* + PSB}, T₆ {75% RDN through VC + *Azotobacter* + PSB}, T₇ {75% RDN (Inorganic) + 25% RDN through FYM + *Azotobacter* + PSB}, T₈ {50% RDN (Inorganic) + 50% RDN through FYM + *Azotobacter* + PSB}, T₉ {75% RDN (Inorganic) + 25% RDN through VC + *Azotobacter* + PSB}, T₁₀ {50% RDN (Inorganic) + 50% RDN through VC + *Azotobacter* + PSB}, T₁₁ {75% RDN through FYM + 25% RDN through VC + *Azotobacter* + PSB}, T₁₂ {50% RDN through FYM + 50% RDN through VC + *Azotobacter* + PSB}, T₁₃ {25% RDN through FYM + 75% RDN through VC + *Azotobacter* + PSB}, T₁₄ {100% RDN (Inorganic)},

T₁₅ {100% RDN through FYM}, T₁₆ {100% RDN through VC}, T₁₇ {*Azotobacter* + PSB} and T₁₈ {control i.e. without nitrogen and biofertilizers} in randomized block design (RBD) with three replications. Freshly harvested seed (having moisture content of 8%) from each treatment was subjected to accelerated ageing for 24, 48, 72, 96 and 120 h at 40±1°C at 100% relative humidity.

The seeds from each treatment were tested in completely randomized design (CRD) for germination after every stage of accelerated ageing by adopting between papers methods kept at optimum conditions of temperature (25°C) in three replications of 100 seeds (ISTA 2011). The numbers of normal seedlings were counted at 21st day and the germination percentage was calculated by number of seeds germinated/number of seeds sown × 100. The seedling length was recorded on 21st day by randomly selecting 10 seedlings which were averaged and expressed in centimeters. The seedling used for measuring dry weight were kept in a paper bag and dried in hot air oven for 48 hours at 80±10°C. The seedlings were cooled in desiccator and the weight was recorded by using electronic balance and average seedling dry weight of each treatment was calculated and expressed in milligrams. Seedling vigour indices were calculated according to the method suggested by Abdul- Baki and Anderson (1973). To measure the electrical conductivity, 50 normal and uninjured seeds in three replications were soaked in 75 ml deionized water in 100 ml beakers. Seeds were immersed completely in water and beakers were covered

Table 1 Effect of accelerated ageing on standard germination (%) and seedling length (cm) after accelerated ageing for different periods (Pooled)

Treatment	Standard germination (%)					Seedling length (cm)				
	24 h	48 h	72 h	96 h	120 h	24 h	48 h	72 h	96 h	120 h
T ₁	77.83	71.00	62.83	42.67	28.00	19.55	16.64	15.19	13.79	12.27
T ₂	75.83	69.50	62.17	41.17	26.17	18.06	15.16	13.77	12.31	10.76
T ₃	75.17	69.50	62.83	42.33	27.00	18.81	16.01	14.53	12.92	11.38
T ₄	74.33	68.33	61.50	40.67	25.83	17.52	14.65	13.19	11.78	10.24
T ₅	82.50	76.33	70.50	52.67	31.50	21.63	18.68	17.01	15.61	14.09
T ₆	75.33	70.17	63.17	43.67	27.00	18.25	15.31	13.89	12.28	10.75
T ₇	77.00	70.00	61.83	41.33	28.00	19.48	16.65	15.08	13.68	11.97
T ₈	76.17	69.33	62.50	42.33	27.50	18.96	16.14	14.72	13.16	11.79
T ₉	79.17	74.00	65.50	44.83	29.33	20.34	17.42	16.05	14.65	13.12
T ₁₀	80.50	75.50	69.17	49.00	30.33	21.00	18.33	17.03	15.56	14.03
T ₁₁	79.00	71.33	63.17	42.67	28.67	20.04	17.15	15.75	14.29	12.86
T ₁₂	79.17	73.17	64.33	44.33	30.17	20.49	17.59	16.15	14.74	13.23
T ₁₃	80.83	74.67	69.50	51.50	31.00	21.12	18.32	16.83	15.37	13.91
T ₁₄	74.00	67.67	60.33	40.00	23.17	16.72	15.50	14.06	12.66	10.97
T ₁₅	72.33	66.83	59.33	39.00	22.83	16.23	14.79	13.39	11.99	10.46
T ₁₆	74.50	68.33	62.50	42.17	23.83	17.16	15.11	13.68	12.23	10.76
T ₁₇	72.83	66.50	58.83	37.83	22.17	15.67	14.30	12.81	11.38	9.89
T ₁₈	70.50	64.33	55.50	36.00	21.17	15.12	14.00	12.68	11.26	9.64
SE(m)	1.34	1.22	1.09	0.80	0.52	0.35	0.25	0.20	0.17	0.14
CD (P=0.05)	3.85	3.53	3.15	2.31	1.49	1.00	0.72	0.57	0.49	0.39

with foil. Thereafter, these samples were kept for 24 h at 25°C. The electrical conductivity of the seed leachates was measured using a direct reading conductivity meter. The conductivity was expressed in $\mu\text{S}/\text{cm}/\text{gram}$.

Mean values of the parameters in each replication were statistically analyzed by using one factor analysis in the software of CCS HAU, Hisar website <http://hau.ac.in/about/opstat.php> for analysis of variance and test of significance.

RESULTS AND DISCUSSION

Germination percentage of seed produced under all the eighteen treatment decreased as the period of accelerated ageing increased from 24–120 h (Table 1). Results revealed that after 24 h of accelerated ageing period all the seed lots showed germination percentage above Minimum Seed Certification Standards (65.00%). However, after the 48 and 72 h of accelerated ageing, there was a decline in germination percentage some treatment combinations below the Minimum Seed Certification Standard (65.00%). Among all the treatments, 100% RDN through VC + *Azotobacter* + PSB (T_5) recorded highest germination of seed (82.50%, 76.33%, 70.50%, 52.67% and 31.50%) which was at par with the treatments T_{13} (80.83%, 74.67%, 69.50%, 51.50% and 31.00%) and T_{10} (80.50%, 75.50%, 69.17%, 49.00% and 30.33%) while minimum germination was found in control (70.50%, 64.33%, 55.50%, 36.00% and 21.17%) after accelerated ageing of seed for 24, 48, 72, 96 and 120

hours, respectively at $40 \pm 1^\circ\text{C}$ at 100% relative humidity. The higher germination percentage in T_5 after the different period of accelerated ageing might be because of the better accumulation of food reserves like protein and carbohydrates due to the inoculation of biofertilizers along with nitrogen at the time of seed development. There was decrease in germination percent in all the nutrient combinations because there were changes in seed metabolic activities during storage which led to seed deterioration and loss in vigour. The decline in germination percentage with increase in ageing period might be due to degradation of mitochondrial membrane leading to reduction in energy supply necessary for germination (Gidrol *et al.* 1998).

Seedling length (Table 1) and seedling dry weight (Table 2) of all the treatment combinations also showed a significant decrease from 24 hr to 120 hr of accelerated ageing and the highest decline in both the characters was observed after 120 h of accelerated ageing in all the treatments. The highest seedling length after 120 h of accelerated ageing was observed in the treatment T_5 (14.09 cm) which was at par with the treatment T_{10} (14.03 cm) and T_{13} (13.91 cm) while the shortest was recorded in control. Same trend was observed for the seedling dry weight. Among all the treatments T_5 , T_{10} and T_{13} showed better seedling length and dry weight throughout the period of accelerated ageing which might be due to the accumulation of higher quantities of seed constituents like carbohydrates in the seed due to

Table 2 Effect of accelerated ageing on seedling dry weight (mg) and electrical conductivity ($\mu\text{S}/\text{cm}/\text{g}$) after accelerated ageing for different periods (Pooled)

Treatment	Seedling dry weight (mg)					electrical conductivity ($\mu\text{S}/\text{cm}/\text{g}$)				
	24 h	48 h	72 h	96 h	120 h	24 h	48 h	72 h	96 h	120 h
T_1	2.92	2.68	2.38	1.98	1.65	210.94	300.81	404.37	563.98	759.95
T_2	2.73	2.43	2.15	1.84	1.53	224.47	319.26	417.91	593.10	790.45
T_3	2.82	2.53	2.23	1.99	1.60	174.50	268.25	367.30	522.89	714.65
T_4	2.62	2.38	2.08	1.85	1.51	218.62	313.33	409.79	563.80	762.69
T_5	3.09	2.82	2.51	2.23	1.88	141.94	244.37	344.77	499.73	696.92
T_6	2.62	2.40	2.09	1.77	1.42	217.44	313.48	411.68	553.78	751.16
T_7	2.90	2.62	2.32	2.00	1.70	204.90	294.99	404.40	571.37	768.02
T_8	2.85	2.59	2.29	1.91	1.62	191.33	281.50	381.96	552.70	750.06
T_9	2.93	2.68	2.39	2.03	1.77	196.43	290.16	393.38	556.60	747.46
T_{10}	3.04	2.82	2.51	2.18	1.83	181.06	274.18	375.04	543.01	735.39
T_{11}	2.91	2.68	2.38	2.00	1.69	169.62	261.06	361.85	522.02	722.54
T_{12}	2.99	2.74	2.41	2.09	1.76	166.22	258.29	361.73	525.36	716.48
T_{13}	3.04	2.76	2.46	2.14	1.78	152.20	249.57	351.69	510.12	705.31
T_{14}	2.70	2.43	2.16	1.83	1.53	227.25	321.73	419.52	582.42	780.38
T_{15}	2.72	2.48	2.18	1.80	1.50	216.82	306.96	406.87	563.14	757.96
T_{16}	2.78	2.55	2.20	1.98	1.60	213.81	304.22	399.67	552.02	748.52
T_{17}	2.54	2.26	1.96	1.71	1.42	233.72	325.39	427.03	597.86	794.83
T_{18}	2.42	2.13	1.83	1.68	1.39	242.33	338.29	439.69	618.26	816.58
SE(m)	0.04	0.04	0.04	0.03	0.02	3.19	4.64	5.76	7.89	11.13
CD (P=0.05)	0.12	0.10	0.10	0.09	0.06	9.19	13.37	16.57	22.72	32.06

the nutrition of coriander plants by the co-inoculation of *Azotobacter* and PSB along with inorganic nitrogen and conversion of macromolecules into micromolecules due to release of certain enzymes. Reduction in seedling length and seedling dry weight may be due to decrease in mobilization of reserve substances during germination of the stored seeds (Dhakal and Pandey 2001). Ageing led to decrease in seedling length and seedling dry weight which is confirmed in the earlier findings of Nagarajan *et al.* (2004) in okra.

Testing of vigour index is a measure in which seeds can produce the normal seedlings in the adverse situation in the field. The accelerated ageing and vigour are negatively correlated to each other as accelerated ageing increases the vigour decreases (Fig 1 and 2). This result could be explained when coriander seeds were subjected to accelerated ageing for 24, 48, 72, 96 and 120 h at $40\pm 1^\circ\text{C}$ at 100% relative humidity. Vigour index-I and vigour index-II declined significantly with the increase in period of ageing

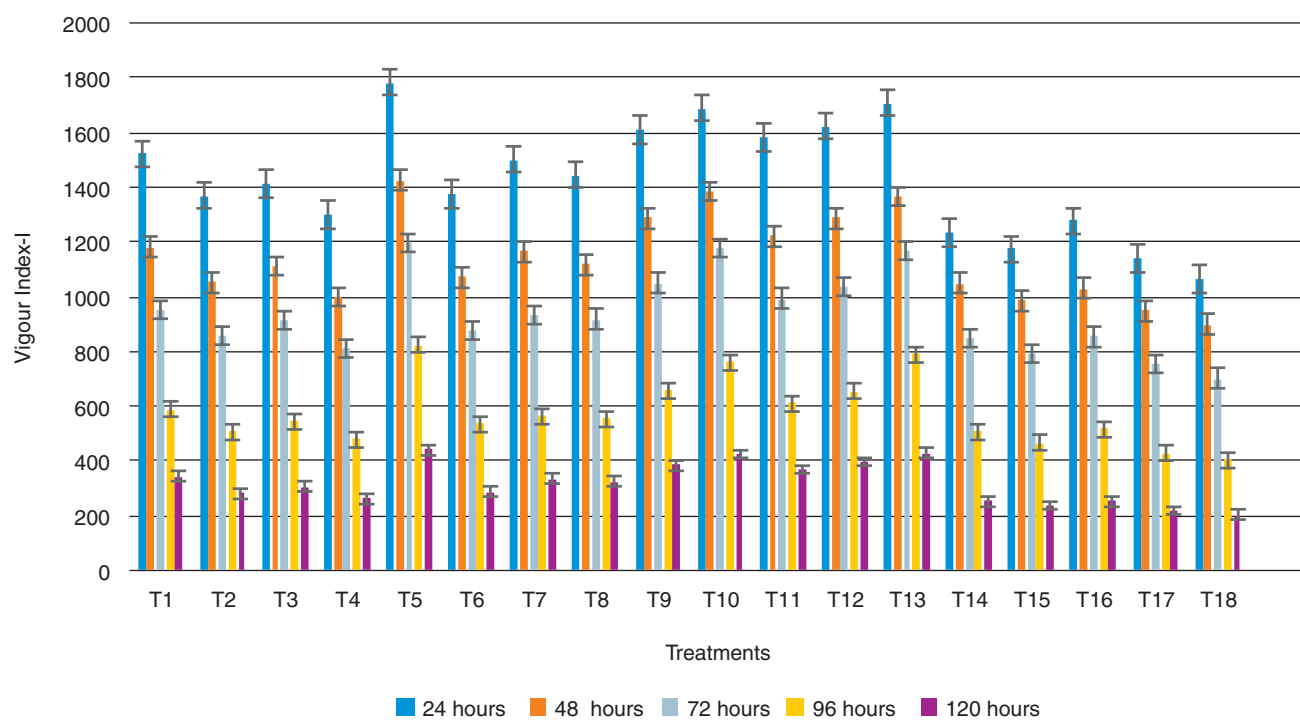


Fig 1 Effect of accelerated ageing on vigour index- I after accelerated ageing for different periods (Pooled).

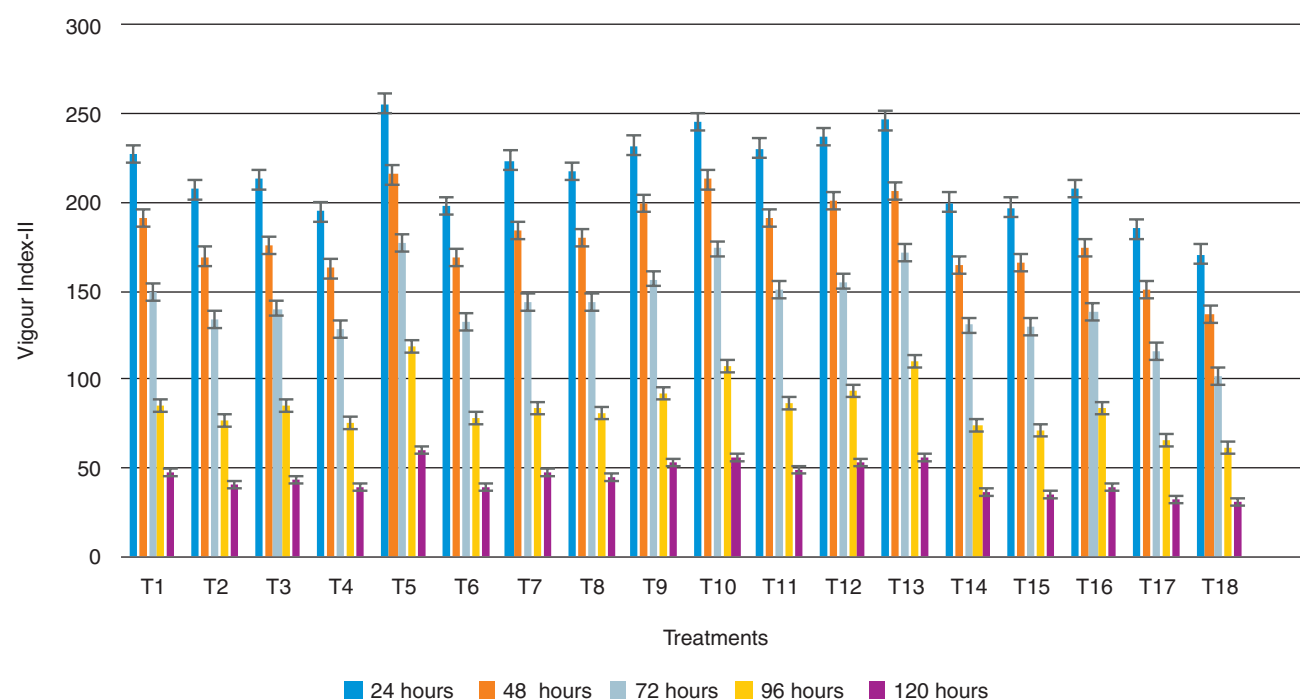


Fig 2 Effect of accelerated ageing on vigour index- II after accelerated ageing for different periods (Pooled).

in all the eighteen treatment combinations of coriander seed. Among treatments, the vigour index-I and II after 120 h of accelerated ageing was maximum in 100% RDN through VC + *Azotobacter* + PSB (T₅) and minimum in control. Decrease in vigour index with increase in ageing was also reported by Vijay *et al.* (2015) in sunflower and in fenugreek by Kumar and Verma (2008).

The change of electrical conductivity during seed soaking is commonly used as an indicator for testing the integrity of plasma membrane (Bewley and Black 1994). Electrical conductivity ($\mu\text{S}/\text{cm}/\text{g}$) of seed leachates increased significantly after ageing in all the treatment combinations of coriander. The maximum electrical conductivity at all intervals of accelerated ageing was recorded in control (T₁₈) while minimum was recorded in the treatment T₅ (Table 2). The better performance in T₅ may be due to the inoculation of biofertilizers along with the nitrogen which may have increased the cell membrane stability and decreased the leakage of solutes from the seeds because of availability of more nutrients for the growth of plant and seed development which ultimately lead to an intact seed coat. The membrane integrity lost due to damage of phospholipids lead to increased membrane permeability and exit of electrolytes and other substances such as enzymes from cells (Kumar *et al.* 2019).

Thus, the study recommends that combined use of 100% recommended dose on nitrogen through vermicompost and biofertilizers could be recommended for production of quality seed in coriander in terms of vigour and viability and also the storability of coriander seed can also be extended by applying the nitrogen through organic sources along with biofertilizers.

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