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Short Research Article

Seed Priming and its Consequences on Seedling Vigour of Bell Pepper (*Capsicum annuum* L.) under Low Temperature Condition

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Abstract

Capsicum (*Capsicum annuum* L.) is an important vegetable crop grown worldwide. In Himachal Pradesh, the seeds of capsicum are generally sown during January-February for raising an off-season crop. The sub-optimal temperature results in slow and poor germination, sometimes causing decay of seeds. The problem of poor or slow germination can be solved through many techniques and one of them is priming. Seed priming is known to endow plants with greater tolerance to subsequent stress exposure of the same or different kind. During priming, the seeds are partially hydrated in such a way that pre-germination metabolic activities start, however, radicle protrusion is prevented followed by drying of seeds to the original moisture content. In the present studies, the effect of seed priming using different priming agents like PEG-6000, Gibberellic acid, KH_2PO_4, Na_2HPO_4, distilled water and cow urine was studied to see its effect on seedling vigour of bell pepper seeds. Seeds were primed at 20 °C for 24 and 48 hours to evaluate the effect on germination and seedling vigour. Results revealed that all priming treatments significantly improved seed performance over control. Seeds primed with GA_3 at 100 ppm for 48 h excelled over all other treatments as this treatment decreased time taken to 50% germination, increased root and shoot length, seedling fresh weight and seedling vigour over all other priming treatments. In addition, the growth performance of the plants obtained from primed seeds was better than control, suggesting chemical seed priming as an eco-friendly approach for enhancing seed germination under low temperature conditions.

1. Introduction

Capsicum also known as bell pepper or Sweet pepper is an important vegetable crop grown worldwide. Capsicum grows better in warm climate and can be cultivated round the year in frost free conditions. Seed is one of the basic agricultural inputs used for obtaining higher yields. Without good quality seed, all other inputs like fertilizers, water, pesticides etc. will not pay the desired dividends. In mid-hills of Himachal Pradesh, bell pepper is generally sown in the nursery during January-February and seedlings are transplanted in March-April. During this period, low temperature prevails in the entire North Western Himalayan region which leads to poor seed germination and seedling growth. Also, seeds of this crop are very difficult to germinate under sub optimal conditions and harbour a huge load of fungi and bacteria, resulting in seed deterioration and poor plant stand (Dutta et al., 2015). The farmers of the state earn lucrative returns since it cannot be grown in the plains during summers due to high temperature. The produce of Himachal Pradesh thus become off-season to the plains and farmers fetch higher prices from off-season vegetables (Joshi and Shukla, 1997). The rate of germination and emergence is markedly reduced at a temperature ranging from 15-20 °C. Various seed treatments have been suggested to improve seed germination and one of them is priming. Seed Priming is a pre-sowing seed treatment in which seeds are exposed to an external water potential that is low enough to restrict germination by various means (i.e., polyethylene glycol, inorganic salts, matrix material, hydration etc.) and yet permits pre-germinative physiological and biochemical activities (Taylor et al., 1998). Priming enables the seed to germinate and emerge faster even at sub-optimal temperatures and also known to reduce the imbibitional damage associated with planting seeds in cold soils (Bennett and Walter, 1987).

Osmopriming is the most commonly used method of seed priming worldwide. Seeds are soaked in priming solutions at a concentration diluted enough to permit seeds to imbibe and initiate pre-germination metabolism, but concentrated enough to prevent emergence of the radicles. The beneficial effects of priming are associated with the repair and building up of nucleic acid, increased synthesis of proteins as well as the repair of both mitochondria and membranes (McDonald, 1999 and McDonald, 2000). It was noticed by Yogananda et al. (2004) that bell pepper seeds invigorated with GA_3 (200ppm) or KNO_3 (1.0%) recorded higher germination, root and shoot length, seeding dry weight, rate of germination and seedling vigour index over control. In Capsicum, Pandita et al. (2009) observed that Osmo and solid matrix priming improves seed germination over non primed seeds at 15 °C, 20 °C and 25 °C temperatures. Priming also reduced mean days to germination (MDG) significantly over control. Yadav et al. (2011) also noticed that germination percentage of primed seeds was increased to as high as 97.5% compared to control (85%) and also tolerated cold and salt stress for 10 days with 100% survival whereas control seedling could not survive. Maiti et al. (2013) found that seed priming techniques improve the seedling vigour, growth and yield especially halopriming increased the speed of emergence, seedling vigour index and root and shoot length as compared to hydropriming in chilli and tomato. Therefore, the present study was undertaken to compare various primers to see their effect on the rate of bell pepper seed germination at low temperature.

2. Materials and Methods

The present investigation entitled "Seed priming and its consequences on seedling vigour of bell pepper (*Capsicum annuum* L.) under low temperature conditions" was carried out in the Department of Vegetable Science, Dr Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, HP during 2013-2014.

2.1. Priming treatment

The seeds of bell pepper were primed using eleven treatments comprising of osmo-priming (PEG 6000 -0.5 MPa for 24 h, PEG 6000 -0.5MPa for 48h (T_1); PEG 6000 -1.0 MPa for 24 h PEG 6000-1.0MPa for 48h (T_2); priming with growth regulator ($GA_3$100 ppm for 24 h, GA_3 100 ppm for 48 h (T_3); GA_3 200 ppm for 24 h and GA_3 200 ppm for 48 h (T_4); halo priming KH_2PO_4 10^{-1}M for 24 h, KH_2PO_4 10^{-1} M for 48 h (T_5); KH_2PO_4 10^{-3} M for 24 h, KH_2PO_4 10^{-3} M for 48 h (T_6); Na_2HPO_4 10^{-1} M for 24 h, Na_2HPO_4 10^{-1} M for 48 h (T_7); Na_2HPO_4 10^{-3} M for 24 h, Na_2HPO_4 10^{-3} M for 48 h (T_8); priming with cow urine (CU 0.5% for 24h, CU 0.5% for 48 h (T_9); CU 1.0% for 24 h, CU 1.0% for 48 h (T_{10}); hydro-priming (Distilled water for 24 h, Distilled water for 48 h (T_{11}); and a control (Untreated, T_{12}). Seeds were primed with different primers at 20 °C for different durations. The treated seeds were washed and were dried in the shade for 48 h. The study was carried out in the laboratory in a Complete Randomized Design (CRD) with four replications.

2.2. Germination and Vigour test

The seeds were tested for standard germination test in a seed germinator at 20 °C using paper towel and seed quality parameters viz; germination (%), seedling length (cm), dry weight of seedling (mg), seed vigour index –I and seed vigour index-II were worked out (ISTA, 1999).

$$\text{Germination(\%)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds kept for germination}} \times 100$$

Seedling length (cm)=Root length (cm)+Shoot length (cm)

Seedling vigour index-I was calculated as per the formula given by Abdul Baki and Anderson (1973).

Vigour index -I=Germination (%)×Seedling length (cm)

Seedling vigour index -II was calculated as per the formula given by Abdul Baki and Anderson (1973).

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

The data so obtained were subjected to analysis of variance following Gomez and Gomez, 1984.

3. Results and Discussion

3.1. Germination (%)

Seed germination is a test indicating the capability of the seed to produce normal seedlings under ambient conditions. The data on germination of seed tested at 20 °C have been presented in Table 1. Analysis of variance revealed significant differences among different priming treatments for germination. Maximum germination (90.25%) was recorded in GA_3 100 ppm which was at par with $GA_3$200 ppm, $Na_2HPO_4$$10^{-1}$, $KH_2PO_4$$10^{-3}$, and PEG1.0mpa. The next best treatment was GA_3 200 ppm (89.38%) which showed non-significant differences with $Na_2HPO_4$$10^{-1}$, $KH_2PO_4$$10^{-3}$ and PEG1.0mpa. On the other hand, minimum germination (69.00%) was recorded in control which showed non-significant differences with CU 1.0 and 0.5%. Duration of priming did not show any significant difference, however, maximum values (82.19%) were recorded in 48 h duration. Regarding interactions, maximum (91.25%) germination was recorded when the seeds were primed with $GA_3$100 ppm for 48 followed by $GA_3$200 ppm for 24 h (90.00%) and $GA_3$100 ppm for 24 h (89.25%). Minimum germination (69%) was recorded in control with both the durations. Enhancement of seed germination due to priming with $GA_3$100ppm may be due to exogenous application of

Table 1: Effect of different priming treatments on germination (%) and seed vigour Index-I of bell pepper under low temperature condition

Treatment	Priming treatment	Germination (%)			Seedling length (cm)			Seed Vigour Index -I		
		Soaking duration			Soaking duration			Soaking duration		
		D_1 (24 hrs)	D_2 (48 hrs)	Mean	D_1 (24 hrs)	D_2 (48 hrs)	Mean	D_1 (24 hrs)	D_2 (48 hrs)	Mean
T_1	PEG 0.5 mpa	83.00	84.5	83.75	10.61	11.73	11.17	898.61	973.33	935.97
T_2	PEG 1.0 mpa	84.75	86.25	85.5	10.7	11.85	11.27	925.66	1003.05	964.35
T_3	GA_3 100 ppm	89.25	91.25	90.25	11.37	12.00	11.68	1016.28	1093.69	1054.98
T_4	GA_3 200 ppm	90.00	88.75	89.38	11.07	12.02	11.55	994.72	1067.58	1031.15
T_5	KH_2PO_4 10^{-1}	85.25	85.75	85.5	10.68	11.62	11.15	912.39	997.66	955.02
T_6	$KH_2PO_4 10^{-3}$	86.00	87.75	86.88	11.23	11.47	11.35	964.78	1006	985.39
T_7	$Na_2HPO_4 10^{-1}$	86.25	87.75	87.00	10.96	11.23	11.09	942.02	985.88	963.39
T_8	$Na_2HPO_4 10^{-3}$	83.75	86.25	85.00	10.86	11.68	11.27	914.49	1008.12	961.31
T_9	CU 0.5%	75.25	69.5	70.88	11.12	11.12	11.12	754.9	757.25	756.07
T_{10}	CU 1%	71.25	70.25	70.75	10.45	10.9	10.67	743.5	742.19	742.84
T_{11}	DW	83.00	79.25	81.13	10.41	10.59	10.5	921.84	880.88	901.36
T_{12}	Control	69.00	69.00	69.00	10.35	10.35	10.35	713.76	713.71	713.73
	Mean	81.98	82.19		10.82	11.38		891.91	935.78	
			CD (p=0.05)			CD (p=0.05)			CD (p=0.05)	
	Pr		4.81			0.91			95.85	
	Du		1.96			0.37			39.19	
	P×D		6.8			1.29			135.56	
SEm±	Germination (%) 3.411				Seedling length (cm) 0.645			SV-I 0.0429		

GA_3 which could affect cytokinins on transport across the membranes and also play a key role in initiation of biochemical process necessary for germination to occur (Siadat et al., 2011). Further, priming with growth regulators can enhance germination metabolism and allow radicle to emerge earlier (Bahman and Sedghi, 2012).

3.2. Seedling length (cm)

Seedling length is an important character as it decides the vigour of seed which is an important component in seed studies. The observations recorded on seedling length tested at 20 °C have been presented in the Table 1. An examination of the data depicted that maximum seedling length (11.68 cm) was observed in $GA_3$100ppm which was at par with GA_3 200 ppm, $KH_2PO_4 10^{-3}$ and $Na_2HPO_4 10^{-3}$. The next best treatment was $GA_3$200ppm which showed non-significant differences with $KH_2PO_4 10^{-3}$ and $Na_2HPO_4 10^{-3}$. Minimum (10.35 cm) seeding length was observed in control. Duration of priming showed significant differences with each other. Maximum seedling length (11.38 cm) was observed in 48 h duration. The interaction effect was also significant with maximum value of seedling length measured when seeds treated with GA_3 200 ppm for 48 h which was at par with PEG1.0 mpa for 48 h and PEG 0.5 mpa for 48 h. Minimum seedling length (10.35 cm) was recorded in control with both the durations. It seems that more seedling length or growth of the seedlings was due to earlier germination of seeds following priming which provided the seedlings more time to grow. The earlier and synchronized germination may be attributed to increase in metabolic activities in the primed seeds (Shakirova et al., 2003). An increase in seedling length might be the result of higher embryo-cell wall extensibility. Increased seedling length and its growth may be due to increase in cell division within the apical meristem of seedling shoots and roots which was responsible for increase in overall seedling growth. The present results are in line with those of Rehman et al. (2011).

3.3. Seedling Vigour Index-I

Vigour index is a qualitative term encompassing the sum of those properties of the seed which determine the potential level of activity and performance of the seed or lot during germination and seedling emergence. The data pertaining to

vigour index-I tested at 20 °C have been presented in the Table 1. A perusal of the data showed that maximum vigour index-1 (1054.98) was recorded in $GA_3$100 ppm which was statistically at par with GA_3 200 ppm, PEG1.0 mpa and $Na_2HPO_4 10^{-3}$. The duration of priming also produced significant differences for this trait. Maximum value (935.78) was recorded with duration 48h duration as compared to (891.91) duration 24 h duration. Seed priming also showed significant effects on treatment and duration combination. Treating seeds with $GA_3$100 ppm for 48 h produced maximum (1093.69) vigour index-1. Treatment and duration combination was also statistically at par with $GA_3$100 ppm for 48 h and $Na_2HPO_4 10^{-3}$ for 48 h. Minimum (713.71) vigour index-I was recorded in control with both the durations. This may be due to the maintenance of controlled but sufficient hydration of seed to a level that permits pre-germinative metabolic activity to proceed but prevented the actual radical emergence and increased stand establishment in bell pepper (Thakur et al., 1997).

3.4. Seedling dry weight (mg)

Seedling dry weight is an important character in seed studies as it is directly correlated with seedling vigour. The seed lot having high seedling dry weight together with better germination is beneficial and considered better for longer storage. The data recorded on seedling dry weight when tested at 20 °C have been presented in the Table 2. It is evident from the data that maximum seedling dry weight (2.87 mg) was observed in $GA_3$100 ppm. This treatment was statistically at par with KH_2PO_4 10^{-3}, PEG 0.5 mpa and $GA_3$200 ppm. Minimum (2.31 mg) seedling dry weight was observed in control which showed non-significant differences with CU 0.5% and CU 1.0%. The duration D_2 (48 h) recorded maximum (2.66 mg) seedling dry weight as compared to D_1 (2.63 mg). Seed priming exhibited significant effect on the interaction of treatment and duration. Maximum (2.92 mg) seedling dry weight was observed in treatment duration combination of $GA_3$100 ppm for 48 h which showed significant differences with KH_2PO_4 10^{-3} for 24 h, $GA_3$200 ppm for 48 h and PEG 0.5 mpa for 48 h.Whereas, minimum (2.31 mg) seedling dry weight was observed in control with both the durations. Improvement in seedling dry weight has also been reported by (Nagarajan et al., 2003) who were of the opinion that priming treatments increased the activities of dehydrogenases (an indicator of seed viability) and peroxidises (free radical scavenging enzyme).

3.5. Seedling Vigour Index-II

Vigour index is a very important character as it determines the

Table 2: Effect of different priming treatments on dry weight (mg) and seed vigour index-II of bell pepper under low temperature condition

Treatment	Priming solution	Dry weight (mg)			Seed vigour index-II		
		Soaking duration			Soaking duration		
		D_1 (24 hrs)	D_2 (48 hrs)	Mean	D_1 (24 hrs)	D_2 (48 hrs)	Mean
T_1	PEG 0.5 mpa	2.68	2.78	2.73	226.33	230.41	228.37
T_2	PEG 1.0 mpa	2.63	2.77	2.7	226.84	234.09	230.46
T_3	GA_3 100 ppm	2.83	2.92	2.87	252.55	266.18	259.36
T_4	GA_3 200 ppm	2.68	2.79	2.73	242.33	247.65	244.99
T_5	KH_2PO_4 10^{-1}	2.72	2.71	2.72	231.56	233.99	232.77
T_6	$KH_2PO_4 10^{-3}$	2.86	2.75	2.8	245.37	241.06	243.21
T_7	$Na_2HPO_4 10^{-1}$	2.7	2.66	2.68	233.42	232.96	233.19
T_8	$Na_2HPO_4 10^{-3}$	2.68	2.76	2.72	175.7	237.33	206.52
T_9	CU 0.5%	2.37	2.42	2.39	171.02	168.01	169.52
T_{10}	CU 1%	2.41	2.47	2.44	171.08	173.12	172.1
T_{11}	DW	2.7	2.63	2.66	223.93	208.32	216.13
T_{12}	Control	2.31	2.31	2.31	159.39	159.39	159.39
	Mean	2.63	2.66		213.29	219.38	
	CD (p=0.05)						
	Pr		0.15			27.26	
	Du		0.06			11.13	
	P×D		0.21			38.55	
SEm±	Dry weight	0.035			SV-II	1.198	

actual germeability of seed (plant stand) under field conditions. It also shows the vigour of seed to germinate under adverse soil and temperature conditions. The observations recorded on seedling vigour index-II when tested at 20 °C have been presented in the Table 2. Analysis of variance depicted that maximum (259.36) seedling vigour index-II was when seed treated with $GA_3$100 ppm which was statistically at par with $GA_3$200 ppm, $KH_2PO_4 10^{-1}$ and PEG 1.0 mpa. Minimum seedling vigour index-II (159.39) was recorded in treatment control which showed non-significant differences with CU 0.5% and CU 1.0%. Duration of priming did not show any significant differences, however, maximum values (219.38) were recorded in D_2 (48 h) as compared (213.29) to D_1 (24 h). The interaction effect i.e., treatment and duration was also found significant for this trait. Maximum (266.18) vigour index-II was recorded in the treatment duration combination $GA_3$100 ppm for 48 h followed by $GA_3$100 ppm for 24 h and $KH_2PO_4 10^{-3}$ for 24 h. Minimum vigour index-II (159.39) was recorded in control with both the durations. Seeds during these pre-treatments became physiologically advanced by having enhanced hydration and carrying out some of the initial steps of germination thus improving the subsequent germination, emergence index and seedling vigour. The osmotic and chemical conditioning of seeds, therefore, could improve the germination and vigour. Further, priming improve the ATPase activity, RNA and acid phosphatase synthesis, also by improvement of amylase, lipases and protease synthesis which improve the germination by providing an opportunity to low vigour seeds to cope up with the more vigorous seeds (Ansari et al., 2013).

4. Conclusion

Seed priming certainly improve germination, seedling vigour and overall seedling establishment under low temperature stress. Among the treatments, seed priming with GA_3 was more effective under low temperature than the other treatments. Thus, it can be concluded that hormone priming with GA_3 could be a suitable strategy for enhancing germination especially for cold regions.

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6. References

Ansari, O., Azadi, M.S., Sharif, Z.F., Younesi, E., 2013. Effect of hormone priming on germination characteristics and enzyme activity of mountain rye (*Secale mountanum*) seeds under drought stress conditions. Journal of Stress Physiology & Biochemistry 9(3), 61-71.

Bahman, A.B., Mohammad, S., 2012. Effect of aging and priming on physiological and biochemical traits of common bean (*Phaseolus vulgaris* L.). Notulae Scientia Biologicae 4(2), 95-100.

Baki, A.A., Anderson, J.D., 1972. Physiological and biological deterioration of seeds. Seed biology, Vol. II. Academic Press, New York.

Bennett, M.A., Walter, L., 1987. Seed hydration treatments for improved sweet corn germination and stand establishment. Journal of the American Society of Horticulture Science 112: 45-49.

Dutta, S.K., Singh, A.R., Boopathi, T., Singh, S.B., Singh, M.C., Malsawmzuali. 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), 279-284.

Gomez, K.A., Gomez, A.A., 1984. Statistical procedure for agricultural research. John Wiley and Sons, NewYork 690.

ISTA.1999. International rules for seed testing. Seed Science and Technology 27, 1-33.

Joshi, A., Shukla, Y.R., 1997. Diversification of vegetable crop in the temperate region of India-A Model Punjab Vegetable Grower 32, 24-27.

Maiti, R., Rajkumar, D., Jagan, M., Vidyasagar, P., 2013. Effect of seed priming on seedling vigour and yield of tomato and chilli. International Journal of Bio-resource and Stress Management 4(2), 119-115.

McDonald, M.B., 1999. Seed deterioration: physiology, repair and assessment. Seed Science and Technology 27, 177-237.

McDonald, M.B., 2000. Seed priming. In: Black, M., Bewley, J.D., (Eds) Seed technology and its biological basis. Sheffield Academic Press, Sheffield, UK.

Nagarajan, S., Pandita, V.K., Modi, B.S., 2003. Physiology and enzymatic activity of Asiatic carrot seeds as affected by invigoration treatments. Indian Journal of Plant Physiology 3, 222-227.

Pandita, V.K., Nagarajan, S., Anand, A., 2009. Physiological aspects of seed priming in capsicum (*Capsicum annuum* L.) souvenir National Seed Congress; Quality seed for livelihood and Profitability, IARI, New Delhi, January 18-20, 127.

Rehman, H., Farooq, M., Basra, S.M.A., Afzal, I., 2011. Hormonal priming with salicylic acid improves the emergence and early seedling growth in cucumber. Journal of Agriculture and Social Science 7, 109-113.

Shakirova, F.M., Sakhabutdinova, A.R., Bezrukova, M.V., Fatkhutdinova, R.A., Fatkhutdinova, D.R., 2003. Changes in the hormonal status of wheat seedlings induced by salicylic acid and salinity. Plant Science 164, 317-322.

Siadat, S.A., Moosavi, S.A., Zadeh, M.S., Fotouhi, F., Zirezadeh, M., 2011. Effects of halo and phytohormone seed priming on germination and seedling growth of maize under different duration of accelerated ageing treatment. African Journal of Agricultural Research 6(31), 6453-646.

Taylor, A.G., Allen, P.S., Bennett, M.A., Bradford, K.J., Burris, J.S., Misra, M.K., 1998. Seed enhancements. Seed Science Research 8, 245-256.

Thakur, A., Thakur, P.S., Bhardwaj, J., 1997. Influence of seed osmo-conditioning on germination potential and seedling performance of bell pepper. Seed Research 25(1), 25-30.

Yadav, P.V., Kumari, M., Ahmed, Z., 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.

Yogananda, D.K., Vyakaranahal, B.S., Shekhargouda, M., 2004. Effect of seed invigoration with growth regulators and micronutrients on germination and seedling vigour of bell pepper cv. California wonder. Karnataka Journal of Agricultural Science 17(4), 811-813.