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Sowmeya TV
Department of Seed Science and Technology, University of Agricultural Sciences, Raichur, Karnataka, India

Sangeeta I Macha
Department of Seed Science and Technology, University of Agricultural Sciences, Raichur, Karnataka, India

SN Vasudevan
Department of Seed Science and Technology, University of Agricultural Sciences, Raichur, Karnataka, India

NM Shakuntala
Department of Seed Science and Technology, University of Agricultural Sciences, Raichur, Karnataka, India

Ramesh G
Department of Horticulture, University of Agricultural Sciences, Raichur, Karnataka, India

Correspondence
Sowmeya TV
Department of Seed Science and Technology, University of Agricultural Sciences, Raichur, Karnataka, India

Influence of priming on seed quality of fresh and old seed lots of carrot (*Daucus carota* L.)

Sowmeya TV, Sangeeta I Macha, SN Vasudevan, NM Shakuntala and Ramesh G

Abstract
An attempt was made to study the influence of priming on seed quality in fresh and old seed lots of carrot. This experiment consisted of 14 priming treatments and seeds were primed for 24 hours. Fresh seed lot recorded significantly higher germination (77.00 %), SVI (1257), dehydrogenase enzyme activity (0.555 OD value) and alpha amylase activity (23.23 mm) as compared to old seed lot (70.66%, 1089, 0.337 OD value and 19.50 mm, respectively). However, effects of seed priming were more pronounced in old seed lot compared to fresh seed lot. Carrot seeds in both fresh and old lots primed with panchagavya (5 %) showed highest germination (93.00 % and 87.75 %, respectively), SVI (1584 and 1422, respectively), dehydrogenase enzyme activity (0.617 OD value and 0.512 OD value, respectively) and alpha amylase activity (29.05 mm and 25.08 mm, respectively) whereas, seeds primed with GA_3 (100 ppm) showed highest root (8.33 cm and 8.12 cm, respectively) and shoot length (8.72 cm and 8.12 cm, respectively) as compared to control. However, there was no germination in cinnamon (10 % and 15 %, respectively) primed seeds in both the lots and they had less enzymatic activity.

Keywords: Carrot, priming, germination, enzyme activity

Introduction
Carrot (*Daucus carota* L.) is one of the most important root vegetable crops and most widely cultivated member of the family Umbelliferae. It is a biennial plant having diploid (2n =2x = 18) chromosome number. Commercially cultivated carrots mostly depend on seed for regeneration. Cultivation of carrot is carried out in cooler regions as it requires 15-20˚C temperature for flowering and seed production.

An important problem encountered in the cultivation of carrot is the poor germination of the seeds when planting is done in extremely warm temperatures. High temperature may delay or inhibit seed germination in the field, reduce uniformity, total stand establishment and ultimately reduce the yield in carrot. Poor germination of seeds is of common occurrence in the family Umbelliferae. It has been suggested that the seeds with rudimentary embryos are the cause for the delayed germination often encountered in carrots. Also the smaller size of carrot seeds causes difficulty in field emergence. (Robinson, 1954).

Different techniques could be used to enhance carrot seed quality particularly under adverse conditions. One of the simple techniques which can improve germination, seedling vigour and establishment is seed priming (Khan *et al*., 2005) [7]. Seed priming is a controlled hydration process that involves exposing seeds to low water potentials that restrict germination, but permits pregerminative physiological and biochemical changes to occur (Heydecker and Coolbear, 1977; Bradford, 1986) [1, 3]. Upon rehydration, primed seeds may exhibit faster rate of germination, more uniform emergence, greater tolerance to environmental stresses and reduced dormancy in many species.

Material and methods
A laboratory experiment was conducted in Department of Seed Science and Technology, College of Agriculture, Raichur to know the effect of priming on seed quality of fresh and old seed lots (one year old) of carrot variety UHS 14. The experiment was laid in a factorial completely randomised design with factors *viz.,* seed lots and priming treatments.

There were 14 treatments along with control *viz.,* T_1 - GA_3 (50 ppm), T_2 - GA_3 (100 ppm), T_3 - Tulsi leaf extract (10 %), T_4 - Tulsi leaf extract (15 %), T_5 - Custard apple leaf extract (3 %), T_6 - Cinnamon (10 %), T_7 - Cinnamon (15 %), T_8 - Coconut water (5 %), T_9 - Coconut water (12.5 %), T_{10} - Panchyagavya (3 %), T_{11} - Panchyagavya (5 %), T_{12} - Ethrel (100 ppm), T_{13} - Water, T_{14} – Control. The seeds from both the lots were subjected to priming treatments for 24 hours and then seeds were air dried overnight to their original moisture content. These seeds were used for testing seed quality parameters.

Germination test was conducted using sixteen replicates of 25 seeds each in the petri plates where seeds were placed on top of two layers of blotter papers and incubated in the walk in seed germination room at 25 ± 2°C temperature and 90 ± 5 per cent RH. The number of normal seedlings in each replication was counted at the end of 14th day and the germination percentage was calculated and was expressed in percentage. Five grams of seeds in four replications were soaked in acetone for half a minute and thoroughly washed in distilled water three times. Then, the seeds were soaked in 25 ml distilled water and kept in an incubator maintained at 25°C ± 1°C for 12 h. The seed leachate was collected and the volume was made up to 25 ml by adding distilled water. The electrical conductivity of the seed leachate was measured in the digital conductivity bridge (ELICO) with a cell constant 1.0 and the mean values were expressed in deci simons per meter (dSm^{-1}) (Milosevic *et al*., 2010) [11].

Twenty five representative seeds from each treatment in four replications were taken and preconditioned by soaking in water overnight at room temperature. The half cut seeds were steeped in 0.25 per cent solution of 2, 3, 5-triphenyl tetrazolium chloride and kept in dark for 2 h at 40°C for staining. The stained seeds were thoroughly washed with water and then soaked in 10 ml of 2 methoxy ethanol (methyl cellosolve) and kept overnight for extracting the red colour formazan. The intensity of red colour was measured using ELICO UV-VIS spectrophotometer (model SC-159) using blue filter at 470 nm wave length and methyl cellosolve was used as a blank. The OD value obtained was reported as dehydrogenase activity (Kittock and Law, 1968) [8].

Results and discussion

Seed priming had an influence on both the lots. Fresh seed lot (L_1) recorded significantly higher field emergence (69.80 %), germination (77.00 %), speed of germination (26.54), root length (6.87 cm), shoot length (7.11 cm), seedling dry weight (17.27 mg), seedling vigour index (1257), dehydrogenase enzyme activity (0.555 OD value), alpha amylase activity (23.23 mm) and lower electrical conductivity (0.282 dSm^{-1}) as compared to old seed lot (L_2) (65.18 %, 70.66 %, 20.08, 6.59 cm, 6.60 cm, 13.55 mg, 1089, 65.18 %, 0.337 OD value, 19.50 mm and 0.364 dSm^{-1}, respectively). Decreased quality of old seed lot might be due to low vigour and initial slow growth rate might be due to ageing in old seed lot and this tend to continue during antogenetic development of seedling (Heydecker, 1972) [4]. The progressive reduction in these parameters due to low vigour levels are in accordance with the earlier findings of Schuch and Lin (1982) [18] in wheat, Ravinder (1990) [16] and Krishna (1993) [9] in sunflower. However, the effects of seed priming treatments were more pronounced in old seed lot compared to fresh seed lot.

Among the priming treatments, carrot seeds primed with panchagavya 5 per cent (T_{11}) showed significantly higher field emergence (84.25 %), germination percentage (90.38 %) and speed of germination (31.35) followed by GA_3 at 100 ppm (84.00%, 89.88 % and 31.23, respectively) as compared to control (67.13 %, 81.25 % and 21.11, respectively) but there was no germination in seeds primed with cinnamon at 10 per cent and 15 per cent. The higher field emergence in the priming treatments could be due to attributed to increased vigour of the seeds due to the presence of beneficial bacteria in panchagavya which not only produces plant growth promoting substances but also produce biological deterrent activities (Nagaraj and Sreenivasa 2009) [13]. Presence of such beneficial microbial biomass might have resulted in improving seed quality parameters. The results are in accordance with the findings of Kavitha (2007) [6] in chilli and Kumaravelu and Kadamban (2009) [10] in green gram. However, the seeds primed with cinnamon at 10 and 15 per cent showed no germination. This may be due to the presence of chromium (0.4 mg / g) in cinnamon (Shumaila and Mahpala 2009) [19].

The root length, shoot length and seedling dry weight were significantly higher in seeds primed with GA_3 at 100 ppm (T_2) (8.22 cm, 8.44 cm and 21.25 mg, respectively) followed by panchagavya at 5 per cent (T_{11}) (8.21 cm, 8.42 cm 20.75 mg, respectively) as compared to control (6.94 cm, 7.00 cm and 14.25 mg, respectively) (Table 1). Eisvand *et al*. (2011) [2] demonstrated that hypocotyl growth rate is directly associated with amount of GA_3 in carrot seeds. Similar results were obtained by Jagadish *et al*. (1994) [5] in tomato, capsicum and onion and Muruli (2013) [12] in onion and capsicum. The electrical conductivity of the seeds was significantly lowest in T_{11} (Panchagavya @ 5 %) (0.289 dSm^{-1}) followed by T_2 (GA_3 @ 100 ppm) (0.291 dSm^{-1}) and control recorded highest electrical conductivity (0.384 dSm^{-1}). Significantly highest dehydrogenase and alpha amylase activity were reported in T_{11} (Panchagavya @ 5 %) (0.514 OD value and 27.06 mm, respectively) followed by T_2 (GA_3 @ 100 ppm) (0.512 OD and 26.94 mm, respectively). The probable reason for increased enzymatic activity is due to the presence of essential growth hormones in panchagavya and GA_3 which stimulates the synthesis of enzymes for reserve food mobilization in seeds. However, lowest activity of dehydrogenase enzyme (0.333 OD value) and alpha amylase (12.91 mm) were observed in T_7 (Cinnamon @ 15 %).

The study on interaction between the seed lots and the priming treatments revealed that the combination of fresh seed lot and panchagavya at 5 per cent recorded highest field emergence (87.00 %), seed germination (93.00 %), speed of germination (34.50), seeding vigour index (1584), dehydrogenase enzyme activity (0.617 OD value), alpha amylase activity (29.05 mm) and lowest electrical conductivity (0.254 dSm^{-1}) whereas the combination of fresh seed lot primed with GA_3 at 100 ppm recorded significantly highest root length (8.33 cm) and shoot length (8.72 cm) and seedling dry weight (23.00 mg). However, lowest field emergence (63.75 %), seed germination (74.25 %), speed of germination (17.00), root length (6.94 cm), shoot length (7.00 cm), seedling dry weight (12.25 mg), seeding vigour index (1035), and highest electrical conductivity (0.442 dSm^{-1}) were recorded in control. Whereas, seeds primed with cinnamon at 10 and 15 per cent showed no germination in both the seed lots and they also registered lowest dehydrogenase enzyme and alpha amylase enzyme activity (0.229 OD value and 12.91 mm).

The data obtained here also showed that old seed lot of carrot which were less vigorous were less favoured by priming treatments, whereas fresh seed lot were highly vigorous, had higher enzymatic activities and performed even better with priming treatments which might be due to changes in ribonucleic acids through increased enzymatic activity in primed seeds as reported by Sanjaykumar (1996) [17] and Pushpalatha (2008) [15] in okra.

The results obtained from this experiment clearly suggest that priming treatments improve both physiological and biochemical parameters of carrot seeds. Also, these treatments were more effective on the old seed lots as compared to fresh lots. Among the treatments panchagavya at 5 per cent and GA_3 at 100 ppm are suitable for seed quality enhancement in carrot.

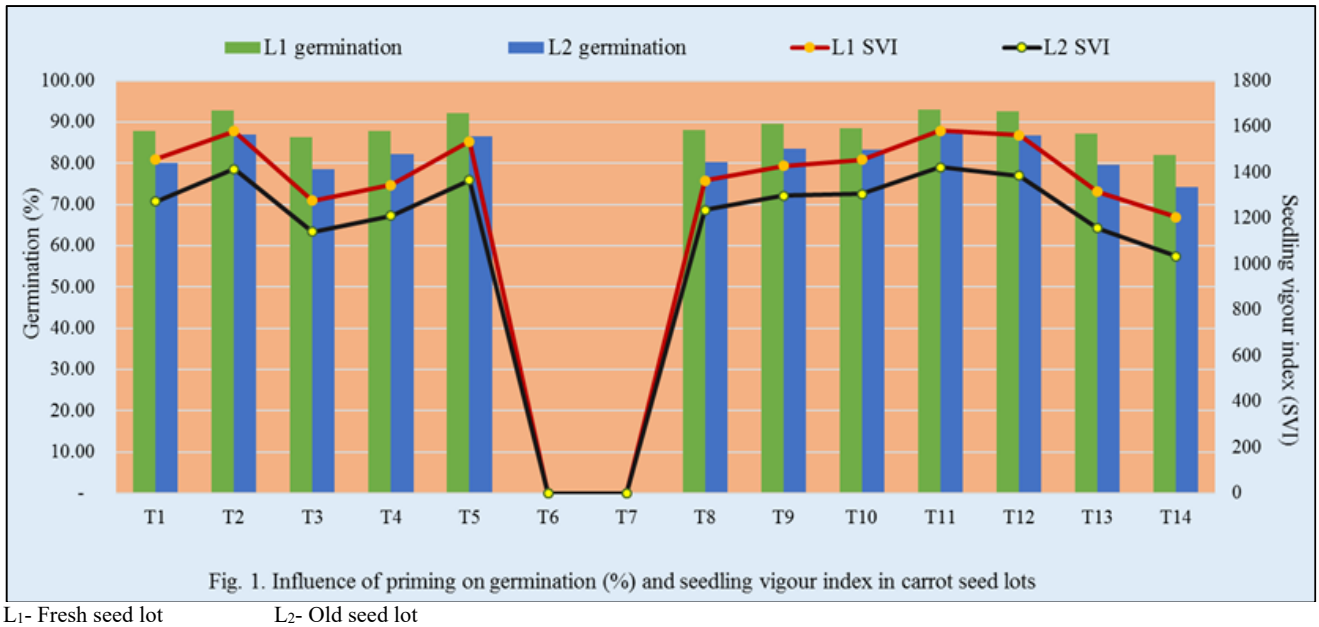

Fig. 1. Influence of priming on germination (%) and seedling vigour index in carrot seed lots

L_1- Fresh seed lot
L_2- Old seed lot
T_1- GA_3 at 50 ppm
T_2- GA_3 at 100 ppm
T_3- Tulsi leaf exract at 10%
T_4- Tulsi leaf extract at 15
T_5- Custard apple leaf extract at 3%
T_6- Cinnamon at 10%
T_7- Cinnamon at 15%
T_8- Coconut water at 5%
T_9- Coconut water at 12.5%
T_{10}- Panchagavya at 3%
T_{11}- Panchagavya at 5%
T_{12}- Ethrel at 100 ppm
T_{13}- Water
T_{14}- Control

Table 1: Influence of seed priming on root length and shoot length in carrot

Treatments	Root length (cm)			Shoot length (cm)		
	L_1	L_2	Mean	L_1	L_2	Mean
T_1	8.14	7.95	8.05	8.48	7.96	8.22
T_2	8.33	8.12	8.22	8.72	8.15	8.44
T_3	7.36	7.31	7.33	7.44	7.24	7.34
T_4	8.10	7.42	7.76	8.35	7.31	7.83
T_5	8.16	7.91	8.04	8.50	7.97	8.24
T_6	0.00	0.00	0.00	0.00	0.00	0.00
T_7	0.00	0.00	0.00	0.00	0.00	0.00
T_8	7.70	7.69	7.70	7.81	7.73	7.77
T_9	7.91	7.77	7.84	8.05	7.80	7.93
T_{10}	8.00	7.83	7.92	8.44	7.86	8.15
T_{11}	8.32	8.10	8.21	8.71	8.12	8.42
T_{12}	8.20	7.98	8.09	8.67	8.00	8.34
T_{13}	8.00	7.28	7.64	8.24	7.24	7.36
T_{14}	7.96	6.94	7.45	8.18	7.00	7.59
Mean	6.87	6.59		7.11	6.60	

Factors	Root length (cm)		Shoot length (cm)	
	S.Em±	CD at 1%	S.Em±	CD at 1%
L	0.003	0.008	0.003	0.009
T	0.007	0.020	0.008	0.021
L × T	0.010	0.028	0.011	0.030

L_1- Fresh seed lot
L_2- Old seed lot
T_1- GA_3 at 50 ppm
T_2- GA_3 at 100 ppm
T_3- Tulsi leaf extract at 10%
T_4- Tulsi leaf extract at 15%
T_5- Custard apple leaf extract at 3%
T_6- Cinnamon at 10%
T_7- Cinnamon at 15%
T_8- Coconut water at 5%
T_9- Coconut water at 12.5%
T_{10}- Panchagavya at 3%
T_{11}- Panchagavya at 5%
T_{12}- Ethrel at 100 ppm
T_{13}- Water
T_{14}- Control

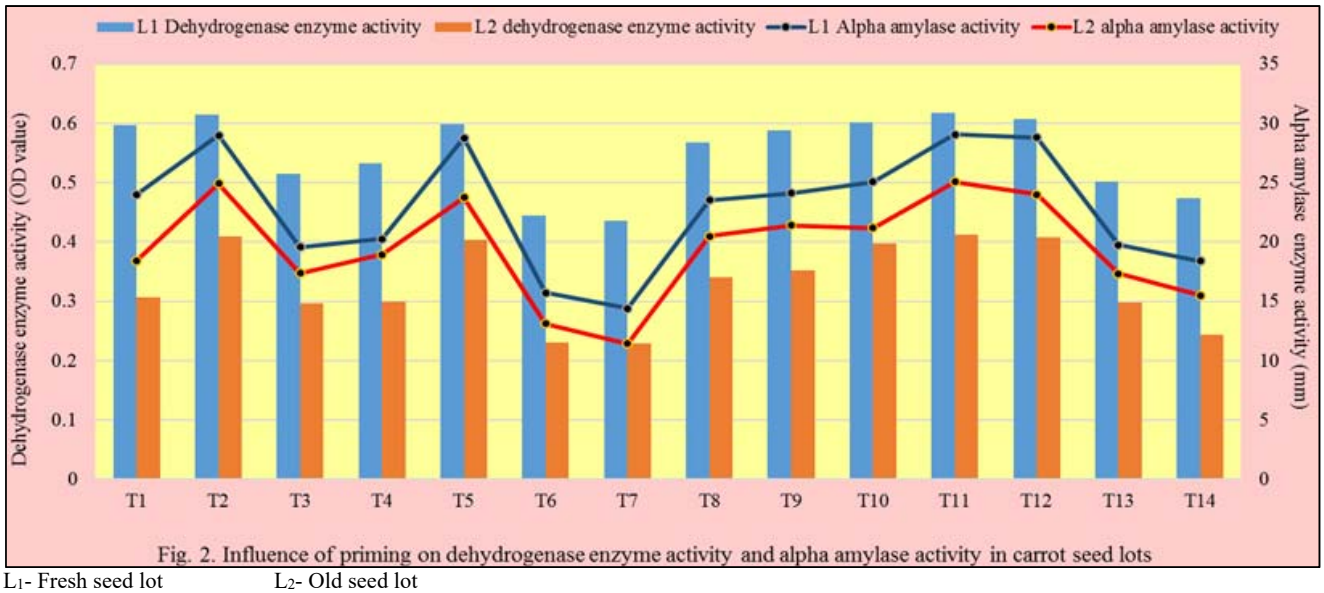

Fig. 2. Influence of priming on dehydrogenase enzyme activity and alpha amylase activity in carrot seed lots

L_1- Fresh seed lot L_2- Old seed lot

T_1- GA_3 at 50 ppm T_5- Custard apple leaf extract at 3% T_9- Coconut water at 12.5% T_{13}- Water

T_2- GA_3 at 100 ppm T_6- Cinnamon at 10% T_{10}- Panchagavya at 3% T_{14}- Control

T_3- Tulsi leaf exract at 10% T_7- Cinnamon at 15% T_{11}- Panchagavya at 5%

T_4- Tulsi leaf extract at 15 T_8- Coconut water at 5% T_{12}- Ethrel at 100 ppm

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