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Short communication

Standardization of priming treatments for enhancement of seed germination and field emergence in carrot

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ABSTRACT

Carrot (*Daucus carota* L.) seeds were subjected to solid matrix priming with moist vermiculite at 15°C and 20°C for 12, 24, 36 and 48 h. Seeds were also osmoprimed at -0.5, -1.0 and -1.5 MPa potential for 2, 4 and 6 days. Solid matrix priming for 24 h registered significantly higher seed germination (85%) and speed of germination (14.45), while priming duration of 48 h gave minimum value for speed of germination. However, no significant differences in speed of germination were found at different temperatures. Solid matrix priming for 24 h at 20°C was optimum for obtaining maximum speed of germination (14.67) and vigour index I (821.5). With increase in priming duration from 2 to 6 days, there was significant decrease in germination. Osmopriming at -1.0 MPa PEG potential significantly improved speed of germination (7.07) and was at par to PEG priming at -0.5 MPa. Osmopriming for 2 days at -1.0 MPa PEG potential recorded maximum speed of germination (9.24) over all other treatment combinations. Osmopriming at -1.0 MPa and solid matrix priming for 24 h at 20°C improved germination and field emergence over control in carrot. Hence, osmopriming and solid matrix priming can be effectively employed for improved field performance in carrot.

Key words: *Daucus carota,* field emergence, germination, osmopriming, solid matrix priming.

Rapid and uniform field emergence is a prerequisite for increased production and productivity in annual crops. Uniformity and percentage of final seedling emergence of direct seeded crops have a major impact on final yield and quality. Rate and uniformity of emergence are inherent to seed quality and environmental conditions during seedling emergence and establishment. The time from sowing to seedling establishment is of considerable importance in crop production and has a major impact on plant growth, final yield and post harvest seed quality. Various presowing treatments have been used to increase the rate and uniformity of emergence in many vegetable and flower species (Parera and Cantliffe, 10). Seed priming allows seed to imbibe moisture using certain protocols, followed by re-drying to permit routine handling. This process controls hydration of seed to a level that allows pre germination activity but does not permit primary root protrusion. Low temperature can inhibit or delay emergence of seedlings and increase exposure to biological and physical stresses Priming can also improve seed vigour especially under adverse conditions such as low/high temperatures, reduced water availability and salinity (Khan, 5; Parera & Cantliffe, 10), In the present study, osmotic and solid matrix priming treatments were standardized for improving germination and emergence of carrot seeds.

Seeds harvested from carrot (*Daucus carota* L. cv. Pusa Rudhira) crop grown at the experimental field of Indian Agricultural Research Institute, Regional Station, Karnal during winter season of 2009- 10 were used for priming experiment. The seeds were hermetically sealed in aluminium foil and stored at room temperature before performing priming treatments. For solid matrix priming 100 g seeds \per treatment were mixed with 200 g vermiculite to which 250 ml of distilled water was added. The vermiculite and seeds were mixed thoroughly and sealed in plastic bags. These were then incubated for 12, 24, 36 and 48h at 15°C and 20°C temperature. After the completion of incubation period of each treatment, seeds were sieved out and dried to the original moisture content. Seeds were osmotically primed on one layer of filter paper wetted with –0.5, -1.0, and -1.5 MPa PEG 6000 solution in 9 cm diameter petri dishes. In this treatment, petri dishes for each treatment were kept under dark in an incubator at 25°C for 2, 4, and 6 days. After the completion of treatment duration, seeds were washed in running water to remove osmoticum and redried to their original moisture content in cold room at 15°C and 30% relative humidity. To maintain constant osmotic potential, the solution was changed every 48 hrs and evaporation of solution was reduced by sealing the petri dishes with parafilm.

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Germination was performed as per ISTA (4) procedures. One hundred seeds per replicate were used. Seeds were incubated in growth cabinets (Sanyo, Japan) maintained at 20°C. Daily germination counts were performed until no further germination occurred for three consecutive days, when percentage and speed of germination were calculated. Seedling vigour indices were calculated following formula suggested by Abdul-Baki and Anderson (1).

Based on the observations recorded on germination, speed of germination and vigour index of primed seeds, two best treatments each in osmopriming and SMP were selected for evaluating field performance *vis-a-vis* control. In all these six treatments were sown in the field following standard package and practices. The experiment was laid in a Randomized Complete Block Design (RCBD) with four replications. Field emergence percentage was estimated on the basis number of seedling emerged after 21 days of sowing (DAS) for each crop. Field emergence index (FEI) was calculated based on the procedure used by Egli and Tekrony (3).

There are various variables affecting the outcome of the priming treatments, regardless of the method used. The temperature at which seed priming is done influence their subsequent germination. The temperature of priming solution can affect the length of priming (Parera and Cantliffe, 10). Solid matrix priming for 24 h significantly improved seed germination (85%) as compared to 12, 36 or 48 h duration (Table 1). With increase in priming duration from 24 to 48 h, there was significant decrease in germination. Among the different priming temperatures tested, higher seed germination of 78.8% was observed at 15°C as compared to 20°C (74%). The interaction effect of priming duration and temperature revealed that solid matrix priming for 24 h at 15°C gave the maximum seed germination (85.3%) over all other treatment combinations. The minimum seed germination of 60% was recorded at a priming duration of 48 h and 20°C temperature. A priming duration of 24 h gave maximum speed of germination (14.45), while priming duration of 48 h gave minimum value for speed of germination (10.21). No significant differences in speed of germination were found among different temperatures. The interaction effect of priming duration and temperature revealed that solid matrix priming for 24 h at 20°C was optimum for obtaining maximum speed of germination (14.67). Pandita *et al.* (8) also reported that solid matrix priming improved germination by 16% at 15°C and 10% at 20° and 25°C in pepper.

Table 1. Effect of solid matrix priming duration and temperature on seed quality parameters of carrot.

Priming duration (h)	Temp. (°C)		Mean	Temp. (°C)		Mean
	15	20		15	20	
	Germination (%)			Speed of germination		
12	79.3	80.0	79.6b	12.05	11.8	11.92c
24	85.3	84.6	85.0a	14.24	14.67	14.45a
36	80.0	71.3	75.6c	12.51	12.50	12.50b
48	70.6	60.0	65.3d	10.27	10.16	10.21d
Mean	78.8A	74.0B		12.27	12.20	
CD (P = 0.05)	Duration	3.56		CD (P = 0.05)	Duration	0.526
	Temperature	2.52			Temperature	NS
	Interaction	5.04			Interaction	0.744
	Vigour index-I				Vigour index-II	
12	723.5	708.7	716.1b	0.976	0.975	0.976b
24	778.2	821.5	799.8a	0.964	1.303	1.133a
36	820.4	778.7	799.6a	1.10	0.968	1.034ab
48	711.5	710.4	711.0b	0.988	0.982	0.985b
Mean	758.4	754.8		1.007	1.057	
CD (P = 0.05)	Duration	23.46		CD (P = 0.05)	Duration	0.124
	Temperature	NS			Temperature	NS
	Interaction	33.18			Interaction	0.176

Means followed by the same letters are not significantly different.
Separation by Duncan's Multiple Range test at 5% level of significance.

SMP significantly improved speed of germination and also reduced leakage of electrolytes in steep water over control. They suggested that solid matrix priming can be effectively employed to prime large amount of hot pepper seed at one time. It is also cost effective as the medium can be re-used many times. The priming improved germination might be due to priming-enhanced repair of membranes (Chiu *et al.*, 2). Among the different priming durations tested, higher vigour index-I (799.8) was noticed at 24 h priming duration when compared to all other priming durations. Increasing priming duration beyond 24 h, significantly reduced vigour index, while minimum values (711) for vigour index were recorded at 48 h priming duration. There were no significant differences in vigour index-I at different temperatures. Maximum vigour index I (821.5) was obtained in solid matrix primed seeds for 24 h duration at 20°C temperature. Minimum values for vigour index I were recorded in 12 h duration and 20°C treatment. Among the different priming durations tested higher vigour index-II (1.133) was observed in case of 24 h priming duration as compared to other priming durations.

Osmotic priming has shown to promote increase in the rate and uniformity of germination in several crops (Pandita and Nagarajan, 7; Nagarajan *et al.*, 6). Osmopriming using -1.5 MPa PEG 6000 significantly improved seed germination (79.7%) as compared to other PEG potentials (Table 2). Seed germination improved significantly with the increase of PEG potential from -0.5 to -1.5 MPa. Osmopriming for 2 days significantly improved seed germination to 82.2%. However, a significant decrease in germination was observed with the increase in priming duration from 2 to 6 days.. Osmopriming at -1.0 MPa PEG potential significantly improved speed of germination (7.07) and was at par to PEG priming at -0.5 MPa. Osmopriming for 2 days significantly improved speed of germination (8.85) compared to other durations. Osmopriming at -1.0 MPa PEG potential also significantly improved vigour index-I (830.8) as compared to other PEG potentials. With increase in priming duration from 2 days to 6 days, there was significant reduction in vigour index-I. The interaction effects suggest that osmopriming onion seed at -1.0 MPa PEG 6000 for 2 days siginificantly improved seedling vigour index-I. Osmopriming for 2 days at -0.5 MPa PEG potential gave maximum vigour index-II (1.168) over all other treatment combinations. The minimum vigour index-II (0.972) was recorded with osmopriming pf seeds for 6 days at -1.5 MPa PEG potential.

Based on the above observations two best treatments each in osmopriming and SMP were further selected for field performance evaluation *vis-a-vis* control. Osmopriming at -1.0 MPa for 2 days gave maximum standard seed germination (86.0%) over other priming treatments, while minimum

Table 2. Effect of osmopriming potential and duration on seed quality parameters of carrot.

Priming potential (MPa)	Duration (days)			Mean	Duration (days)			Mean
	2	4	6		2	4	6	
	Germination (%)				Speed of germination			
-0.5	80.0	65.3	50.0	65.1c	8.55	8.48	8.38	8.67b
-1.0	84.0	72.0	63.3	73.1b	9.24	8.72	9.07	9.71a
-1.5	82.6	82.0	74.6	79.7a	8.75	8.11	8.58	8.48b
Mean	82.2A	73.1B	62.6C		8.85A	8.44B	8.67AB	
CD (P = 0.05)		Potential	2.40		CD (P = 0.05)		Potential	0.363
		Duration	2.40				Duration	0.363
		Interaction	4.16				Interaction	0.629
	Vigour index-I				Vigour index-II			
-0.5	836.9	806.2	771.7	804.9b	1.168	1.011	1.057	1.079
-1.0	867.6	812.15	812.8	830.8a	1.166	1.007	1.059	1.077
-1.5	811.6	806.58	800.0	806.0b	1.056	0.972	1.032	1.020
Mean	838.7A	808.3B	794.8B		1.130	0.996	1.049	
CD (P = 0.05)		Potential	23.94		CD (P = 0.05)		Potential	NS
		Duration	23.94				Duration	NS
		Interaction	41.47				Interaction	0.162

Means followed by the same letters are not significantly different.
Separation by Duncan's Multiple Range test at 5% level of significance.

Table 3. Effect of various priming treatments on germination and emergence in carrot.

Treatment	Germination (%)	Field emergence (%)	Field emergence index
Solid matrix priming at 15°C for 24 h	79.5c	60.2b	75.8ab
Solid matrix priming at 20°C for 24 h	82.5b	63.2a	76.6a
Osmopriming-1.0 MPa for 2 days	86.0a	63.0a	73.2ab
Osmopriming-1.5 MPa for 4 days	82.5b	60.0b	72.7b
Hydropriming Water soaking 24 h	72.2d	53.5c	74.0ab
Dry control	68.2e	51.0c	74.7ab
CD (P = 0.05)	2.22	2.57	3.51

Means followed by the same letters are not significantly different.
Separation by Duncan's Multiple Range test at 5% level of significance.

germination (68.2%) was recorded in dry control (Table 3). It is well established that both laboratory and field performance were generally improved by seed enhancement over untreated seeds in soybean. Solid matrix priming at 20°C for 24 h gave maximum field emergence percentage (63.2%) and was at par with osmopriming at -1.0 MPa PEG 6000 for 2 days. Unprimed seed had minimum field emergence percentage (51). Maximum field emergence index (76.6) was recorded in solid matrix primed seed for 24h at 20°C while osmopriming at -1.5 MPa PEG 6000 for 4 days showed minimum field emergence index (72.7). Pandita *et al.* (9) also indicated that solid matrix priming alone or in combination with *Trichoderma viride* can be used to improve field emergence and marketable pod yield in okra grown under sub-optimal temperatures. These results suggest that solid matrix priming at 20°C for 24 h and osmopriming (-1.0 MPa PEG 6000 for 2 days) can be effectively used for the improvement of germination and field emergence in carrot seeds.

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