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Full Length Article

Halopriming Triggers Higher Germination Potential and Early Seedling Growth of Tomato

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ABSTRACT

Poor germination due to improper storage conditions is a common problem in local tomato cultivars. This problem can be minimized and yield can be maximized by seed priming. The study was design to improve germination and early seedling growth of tomato cultivars Nagina and Roma. Seeds were primed with varying concentration of salts ($CaCl_2$ or KNO_3) for 24 h. All priming treatments significantly improved final germination. Higher germination and earlier germination or emergence was recorded in seeds primed with 50mM $CaCl_2$.Similarly, maximum root and shoot lengths were also recorded by priming with 50 mM $CaCl_2$, which was due to enhanced chlorophyll contents and better germination pattern. Moreover, the response of both tomato cultivars to higher concentration of salts (150 mM $CaCl_2$ or 3% KNO_3) was not positive. It may be concluded that seed priming of tomato cultivars with 50 mM $CaCl_2$ improved germination potential and stand establishment of both cultivars. © 2011 Friends Science Publishers

Key words: Tomato; Priming; Salts; Stand establishment

INTRODUCTION

Tomato, both for processing and fresh market, has become one of the most important crops in agriculture. It is the second most cultivated vegetable in the world, after the potato. Tomato Production in the world was 129,649,883 tones (FAOSTAT, 2008) and is cultivated on more than 5.0Mha, China is the major grower of tomato and contributing 1/4thof the world tomato production and area, while Asia and Africa are contributing 79% of the global tomato producing areas.Pakistan ranks at 35th position in the world for tomato production. It is grown on an area of 53393 ha with production of 536217 tones (FAO STAT, 2008).

Tomato fruit contains vitamin A ad C and minerals including K, P, Mg and Ca(USDA, 2009).In the recent studies it is reported that tomato isbeneficial to human health, because of its phytochemicals such as lycopene, β-carotene, flavonoids and many essential nutrients (Beutner*et al*., 2001).Lycopene contents that have an antioxidant role, which minimized the danger of cancer (Miller *et al*., 2002) and prostate adenocarcinoma in humans, as well as slow down germination, reduced plant height due to negative pleiotropic effects that might be due to high levels of ABA, which is responsible for seed dormancy. Similarly, many seeds from freshly harvested tomato seed lots often fail to germinate due to presence of dormancy (Afzal*et al*., 2009a).

Seed priming (controlled hydration process followed by redrying) is being used to enhance seed performance by increasing the rate and uniformity germination that results in faster and better seedling development in various crops (Taylor *et al*., 1998; Powell *et al.,* 2000; Afzal *et al.,* 2008a). Seed priming breaks dormancy and improves speed of germination under broad range of temperature and moisture conditions (Afzal *et al.,*2008b; 2009a).The enhancement of seed germination by priming has also been associated with stimulation of hydrolytic enzyme activities (Sung & Chang, 1993), protein synthesis (Hameed *et al.*, 2011)and total soluble sugars (Lee& Kim, 2000). Priming is a valuable tool for the improvement of seedling quality in rootstock tomato seedling production (Mavi*et al.,* 2006).During priming with osmotica (halopriming), ions from a potassium nitrate and sodium chloride solutions accumulate within the seeds, reducing water potential and increasing water absorption (Parera & Cantliffe, 1994). It is very important to understand physiological changes in tomato induced by halopriming. Therefore, this study was carried out to investigate the effect of halopriming on enhancing germination and seedling vigourof tomato cultivars.

MATERIAL AND METHODS

Plant materials: Seeds of two tomato (*Lycopersicon esculentum* Mill.) cultivar (Nagina & Roma) used in this study were obtained from Vegetable Research Institute, Faisalabad, Pakistan.

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Priming protocol: Seeds were soaked in aerated solution of 50, 100 and 150 mM $CaCl_2$ and 1, 1.5 and 2% KNO_3 for 24 h at 25°C. The ratio of seed weight to solution volume was 1:5 (g/mL) (Afzal *et al.,* 2009a).During priming, fresh air was supplied continuously. After priming, the seeds were washed with distilled water and dried back near to original weight with forced air under shade (approximately for 48 h). The seeds were packed in polythene bags and stored in a refrigerator 7±2 for further studies.

Seed germination and seedling vigor evaluation: Four replicates of 25 seeds each were germinated in 9 cm diameter petri dishes on Whatman No.1 filter paper at 25°C in a growth chamber (Vindon, England) for seven days. Visible root protrusion was recognized as germination. The time to get 50% germination (T_{50}) was calculated according to the formulae of Coolbear *et al*. (1984). Mean germination time (MGT) was calculated according to Ellis and Roberts (1981). Germination index (GI) was calculated as described in the Association of Official Seed Analysts (1983).

Seedling emergence: Control and treated seeds were sown in plastic trays (25 in each) containing moist sand, replicated four times and were placed in a growth chamber (Vindon, England) maintained at 25°C under continuous fluorescent light for seven days. Emergence was recorded daily according to the seedling evaluation of the Handbook of Association of Official Seed Analysts (1983).

Determination of chlorophyll contents: For chlorophyll determination, shoot sample of 1g was grinded in 10 mL of 80% acetone. From this 1 mL aliquot was taken and total volume of 5 mL was made by adding 4 mL of acetone. Poured it in cuvettes and read at 663 and 645 nm using UV-Vis spectrophotometer (Bruinsma, 1963).

RESULTS

The present study indicates that most of the halopriming treatments significantly improved germination potential and synchronized stand establishment of both tomato cultivars (Table I). Halopriming with 50mM $CaCl_2$ maximally improved FGP (66%) and took less time for

Table I: Effect of halopriming on germination capacity of two tomato cultivars

Varieties	Treatments	FGP (%)	T_{50} (days)	MGT (days)	GI	Root length (cm)	Shoot length (cm)
Roma	Control	30.00 f	3.42 a	11.70 a	4.42 ab	4.26 bcd	04.32 d
	1% KNO_3	58.00 b	2.00 c	11.01 ef	3.40 cd	4.04 cd	14.46 b
	1.5% KNO_3	52.00 cd	2.00 c	11.10 de	3.99 bc	4.63 abc	13.93 b
	2% KNO_3	50.00 d	2.67 b	11.24 cd	2.64 d	4.18 bcd	10.60 c
	50mM $CaCl_2$	66.00 a	2.18 bc	10.89 f	5.30 a	5.06 a	20.78 a
	100 mM $CaCl_2$	51.00 cd	2.33 bc	10.94 ef	4.68 ab	3.92 d	14.73 b
	150 mM $CaCl_2$	34.00 e	2.52 bc	11.43 b	3.84 bc	4.82 ab	06.98 d
	LSD at P<0.05	**03.12**	**0.57**	**0.16**	**1.02**	**0.66**	**3.28**
Nagina	Control	25.33 c	5.14 abc	10.49 ab	5.16 ab	4.49 b	3.53 c
	1% KNO_3	32.67 b	6.67 a	11.07 a	4.14 b	6.04 a	3.15 c
	1.5% KNO_3	36.67 ab	3.00 d	11.16 a	4.52 ab	6.28 a	5.15 b
	2% KNO_3	38.67 a	3.17 d	10.59 ab	5.07 ab	6.80 a	5.67 b
	50mM $CaCl_2$	40.67 a	6.38 ab	09.75 b	5.80 a	7.24 a	6.99 a
	100 mM $CaCl_2$	32.00 b	4.21 cd	10.10 ab	4.82 ab	6.52 a	5.09 b
	150 mM $CaCl_2$	36.00 ab	4.87 bc	10.71 ab	4.05 b	6.10 a	3.70 c
	LSD at P<0.05	**5.56**	**1.65**	**1.18**	**1.32**	**1.52**	**1.30**

Figures not sharing the same letters in a column differ significantly at p 00.05

FGP= Final Germination Percentage, GI= Germination index, MGT= mean germination time, T_{50} = time taken to 50% germination

Table II: Effect of halopriming on emergence and early seedling growth of two tomato cultivars

Varieties	Treatments	FEP (%)	E_{50} (days)	MET (days)	Root length (cm)	Shoot length (cm)
Roma	Control	21.00 e	10.50 b	13.68 a	3.93 de	3.74 e
	1% KNO_3	33.00 c	9.75 c	12.72 b	3.95 de	5.12 cd
	1.5% KNO_3	37.00 b	11.08 a	11.77 cd	4.49 b	5.38 bc
	2% KNO_3	25.00 d	10.67 ab	12.66 b	4.44bc	5.52 bc
	50mM $CaCl_2$	40.00 a	7.83 e	11.12 d	5.23 a	6.16 a
	100 mM $CaCl_2$	35.00 bc	8.10 de	11.64 cd	4.16 cd	5.84 ab
	150 mM $CaCl_2$	26.00 d	8.50 d	12.12 bc	3.67 e	4.75 d
	LSD at P<0.05	**2.88**	**0.51**	**0.83**	**0.31**	**0.48**
Nagina	Control	26.00 f	13.26 a	14.83 a	4.16 b	4.49 d
	1% KNO_3	41.00 c	8.580 d	15.18 a	4.11 b	6.50bc
	1.5% KNO_3	30.00 e	12.30ab	15.44 a	5.13 a	6.52 bc
	2% KNO_3	50.00 a	8.60 d	12.65 c	4.14 b	7.00 ab
	50mM $CaCl_2$	52.00 a	7.158 e	11.12 d	5.52 a	7.13 a
	100 mM $CaCl_2$	45.00 b	11.12 c	13.77 b	4.52 b	6.27 c
	150 mM $CaCl_2$	35.00 d	11.42 bc	15.62 a	4.09 b	6.41 c
	LSD at P<0.05	**03.44**	**01.15**	**00.92**	**0.56**	**0.55**

Means not sharing the same letters in a column differ significantly at p 00.05

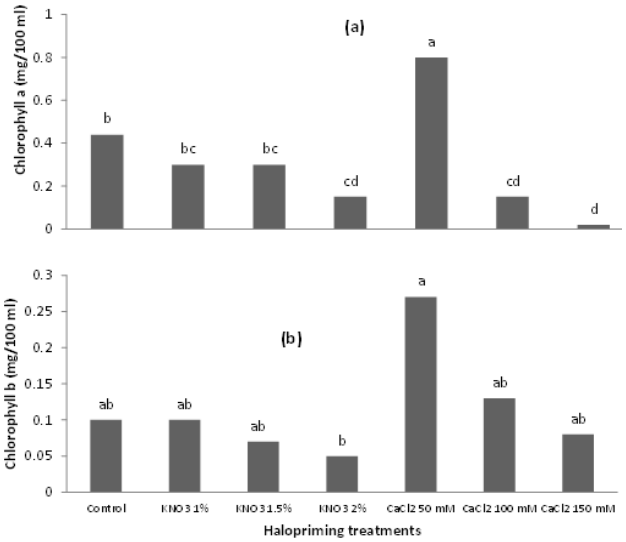
FEP= Final emergence Percentage, MET= mean emergence time, E50 = Time taken to 50% emergence

germination as indicated by less value of T_{50} and MGT in comparison with control and other priming treatments. In addition to 50 mM $CaCl_2$, 1% KNO_3 also triggered higher germination, vigorous seedling length and reduced MGT in tomato cv. Roma. Higher concentration of both salts failed to improve GI and shoot length of both cultivars.

During emergence assay, all priming treatments significantly improved final emergence (Table 2). In both tomato cultivars halopriming with 50mM $CaCl_2$ maximally improved final emergence and took less time for germination as indicated by lower values of E_{50} and MET in comparison with control and other priming treatments. Maximum root and shoot lengths were reported in seedlings raised from seeds primed with 50 mM $CaCl_2$ in both tomato cultivars. Minimum root length was reported in seeds exposed to 150mM $CaCl_2$in cultivar Nagina.

Chlorophyll contents were highly elevated in the seedlings raised from seeds primed with 50 mM $CaCl_2$ (Fig. 1). Moreover, chlorophyll contents were decreased due to seed priming with higher concentration of salts (2 % $KNO_3$and 150 mM $CaCl_2$).

Fig. 1: Chlorophyll contents of tomato seedlings when their seeds were exposed to different halopriming treatments



DISCUSSION

It is well reported that seed priming not only enhances germination capacity, overcomes dormancy but also improves stand establishment which results in higher yield of agronomic and vegetable crops (Afzal *et al*., 2009a; Farooq *et al.,* 2005& 2007; Rasheed *et al.,* 2010). Rapid and harmonized germination was observed in seeds primed with 50 mM $CaCl_2$as indicated by lower MET, T_{50} and MGT, and higher FEP and GI in treated seeds compared with untreated ones in both cultivars (Table I & II).This earlier germination can be linked to the efficient production and utilization of germination metabolites (Lee & Kim, 2000; Basra *et al*., 2005) and better repair (Farooq *et al.*, 2011). A strong association of earlier germination with increased hydrolytic enzyme activity and total sugars is reported in marigold (Afzal *et al*., 2009b) and tomato (Handa *et al.,* 1983).

Higher root and shoot lengths of seedlings raised from treated seeds might be the result of earlier germination and emergence of tomato cultivars (Tables I & II). Haloprimed tomato seeds showed higher seedling stand establishment and early seedling growth, seedlings from primed seeds evolve earlier and more uniformly than seedlings from unprimed seeds (Alvarado *et al.,* 1987). The earlier and superior germination is connected with dormancy breakdown in tomato cultivars (Afzal *et al.*, 2009a). In earlier studies, it was observed that seedlings from primed tomato seeds maintained greater mean plant dry weights, leaf areas and ground cover than untreated seedlings throughout the pre-flowering period (Alvarado *et al.,* 1987).

The findings of present study also suggest that an increase in chlorophyll contents was correlated with enhanced seedling vigor of tomato raised from seeds primed with 50 mM $CaCl_2$. Our findings agree with the Farooq *et al.* (2007) who reported that $CaCl_2$ and KNO_3 improved the early seedling growth of melons compared to untreated. Poor germination and less chlorophyll contents in tomato seedlings raised from seeds primed with higher concentration of salts ($CaCl_2$ or KNO_3) might be due to increased uptake of toxic mineral elements such as Cl^- or NO_3 (Afzal *et al*., 2008b).

In crux, seeds of both Roma and Nagina responded similarly to different halopriming seed treatments. Halopriming with 50 mM$CaCl_2$ showed maximum seed invigoration and better performance in tomato seeds.

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