Biological Forum – An International Journal **15(8): 42-46(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Seed Enhancement Treatments for Improved Performance in Chilli (*Capsicum annuum* L.)

Jayasri Sundarraj[1], Sudipta Basu[1*], Sandeep Kumar Lal[1], Anjali Anand[2] and Mohammed Athar[1]
[1]Division of Seed Science and Technology,
ICAR-Indian Agricultural Research Institute, New Delhi-110012, India.
[2]Division of Plant Physiology,
ICAR-Indian Agricultural Research Institute, New Delhi-110012, India.

(Corresponding author: Sudipta Basu)*
(Received: 22 May 2023; Revised: 28 June 2023; Accepted: 17 July 2023; Published: 15 August 2023)
(Published by Research Trend)

ABSTRACT: Rapid seed germination and early emergence are vital for high value vegetable crops like chilli. Pre sowing seed enhancement treatments improve field emergence, speed, early seedling growth and yield especially for various vigour lots under normal and adverse conditions. This study aimed to determine the optimal enhancement protocol for improving the performance of chilli seeds under field conditions. Chilli variety; Arka Lohit was given various seed enhancement treatments with different duration and concentration namely; hydro (24, 48 hr), halo (24, 36, 48 hr), osmo (36, 48 hr), matrix (24, 48 hr) and magneto (50, 100, 150mT) priming and assessed for seed quality. The results showed that hydropriming for 24 hr, halopriming with NaCl @ 2% for 24 hr, osmopriming with PEG 6000 @-1.5 MPa for 36 hr, solid matrix priming with vermiculite for 24 hr and magneto priming @ 50mT for 30 min were found best among the screened treatment combinations for increasing seed germination and vigour of chilli seeds. Subsequently, the optimized seed enhancement treatments were validated under suboptimum and optimum conditions for field emergence. The field emergence was low under suboptimum conditions, wherein maximum emergence was observed with magneto (48%) and solid matrix priming (43%), while under optimum conditions; solid matrix priming (56%) showed highest improvement over control in field emergence. Seed enhancement treatments had beneficial effect on achieving early and uniform emergence, as well as enhancing germination and seedling vigour in chilli seeds.

Keywords: Seed priming, temperature, solid matrix priming, magneto priming, germination, vigour index

INTRODUCTION

Chilli (*Capsicum annuum* L.,) is an important spice crop of India. India is the largest producer, consumer and exporter of chilli, accounting for approximately 40% of total global production. The cultivation of chilli in India spans across an area of 702.05 thousand ha with annual production and productivity of 2049.21 thousand MT and 2.92 MT / ha respectively (India Stat, 2020-2021). Chilli cultivation requires a moist and warm climate, with an optimum temperature ranging from 20-25°C for achieving high seed germination, stand establishment, yield and quality. However, challenges such as insufficient moisture, low temperature and pre-emergence damping off often lead to slow and uneven germination and emergence under field conditions (Yadav *et al*., 2011).

Seed quality enhancements are the post-harvest beneficial treatments aimed at improving synchronous germination and overall growth of seedlings, especially under stressful conditions. The efficacy of enhancement treatments relies on the extent of stress experienced (Taylor *et al*., 1998). Various approaches including primitive methods like hydration or invasive treatment includes hydropriming i.e. soaking in water (Debbarma *et al*., 2018), halopriming i.e. soaking in salt solution (Dutta *et al*., 2015), osmopriming i.e. soaking in an osmoticum (Rahman *et al*., 2016) and solid matrix priming (SMP) i.e. invigouration using solid carriers (Pandita *et al*., 2007) are used to manipulate seed vigour or physiological status. Invasive treatments ensure controlled hydration of seed for a predetermined duration and temperature in a solution with low water potential, followed by dehydration to the original moisture content. On the other hand, non invasive approaches, such as magneto priming (exposing seeds to magnetic field), have shown positive effects on germination percentage, germination rate and seedling vigour in many vegetable crops (Vashisth and Nagarajan 2010; Ahamed *et al*., 2013; Vaidya *et al*., 2017; Anand *et al*., 2019; Konefal-Janocha *et al*., 2019). Several studies have reported seed enhancement treatments for improvement of rate and uniformity of germination and growth thereby reducing the emergence time in horticultural crops (Maiti and Pramik 2013; Thakur *et al*., 2019; Thakur *et al*., 2022).

The present study was undertaken for standardization of seed enhancement treatments in seeds based on

germination, vigour and its validation under field conditions.

MATERIALS AND METHODS

Seeds of chilli variety; Arka Lohit procured from ICAR-Indian Institute of Horticultural Research, Bangaluru was used for the study. The initial germination and moisture content was 64% and 6.4% respectively. Various seed enhancement treatments along with their detailed information regarding concentration and duration are given in Table 1. The untreated seeds were used as control. Seeds after invasive treatments like hydro, halo and osmopriming were thoroughly rinsed while, in solid matrix priming, the seeds were separated from matrix, rinsed. The treated seeds were dried for 48 hr at room temperature. In magneto priming, the seeds were exposed to magnetic field of different field strength for 30 min in a static magnetic field generator namely "Resonance - 2K".

Table 1: Seed enhancement treatments given to chilli seeds.

Method	Treatment substrate	Duration (hr)	Concentration	Reference and crop
Control	Unprimed seeds	-	-	-
Hydropriming	Distilled water	24 36 48	-	Debbarma *et al*. (2018) (Chilli and Coriander)
Halopriming	Potassium nitrate (KNO_3) Sodium Chloride (NaCl)	24 36 48	1% 2%	Dutta *et al*. (2015) (Tomato)
Osmopriming	Polyethylene glycol (PEG 6000) Mannitol	36 48	- 1.0 MPa - 1.5 MPa	Rahman *et al*. (2016) (Okra)
Solid matrix priming	Vermiculite Perlite	24 48	1:2:4 (Seed:SM:Water)	Pandita *et al*. (2010) (Chilli)
Magneto priming	Magnetic field	30 min	50mT 100mT 150mT	Vaidya *et al*. (2017) (Okra and Chilli)

Standard germination and vigour indices. Four replications of twenty five seeds were placed on top of moist paper and placed in the walk in germinator maintained at 25°C. First and final count was taken on 7 and 14 days respectively. Germination percentage was worked out on the basis of normal seedling counted on final day. Ten normal seedlings from each replicate were randomly selected and dried for 17 hr at 80°C. The seedlings were weighed for calculating the dry weight. The vigour index was calculated using the formula as suggested by Abdul-Baki and Anderson 1973.

Vigour index II = Germination % × Seedling dry weight (mg)

Field emergence studies. The field emergence studies were conducted with the standardized seed enhancement treatments i.e. hydropriming (24 hr), halopriming (2% $NaCl_2$ for 24 hr), osmopriming (1.5 MPa PEG 6000 for 36 hr), solid matrix priming (Vermiculite for 24 hr) and magneto priming (50mT for 30 min). The treated seeds were sown in rows (600 seeds: 50 in each row; 2 row each treatment) under optimum (15 March 2020) and suboptimum (10 Nov 2021) conditions. During sowing under suboptimum and optimum conditions the temperature varied between 4.8 to 13.3°C (Min temperature) and 16.1 to 28.5 °C (Max temperature) and 9.5 to 18.5 °C (Min temperature) and 21.0 to 31.8 °C (Max temperature) respectively.

Number of seedlings emerged in two rows of each replication were counted in daily intervals until seedling establishment became stable and the emergence was expressed in percentage

Field emergence percentage =

$$\frac{\text{Number of seedlings in two rows}}{\text{Total number of seeds sown}} \times 100$$

Statistical Analysis. The experiment data was laid in a completely and randomized block design respectively for lab and field emergence studies were statistically analysed using SPSS software (version 21.0). The data recorded as percentage were transformed to the respective angular (arcsine) values before subjecting them to statistical analysis.

RESULTS AND DISCUSSION

Different durations of hydropriming were found to enhance seed germination and vigour in chill seeds, the highest germination percentage (60%) and vigour index (2.05) was achieved with 24 hr hydropriming. However, imbibitions for longer duration of 48 hr resulted in decrease in seed germination percentage (53%) and seed vigour index (1.71) (Table 2).

The optimum duration of hydropriming varies among crops and significantly influences germination properties. Prolonged hydropriming beyond 48 hr leads to excessive water accumulation, surpassing the quantity necessary for the initiation of the lag phase, leading to premature radicle protrusion and loss of dessication tolerance in seeds. Therefore, hydropriming for 24 hr was found optimum for achieving early, uniform emergence along with improved germination percentage and seedling vigour in chilli seeds,

consistent with previous report by Yadav *et al*. (2011); Uche *et al*. (2016); Adinde *et al*. (2016). The presence of an adequate amount of water during hydropriming for 24 hr has been attributed to its positive effect on the completion of pre-germinative process and entry into lag phase (Varier *et al*., 2010; Rahman *et al*., 2016).

Table 2: Effect of hydropriming on germination and vigour of chilli seed.

Duration (hr)	Germination (%)	Vigour index II
Control	51 (46)	1.604
24	60 (51)	2.048
36	54 (47)	1.777
48	53 (47)	1.712
Mean	54 (47)	1.785
CD (0.05)	6.36	0.30

Halopriming treatments, exhibited improved germination by 26 and 35% with 2% KNO_3 for 24 hr and 2% NaCl for 24 hr, respectively (Table 3). The vigour index II (2.25) showed improvement of 8% by NaCl treatment for 24 hr. The halopriming with 2% NaCl for 24 hr was found best for chilli seeds (Table 3). Enhancement of seeds primed with NaCl was also observed in solanaceous vegetables of tomato, brinjal and chilli (Aloui *et al*., 2014).

Osmopriming with PEG 6000 -1.5 MPa and -1 MPa for 36 hr, improved germination by 41 and 39% over unprimed seeds. While, vigour index II was improved by 43% when treated with PEG 6000 -1.5 MPa for 36 hr compared to control seeds (1.60) (Table 4). Osmo conditioning at higher concentration (- 1.5 MPa PEG 6000) for a shorter duration slowed uptake of water, as low water potential aids in completing metabolic repair or stimulating enzymes for enhanced seed germination and vigour. Debbarma *et al*. (2018) reported osmopriming with PEG improved germination and vigour parameters chilli and coriander has been shown in chilli and coriander. Improvement in germination and vigour parameters when exposed to PEG priming was also observed by Madhusudhanreddy *et al*. (2021).

Solid matrix priming has shown enhancement in seed germination and vigour indices in seeds with varying levels of vigour (Pandita *et al*., 2007). Among the seed matrix priming (SMP); the combination of seed, matrix and water was optimum in the ratio of (1:2:4) for both vermiculite and perlite. SMP with vermiculite for 24 hr recorded highest germination percentage (70%) and vigour index (2.28) followed by SMP with perlite for 24 hr achieved 68% germination, 2.20 vigour index (Table 5).

Table 3: Effect of halopriming on germination and vigour of chilli seed.

Salts	Concentration (%)	Germination percentage					Vigour index II				
		Control	24 hr	36 hr	48 hr	Mean	Control	24 hr	36 hr	48 hr	Mean
KNO_3	1	51(46)	65(54)	64(53)	56(48)	59(50)	1.60	2.09	2.17	1.90	1.94
	2	51(46)	64(53)	63(53)	63(53)	60(51)	1.60	2.20	2.20	2.17	2.04
NaCl	1	51(46)	53(47)	55(48)	52(46)	53(47)	1.60	1.86	1.91	1.74	1.78
	2	51(46)	69(56)	61(51)	65(54)	62(52)	1.60	2.25	2.09	2.17	2.03
CD (0.05)	Mean	51(46)	63(53)	61(51)	59(50)	58(50)	1.60	2.10	2.09	1.99	1.95
	Salts (A)	2.10					0.10				
	Concentration (B)	1.72					0.08				
	Duration (C)	NS					0.10				
	A × B	2.98					NS				
	A × C	NS					NS				
	B × C	NS					NS				
	A × B × C	NS					NS				

Table 4: Effect of osmopriming on germination and vigour of chilli seed.

Osmotica	Osmotic potentials (MPa)	Germination percentage				Vigour Index II			
		Control	36 hr	48 hr	Mean	Control	36 hr	48 hr	Mean
PEG	-1	51 (46)	71 (57)	64 (53)	62 (52)	1.60	2.19	2.10	1.96
	-1.5	51 (46)	72 (58)	61 (51)	61 (52)	1.60	2.29	2.05	1.95
Mannitol	-1	51 (46)	57 (49)	60 (51)	56 (48)	1.60	1.86	1.77	1.75
	-1.5	51 (46)	61 (51)	63 (53)	58 (50)	1.60	2.19	2.06	1.99
CD (0.05)	Mean	51 (46)	65 (54)	62 (52)	59 (50)	1.60	2.13	1.99	1.91
	Osmotica (A)	2.43				0.15			
	Concentration (B)	NS				NS			
	Duration (C)	1.98				NS			
	A × B	NS				0.21			
	A × C	3.44				NS			
	B × C	NS				NS			
	A × B × C	NS				NS			

The enhancement observed in low vigour chilli seeds after 24 hr may be due to slow hydration, which improved aeration and facilitated the repair of deteriorated parts in primed seeds. Pandita *et al*. (2007) demonstrated the successful utilization of matric conditioning using vermiculite for 24h enhance germination in pepper seeds. The response of seeds to magneto priming depends upon the intensity of magnetic field, exposure time, signal form, flux density and source frequencies (Sarraf *et al*., 2020; Thakur *et al*., 2022). The free movement of ions activates the metabolic pathways by enhancing the biochemical and physiological, morphostructural aspects in seeds (Zia ul Haq *et al*., 2012). Among the different combination of field strength, maximum germination percentage and vigour index was recorded with 50mT for 30min (69, 2.24) followed by field strength of 100mT for 30 min (63, 2.10) respectively (Table 6).

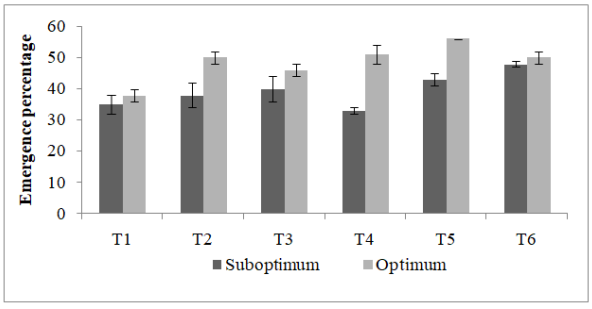
Table 5: Effect of solid matrix priming on germination and vigour of chilli seed.

Substrate	Duration (hr)	Germination (%)	Vigour index II
Vermiculite (Seed:SM:Water) (1:2:4)	Control	51 (46)	1.60
	24	70 (57)	2.28
	36	66 (54)	2.16
	48	63 (53)	2.01
Perlite (Seed:SM:Water) (1:2:4)	24	68 (56)	2.20
	36	65 (54)	2.08
	48	60 (51)	1.73
	Mean	63 (47)	2.01
CD (0.05)	Salts (S)	2.44	0.16
	Duration (D)	2.44	0.16
	S × D	NS	NS

Seed enhancement treatment showed improved performance under optimum conditions, meanwhile enhanced and rapid emergence were also observed under suboptimum conditions in chilli. Low emergence was curtailed in suboptimum conditions, yet highest emergence percentage was achieved with magneto priming (48%) followed by solid matrix priming (43%) where unprimed control showed 35% emergence, whereas, enhanced seeds showed early emergence observed in solid matrix priming (56%) followed by osmopriming (51%) under optimum conditions (Fig. 1).

Table 6: Effect of magneto priming on germination and vigour of chilli seed.

Field strength (mT)	Germination (%)	Vigour index II
Control	51 (46)	1.60
50	69 (56)	2.24
100	63 (53)	2.10
150	64 (53)	1.98
Mean	62 (52)	1.98
CD (0.05)	5.14	0.20



[T1- Unprimed; T2- Hydropriming (24 hr); T3- Halopriming (NaCl 2%, 24 hr); T4-Osmopriming (PEG -1.5 Mpa,36 hr); T5-Solid Matrix Priming (Vermiculite, 24 hr); T6-Magneto priming (50mT, 30 min)]

Fig. 1. Emergence percentage in chilli seeds with seed enhancement treatments under suboptimum and optimum conditions.

CONCLUSIONS

Seed enhancement treatments had beneficial effect on achieving early and uniform emergence, and enhancing germination and seedling vigour in chilli seeds. Among the various enhancement treatments evaluated, hydropriming for 24 hr, halopriming with 2% NaCl for 24 hr, osmopriming with -1.5 Mpa PEG 6000 for 36 hr, solid matrix priming with vermiculite for 24 hr and magneto priming at 50mT for 30min were found significant for enhancing germination and vigour in chilli seeds. Specifically, solid matrix priming and magneto priming had significant effect on field emergence both under suboptimum and optimum conditions.

FUTURE SCOPE

Seed enhancement treatments are known to improve seed germination, emergence, early seedling growth and plant growth especially under stress conditions. Various enhancement treatments effectively alleviates suboptimum temperature during sowing and transplanting of chilli taken under off season, providing sufficient isolation and reducing the incidence of diseases, which facilitates quality seed production.

Acknowledgements. The author acknowledges the financial assistance provided as Senior Research Fellowship by ICAR-IARI, New Delhi during the doctoral programme. The author wishes to thank ICAR-Indian Agricultural Research Institute, New Delhi (India) for pro viding the required necessary facilities to conduct the studies.

Conflict of Interest. None.

REFERENCES

Abdul-Baki, A. A. and Anderson, J. D. (1973). Vigour determination in soybean seed by multiple criteria 1. *Crop science*, *13*(6), 630-633.

Adinde, J., Omeje, T. E., Uche, O. J., and Agu, C. J. (2016). Impact of hydropriming duration on seed germination

and emergence indices of sweet basil. *Journal of Agricultural Science and Practice*, *5*, 1-7.

Ahamed, M., Elzaawely, A. and Bayoumi, Y. (2013). Effect of magnetic field on seed germination, growth and yield of sweet pepper (*Capsicum annuum* L.). *Asian Journal of Crop Science*, *5*, 286–294.

Aloui, H., Souguir, M., and Hannachi, C. (2014). Determination of an optimal priming duration and concentration protocol for pepper seeds (*Capsicum annuum* L.). *Acta Agriculturae Slovenica*, *103*(2), 213-221.

Anand, A., Kumari, A., Thakur, M., and Koul, A. (2019). Hydrogen peroxide signaling integrates with phytohormones during the germination of magnetoprimed tomato seeds. *Scientific reports*, *9*(1), 8814.

Debbarma, A., Devi, J., Barua, M. and Sarma, D. (2018). Germination performance of chilli (*Capsicum annuum* L.) and coriander (*Coriandrum sativum* L.) as affected by seed priming treatments. *Journal of Pharmacognosy and Phytochemistry*, *7*(1), 2648-2652.

Dutta, S. K., Singh, A. R., Boopathi, T., Singh, S. B. and Singh, M. C. (2015). Effects of priming on germination and seedling vigour of bird's eye chilli (*Capsicum frutescens* L.) seeds collected from eastern Himalayan region of India. *The Bioscan*, *10*(1 Supplement), 279-284.

Konefal-Janocha, M., Banas-Zsbczyk, A., Bester, M., Bocak, D., Budzik, S., Górny, S., Larsen, S., Majchrowski, K. and Cholewa, M. (2018). The effect of stationary and variable electromagnetic fields on the germination and early growth of radish (*Raphanus sativus*). *Polish Journal of Environmental Studies*, *28*(2), 709-715.

Madhusudhanreddy, K., Kumar, R., Kumar, Arun and Bhardwaj, A. (2021). Standardization of seed priming techniques in bitter gourd (*Momordica charantia* L.). *Biological Forum–An International Journal (Research Trend)*, *13*(3a), 279-284.

Maiti, R. and Pramanik, K. (2013). Vegetable seed priming: a low cost, simple and powerful techniques for farmers' livelihood. *International Journal of Bio-resource and Stress Management*, *4*(4), 475-481.

Pandita, V. K., Anand, A. and Nagarajan, S. (2007). Enhancement of seed germination in hot pepper following presowing treatments. *Seed Science and Technology*, *35*(2), 282-290.

Pandita, V. K., Anand, A., Nagarajan, S., Seth, R. and Sinha, S. N. (2010). Solid matrix priming improves seed emergence and crop performance in okra. *Seed Science and Technology*, *38*(3), 665-674.

Rahman, M. Z. (2016). Effect of priming on growth, yield and seed quality of okra (*Abelmoschus esculentus* L.) varieties (Doctoral dissertation, institute of seed technology, Sher-E-Bangla Agriculture University Dhaka 1207).

Sarraf, M., Kataria, S., Taimourya, H., Santos, L. O., Menegatti, R. D., Jain, M., Ihtisham, M. and Liu, S. (2020). Magnetic field (MF) applications in plants: An overview. *Plants*, *9*(9), 1139.

Thakur, M., Sharma, P. and Anand, A. (2019). Seed priming-induced early vigor in crops: an alternate strategy for abiotic stress tolerance. In: Hasanuzzaman, M., Fotopoulos, V. (Eds.), Priming and Pretreatment of Seeds and Seedlings. Springer, Singapore. Thakur, M., Sharma, P., Anand, A., Pandita, V.K., Bhatia, A., Pushkar, S., 2020. Raffinose.

Thakur, M., Tiwari, S., Kataria, S. and Anand, A. (2022). Recent advances in seed priming strategies for enhancing planting value of vegetable seeds. *Scientia Horticulturae*, *305*, 111355.

Taylor, A. G., Allen, P. S., Bennett, M. A., Bradford, K. J., Burris, J. S., and Misra, M. K. (1998). Seed enhancements. *Seed science research*, *8*(2), 245-256.

Uche, O. J., Adinde, J. O., Omije, T. E., Ager, C. J., and Anieke, U. J. (2016). Influence of Hydropriming on germination and seedling emergence of green bell pepper (Capsicum annuum cv. Goliath). *International journal of science and nature*, *7*(1), 70-75.

Vaidya, R., Dipak, B. and Patel, K. R. (2017). Study of pre-sowing magnetic treatment on the germination, growth and yield of okra (*Abelmoschus esculentus*) and chilli (*Capsicum annum* L.) Seeds. *Indian Journal of Applied Research*, *7*(12), 1-3.

Varier, A., Vari, A. K. and Dadlani, M. (2010). The subcellular basis of seed priming. *Current Science*, 450-456.

Vashisth, A. and Nagarajan, S. (2010). Effect on germination and early growth characteristics in sunflower (*Helianthus annuus*) seeds exposed to static magnetic field. *Journal of plant physiology*, *167*(2), 149-156.

Yadav, P. V., Maya, K. and Zakwan, A. (2011). Seed priming mediated germination improvement and tolerance to subsequent exposure to cold and salt stress in capsicum. *Research Journal of Seed Science*, *4*(3), 125-136.

Zia-ul-Haq, Jamil, Y., Irum, S., Randhawa, M. A., Iqbal, M. and Amin, N. (2012). Enhancement in the germination, seedling growth and yield of radish (*Raphanus sativus*) using seed pre-sowing magnetic field treatment. *Polish Journal Environmental Studies* (In press).

How to cite this article: Jayasri Sundarraj, Sudipta Basu, Sandeep Kumar Lal, Anjali Anand and Mohammed Athar (2023). Seed Enhancement Treatments for Improved Performance in Chilli (*Capsicum annuum* L.). *Biological Forum – An International Journal*, *15*(8): 42-46.