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Response of bitter gourd (*Momordica charantia*) seed to seed priming treatments under sub-optimal environments

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ABSTRACT

To overcome the problem of delayed, non-uniform and poor seed emergence in bitter gourd (*Momordica charantia* L.), an experiment was laid out in a randomized complete block design (RCBD) with a factorial arrangement during winter and spring season of 2012, 2013 and 2014 at the Research Farm of the Department of Vegetable Science, Punjab Agricultural University, Ludhiana. The treatments consisted of two environments (sowing during third week of January and February) and 18 priming treatments (soaking for 24h in GA_3 100 and 500 ppm, potassium dihydrogen orthophosphate (KH_2PO_4) 10^{-1}M and 10^{-3}M, sodium dihydrogen orthophosphate (NaH_2PO_4) 10^{-1}M and 10^{-3}M, 0.1% potassium nitrate (KNO_3);only hydration followed by burying in farm yard manure for 48hr). The seeds from all these treatments were kept in moist gunny bags for two different durations, i.e. 24 and 48 hr, respectively, at room temperature. Untreated seeds served as control. Following this, the treated seeds were air dried at room temperature and then sown in polythene bags. Emergence per cent (79.22 and 79.67) and speed of emergence (4.45 and 4.75) in each environment was better when seeds were treated with 10^{-1}M KH_2PO_4 and incubated in gunny bags for 48 hr. However, February sown seeds emerged earlier and faster than January sown seeds. Seedling length and seedling fresh weight were highest when seed were treated with 500 ppm GA_3 but statistically at par with 10^{-1}M KH_2PO_4. Other seed quality parameters like seedling dry weight, vigour index-I and II were also superior with 10^{-1}M KH_2PO_4.Therefore it was inferred that to improve the germination of bitter gourd seeds under optimal and sub-optimal temperature, it should be soaked for 24 hr in 10^{-1}M KH_2PO_4 followed by keeping in moist gunny bags for 48 hr.

Key words: *Momordica charantia*, Seed germination, Seed priming, Seed quality, Sub-optimal environments

Poor emergence is a common problem in bitter gourd (*Momordica charantia* L.) even with the seeds of high germinability due to thick seed coat, imposing mechanical restriction on embryo growth and seeds sown directly in the open field fail to germinate late resulting in poor crop stand (Joshi and Srivastava 2002). For successful emergence, it requires temperature range from 25-28ºC. If the soil temperature is below 20ºC, it fails or takes long time to emerge and it altogether ceases when temperature goes below 15ºC. Under North Indian conditions cucurbits are generally grown in early winter (January) in polythene bags/plug tray nursery and direct sowing in spring season in February- March to fetch the premium of early market. However, low temperature prevailing during this period (Table 1) slows down or inhibits the germination of costly seeds. Therefore, in order to improve its emergence, priming treatments are applied to seeds before sowing in the soil (McDonald 2000). Priming offers an effective means for counter acting sub-optimum temperature induced oxidative injury and raising seed performance in several crop species (Chen and Sung 2001). Application of plant growth regulators induces breakdown of seed reserves in storage tissue and increases the activity of enzymes for their mobilization, resulting in improved seed germination (Bewley and Black 1986).

Since, the choice of farmers for sowing of bitter gourd is different, either in winter or early spring, therefore environmental response to different seed priming treatments will be of great significance and needs to be investigated. Therefore present investigations were deliberated to obtain information on different seed priming treatments and to identify the best seed priming treatment for improving emergence and vigour in bitter gourd seeds under different environments.

MATERIALS AND METHODS

The experiment was conducted during winter and spring season of 2012, 2013 and 2014 at the Research Farm of the Department of Vegetable Science and laboratory of Seed Technology, Punjab Agricultural University, Ludhiana.

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Table 1 Mean monthly meteorological data during the crop growth period of bitter gourd

Month	Air Temperature (°C)						Soil temperature at 5cm depth (°C)					
	2012		2013		2014		2012		2013		2014	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	16.9	5.6	16.7	5.26	17.3	6.78	16.6	7.0	17.8	8.0	17.5	8.5
February	19.9	6.7	20.5	8.92	19.2	8.26	22.6	8.7	20.9	11.3	21.3	9.6
March	27.3	11.6	27.2	12.3	24.4	11.6	30.9	15.3	30.1	16.1	27.1	14.2

The region is characterized by hot summer and cold winter with semi-arid and sub-tropical climate conditions prevailing in central districts of Punjab. The mean maximum and minimum temperatures show considerable fluctuations, while minimum temperature falls below freezing point having frosty spells during winter. The month wise meteorological data during investigation period is given in Table 1. The experiment was laid out as a randomized complete block design (RCBD) with a factorial arrangement and replicated three times. The treatments consisted of two environments (sowing in the third week of January and third week of February) and 18 priming treatments along with control (Table 2). Following the treatment, seeds were air dried at room temperature until their original weight was restored. After drying, the seeds were taken to field immediately for sowing in polythene bags. Observations were recorded on per cent field emergence, speed of emergence, seedling length (cm), seedling fresh weight (g), seedling dry weight (g), vigour index-I and vigour index-II.

The seeds were also allowed to germinate in controlled laboratory conditions. Three replicates of 50 seeds each were taken for germination in germination paper using 'Top of the Paper' (TP) method at 25±1ºC and was observed after 14 days (ISTA 1999). To determine field emergence, 100 seeds/replication for each priming treatment were sown in polythene bag containing coco peat, vermiculite and perlite in equal ratio. The number of seeds emerged and developed into seedlings after 24 days was counted. Speed of emergence was computed by recording daily observations on 100 seeds sown in polythene bags until the final count day (24 days). The speed of emergence was calculated as total number of seeds emerged on day basis, and the mean was calculated as suggested by Maguire (1962). For determining seedling length, 10 normal seedlings from each replication of field emergence test were taken at random, and seedlings length was measured. Seedling dry weight was taken after drying ten normal seedlings at 110ºC for 17 hr and mean dry weight was calculated. The vigour index-I were calculated as per the formulae suggested by Abdul Baki and Anderson (1973). Analysis of variance for the data recorded was conducted using CPCS-1 package.

RESULTS AND DISCUSSION

Significant differences were observed for per cent field emergence and speed of emergence during different years. Therefore, these characters were presented year wise while in rest of the characters there was no variation in different

Table 2 Different environments and seed priming treatments

Environments	
E1	Sowing in the 3rd week of January
E2	Sowing in the 3rd week of February
Priming treatments	
T_1	Soaking in GA_3 100 ppm for 24 hr followed by keeping in moist gunny bag layer for 48 hr
T_2	Soaking in GA_3 500 ppm for 24 hr followed by keeping in moist gunny bag layer for 48 hr
T_3	Soaking in Potassium dihydrogen orthophosphate (KH_2PO_4) 10^{-1}M for 24 hr followed by keeping in moist gunny bag layer for 48 hr
T_4	Soaking in Potassium dihydrogen orthophosphate (KH_2PO_4) 10^{-3}M for 24 hr followed by keeping in moist gunny bag layer for 48 hr
T_5	Soaking in Sodium dihydrogen orthophosphate (NaH_2PO_4) 10^{-1}M for 24 hr followed by keeping in moist gunny bag layer for 48 hr
T_6	Soaking in Sodium dihydrogen orthophosphate(NaH_2PO_4) 10^{-3}M for 24 hr followed by keeping in moist gunny bag layer for 48 hr
T_7	Soaking in Potassium nitrate (KNO_3)0.1% for 24 hr followed by keeping in moist gunny bag layer for 48 hr
T_8	Hydration for 24 hr followed by keeping in moist gunny bag layer for 48 hr
T_9	Hydration for 24 hr followed by burying in farm yard manure for 48 hr
T_{10}	Soaking in GA_3 100 ppm for 24 hr followed by keeping in moist gunny bag layer for 24 hr
T_{11}	Soaking in GA_3 500 ppm for 24 hr followed by keeping in moist gunny bag layer for 24 hr
T_{12}	Soaking in K H_2PO_4 10^{-1}M for 24 hr followed by keeping in moist gunny bag layer for 24 hr
T_{13}	Soaking in K H_2PO_4 10^{-3}M for 24 hr followed by keeping in moist gunny bag layer for 24 hr
T_{14}	Soaking in $NaH_2PO_4 10^{-1}$M for 24 hr followed by keeping in moist gunny bag layer for 24 hr
T_{15}	Soaking in $NaH_2PO_4 10^{-3}$M for 24 hr followed by keeping in moist gunny bag layer for 24 hr
T_{16}	Soaking in KNO_3 0.1% for 24 hr followed by keeping in moist gunny bag layer for 24 hr
T_{17}	Hydration for 24 hr followed by keeping in moist gunny bag layer for 24 hr
T_{18}	Hydration for 24h followed by burying in farm yard manure for 24 hr
T_{19}	Control

years and mean value for three years is discussed (Table 3).

It is evident from the data present in (Fig 1) that the germination of all treatments including control was above 80% under laboratory conditions indicating the superiority of priming treatments over control. Maximum germination was obtained when the seeds were treated with T_2 followed by T_3 and the minimum germination was observed when the seeds were untreated under laboratory conditions. Enhanced germination by priming might be due to washing off germination inhibitors.Similar findings were reported by Renuga and Jacqueline (1994) in bitter gourd.

Field emergence of bitter gourd seeds varied significantly during each year (Table 3). Highest field emergence per cent was observed in environment-2 and significant in all the years except in 2012 when the mean monthly temperature of January and February were not significantly different. This is due to the fact that temperature during February becomes conducive for germination of bitter gourd. All priming treatments increased the field emergence significantly over control. Maximum field emergence was observed when seeds were treated

Table 3 Effect of environment and priming treatments on seedling emergence (%) and speed of emergence in bitter gourd.

Variables		Field emergence (%)			Speed of emergence		
Environments	Priming treatments	2012	2013	2014	2012	2013	2014
E-1	T_1	76.33	76.33	75.67	4.12	4.35	4.34
	T_2	73.67	73.00	71.67	4.09	4.24	4.23
	T_3	77.33	80.00	80.33	4.22	4.57	4.57
	T_4	73.33	72.00	67.00	4.07	4.37	4.37
	T_5	74.33	74.00	73.33	3.94	4.41	4.40
	T_6	72.00	69.67	67.33	3.93	4.39	4.38
	T_7	72.67	68.00	66.00	3.81	4.23	4.22
	T_8	72.00	72.67	71.67	3.86	4.34	4.34
	T_9	74.00	63.33	62.33	3.86	4.49	4.48
	T_{10}	73.33	73.67	69.33	3.94	4.19	4.18
	T_{11}	73.33	69.67	67.33	3.95	4.35	4.34
	T_{12}	72.67	75.00	74.67	3.94	4.54	4.52
	T_{13}	73.00	73.67	73.00	3.93	4.47	4.46
	T_{14}	71.33	74.33	73.67	3.87	4.41	4.40
	T_{15}	70.33	69.33	67.33	3.86	4.32	4.32
	T_{16}	71.67	74.00	74.00	3.80	4.22	4.22
	T_{17}	71.33	61.67	60.33	3.75	3.90	3.88
	T_{18}	70.67	69.33	67.33	3.85	4.19	4.18
	T_{19}	64.33	57.33	53.67	3.02	3.04	3.02
E-2	T_1	77.00	77.33	77.00	4.13	4.88	4.87
	T_2	74.00	75.00	71.67	4.11	4.83	4.84
	T_3	78.00	79.00	82.00	4.25	5.01	5.00
	T_4	74.00	75.00	69.33	4.08	4.78	4.77
	T_5	75.00	77.00	71.33	3.95	4.70	4.69
	T_6	72.67	74.00	69.67	3.95	4.56	4.56
	T_7	73.33	74.33	69.67	3.83	4.33	4.33
	T_8	72.33	73.33	72.33	3.88	4.64	4.63
	T_9	74.67	76.67	68.33	3.88	4.80	4.80
	T_{10}	74.00	76.00	69.33	3.96	4.54	4.53
	T_{11}	74.00	74.33	69.67	3.96	4.56	4.54
	T_{12}	73.33	73.67	74.67	3.96	4.97	4.96
	T_{13}	73.67	76.00	73.00	3.94	4.76	4.75
	T_{14}	72.00	73.67	73.67	3.88	4.77	4.76
	T_{15}	71.00	72.00	67.33	3.87	4.55	4.54
	T_{16}	72.33	74.33	74.00	3.82	4.63	4.62
	T_{17}	72.00	73.00	64.67	3.77	4.09	4.08
	T_{18}	71.33	75.33	67.33	3.86	4.33	4.32
	T_{19}	67.33	66.33	61.67	3.03	3.43	3.52
	CD (P=0.05)	NS	3.77	3.38	NS	0.11	0.15

with T_3 treatment followed by T_1. The minimum emergence was recorded in untreated control (T_{19}) seeds. It was observed that during third year of investigations the untreated seeds failed to meet minimum seed certification standards (IMSCS) which is 60% for bitter gourd. Interactions were also found to be significant. Seeds treated with T_3 treatment reported maximum emergence of seedlings followed by T_1 in both the environments. Minimum emergence was recorded with untreated seeds in both the environments. The increased field emergence due to priming treatments in low temperature might be linked with increased α-amylase activity for breaking starch stored in seeds during imbibition by increasing germination enhancing metabolites. Pre-sowing treatments might have softened the seed coat that washed off germination inhibitors present inthe seed and contributed towards the enhancement of seedling emergence. Lin and Sung (2001) reported that biochemical reaction responsible for germination of bitter gourd seeds get adversely affected at low temperature but priming counteracts these effects by increasing the activity of different enzymes like iso-citrate lyase, malate synthase and malate dehydrogenase. Similar findings were reported by Kumar *et al.* (1996) in okra and Islam *et al.* (2012*)* in bitter gourd.

As depicted in Table 3, the speed of emergence was better in environment-2 than that in environment-1. However, both the environments were non-significant in year 2012 due to long winter spell and temperature difference during January and February was not significant. Amongst various priming treatments T3 treated seeds emerged early followed by T_9 and minimum speed of emergence was noticed in untreated seeds. Interaction effect of environment and priming treatments was also found to be significant. Seeds treated with T3 treatment recorded minimum days to emergence in both environments (1 and 2) than untreated seeds in both the environments. High speed of emergence in environment-1 over environment-2 might be due to favourable temperature for germination of seeds (Table 1). Similarly early emergence of seeds by priming might be due to increase α-amylase activities for breakdown of starch stored in seeds during imbibition. Lin and Sung (2001) reported that activities of malate synthase and malate dehydrogenase responsible for germination of seed are higher at 25p C and it reduces when temperature goes below 20p C. They observed these biochemical activities better in primed seed than untreated seeds even under low temperature. Chen and Sung (2001) also reported slow rate of imbibition at low temperature thereby preventing successful seedling emergence. Similar results were reported by Islam *et al* (2012) in bitter gourd and Vishwanath *et al.* (2006) in chilli.

The seedling length in environment-2 was significantly better than in environment-1. This may be due to favourable temperature during February sown crop and seeds emerged early than the January sown crop. Amongst various priming treatments highest seedling length (27.53cm) was recorded with the T_2treatment followed by T_4 and T_3 treatments. Lowest seedling length (20.84cm) was observed in untreated seeds. Interaction between environment and priming treatments were also found to be significantly different. Seeds treated with treatment T_2 had maximum seedling length in both the environments. Lowest seedling length was observed in untreated seeds in both the environments. The increased seedling length due to priming treatments might be due to enhanced enzymatic activities responsible for germination that increased the seedling length. Enhanced germination of treated seeds than the untreated seeds also contributed to the seedling length. Similar findings were reported by Kumar (2005) and Bassi *et al.* (2007) in brinjal and Singh *et al.* (1999) in muskmelon. As depicted in Fig 2 seedling fresh weight and dry weight was more in environment-2 than environment-1. Among various priming treatments seeds treated with treatment T_1 and T_2 produced maximum seedling fresh weight but the dry weight was maximum in treatment T_3. Untreated seeds recorded lowest weight of seedlings. The interaction effects showed that seeds treated with T_1 and T_2 had maximum fresh weight in both the seasons. However, seedling dry weight was highest with treatment T_3. The increase in fresh and dry weight in February sown crop is directly related to increase in temperature suitable for early emergence of seeds that allowed plants to accumulate biomass faster than January sown crop. Similarly priming treatments

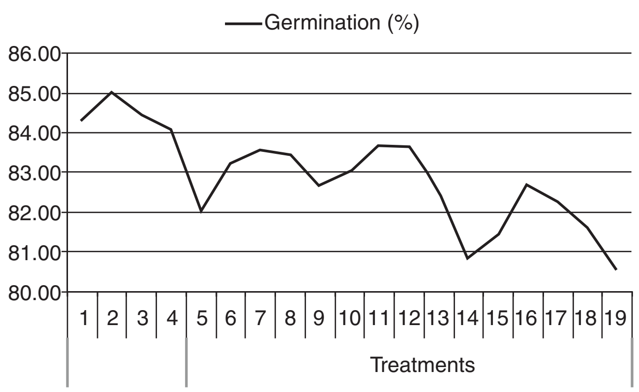

Fig 1 Effect of priming treatments on germination of bitter gourd seeds under laboratory conditions

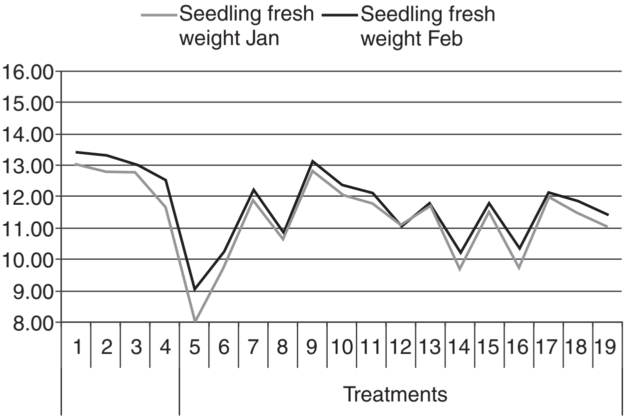

Fig 2 Effect of priming treatments on seedling fresh weight (g) of bitter gourd seeds

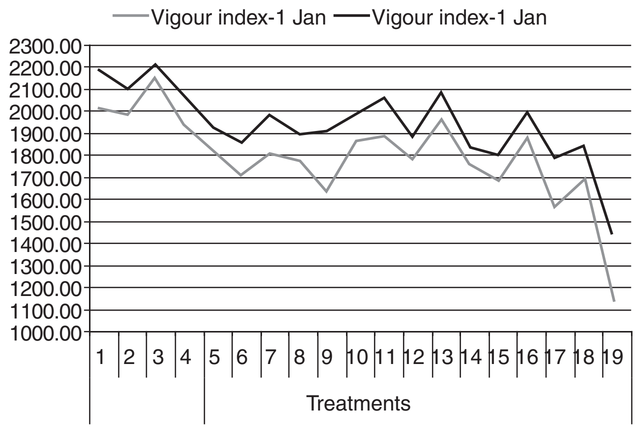

Fig 3 Effect of priming treatments on Vigour index-1 of bitter gourd seeds

increased the seedling length that is positively correlated with the fresh weight and dry weight of the plants. Similar findings were reported by Kumar (2005) in brinjal, Gayathri (2001) in tomato and Singh *et al.* (1999) in muskmelon. Vigour of the plant is an important factor and directly correlated with the seed emergence and seedling length/ seedling dry weight. The environment/treatment showing higher field emergence, seedling length and dry weight would have high vigour indices. Vigour index-I and vigour index-II were significantly greater in environment-2 than in environment-1. Amongst various priming treatments T_3 had the highest vigour indices. Similarly interaction effect showed that seed treatment with treatment T_3 recorded maximum vigour indices in both the environments.

Results obtained in this study allow us to conclude that seed priming with potassium KH_2PO4@ 10^{-1}M for 24 hr followed by keeping in moist gunny bag layer for 48 hr is highly effective to invigorate bitter gourd seeds.

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