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What's the Effect of Saline Priming on Germination Factors of *Capsicum annuum* var. 'California Wonder' Seeds?

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ABSTRACT

Due to the often slow and uneven germination of pepper seeds, this study was carried out to evaluate the effect of priming on germination and other related factors. This investigation also evaluated the effect of priming on germination factors of *Capsicum annuum* var. 'California Wonder' seed. Experimental treatments included 1% NaCl, 1% $CaCl_2$, 3% KNO_3, 3% $FeSO_4$ and a control conducted in a completely randomized design under laboratory conditions. Seed priming with $FeSO_4$ was the best treatment resulting in the maximum radicle dry weight, germination percentage and germination rate with values of 0.126 g, 70% and 5.07, respectively while in the control values were 0.063, 36.81%, and 0.83, respectively.

Keywords: % $FeSO_4$, germination, pepper, seed priming
Abbreviations: DRC, completely randomized design; **DW**, dry weight of radicle; **FW**, fresh weight; **GR**, germination rate; **GP**, germination percentage; **LR**, length of radicle; **PEG**, polyethylene glycol

INTRODUCTION

Seed coats and surrounding structures may influence the ability of a seed to germinate through interference with water uptake, gas exchange, diffusion of endogenous inhibitors, or by the mechanical restriction of embryo growth (Ikuma and Thimann 1963). Priming is one of the physiological methods which improves seed performance and provides faster and synchronized germination (Sivritepe and Dourado 1995). Seed priming sometimes reduces the base water potential towards more negative values, increasing the ability of the seed to germinate under low water availability (Bradford 1990).

Two priming treatments often consist of osmopriming and hydropriming. Osmopriming is a type of seed priming that often uses solutions of polyethylene glycol (PEG) as the priming reagent. As a result, the seed imbibes a PEG solution and is restricted only to partial hydration; primed seeds tend to have an improved seed performance indicated by greater germination rate and uniformity. Evidence is accumulating that osmopriming also increases stress tolerance of germinating seeds (Chen *et al*. 2010).

Using seed priming treatments such as KNO_3 have been effective in improving watermelon germination at low temperatures (Demir and Van de Venter 1999). Salt stress causes both osmotic stress and ionic stress (Ueda *et al.* 2003). Heydecker *et al.* (1973) defined osmotic seed priming as a pre-sowing treatment in an osmotic solution that allows seeds to imbibe water to proceed to the first stage of germination but prevent radicle protrusion through the seed coat. NaCl priming has positive effects on growth and yield of mature tomato plants when salt treatments were applied with seed sowing (Cano *et al.* 1991). Wei and Zhu (2011) reported the best priming method for pepper to be 1.8% KNO_3 + 0.2% $ZnSO_4$ for 4 days. Dursun and Ekinci (2010) reported that priming with PEG (−0.5, −1 and −1.5 Mpa at 20 and 25°C for 2 and 4 days) and KNO_3 (0.30 and 0.35 mol/l at 5 and 20°C, 2 and 4 days) treatments were better than the unprimed treatment at 5, 10, 15, 20 and 25°C in *Petroselinum crispum* seeds.

Ganji Arjenaki *et al*. (2011) suggested that priming with a PEG (6000 at −3 bar) solution could be used as a simple method for improving seed germination of *Calendula officinalis* in the laboratory. Tavlli *et al*. (2010) indicated that priming treatments improved the germination vigour of *Bromus* genotypes in which osmopriming treatment (−0.6 MPa for 12 h) increased final germination percentage of *B. tomentellus*. Chen and Arora (2011) reported that osmopriming with −0.6 MPa PEG at 15°C for 8 d in *Spinacia oleracea* improved the antioxidant system and increased seed germination potential, resulting in increased stress tolerance in germinating seeds. Sathish *et al*. (2011) reported seed priming with 1% KH_2PO_4 for 6 h with an increase in the physiological performance of fresh and aged seeds of corn (*Zea mays* L.) hybrid COH (M) 5, and its parental lines UMI 285 (female) and UMI 61 (male). Increased field emergence potential was also observed in seeds primed with 1% KH_2PO_4 for 6 h.

When seeds are in the primed state, important pre-germinative steps such as DNA and RNA synthesis are accomplished in the seed, hence the seeds are physiologically close to germination and have fewer steps to complete than unprimed seed in order to accomplish germination (McDonald 1999; Foti 2008). Ferrous iron, Fe (II), has been shown to be one of the factors responsible for the suppression of seedling emergence and the establishment of rice (Hagiwara and Imura 1993). Priming with $CaCO_3$ most effectively reduced seedling mortality and priming with Ca compounds resulted in earlier emergence in groundnut (Murata *et al.* 2008). Priming with $CaCl_2 \cdot H_2O$ (−1.25 MPa) shortened the emergence time and enhanced the energy and index of seedling emergence in rice and also enhanced emergence and seedling growth. Seed priming changed the pattern of N and Ca^{2+} homeostasis both of the seeds and seedlings, which were associated with enhanced α-amylase activity and the content of reducing sugars. Positive correlations of seedling attributes with nutrient content suggested that, as a result of seed priming, most N and Ca^{2+} were partitioned to

Received: 13 May, 2011. Accepted: 18 August, 2011.

Short Communication

the embryo, enhancing seedling emergence and subsequent growth of rice seedlings (Farooq *et al*. 2010).

As prolonged and non-uniform germination and emergence are characteristic problems in pepper (Demir and Okcu 2004), in this study, we investigated the effects of seed priming salts on germination parameters of pepper seeds under laboratory conditions.

MATERIALS AND METHODS

This experiment was carried out at the Department of Agronomy, Faculty of Agriculture, University of Mashhad, Iran. Seeds of *Capsicum annuum* var. 'California Wonder' were used for the experiment because this cultivar is highly cultivated in Iran. The mean seed dry weight for 1000 seeds was 7 g and purity was 99% when the experiment was conducted. The experimental design was a completely randomized design (CRD) with three replications and 20 seeds per replication. Seeds were primed in a solution of 1% NaCl, 1% $CaCl_2$, 3% KNO_3 and 3% $FeSO_4$ at 25°C for 72 h under laboratory conditions. The control treatment consisted of seeds that were primed for 72 h in distilled water. After 72 h, seeds were washed three times for 5 min in distilled water and then dried with blotting paper until extra moisture content was lost. Then seeds were placed on another sheet of blotting paper in a Petri dish at 25°C in the laboratory. The number of germinated seeds was recorded daily. Emergence was counted daily for 18 days with seeds recorded as having emerged when the length of the radicle reached 0.5 cm after 18 days. The traits measured were: percentage germination (G%), germination rate (GR), fresh weight (FW), dry weight (DW) and length of the radicle. DW was measured after placing radicles in an oven at 50°C for 12 h. The following formula was used to calculate GR according to the equation of McWhorter (1984):

GR = No. germinated seeds/Days of first count + ……. + No. Germinated seeds/Days of final count.

Data was analyzed statistically using analysis of variance in SAS 9.1 and the LSD test at $P = 0.05$ was used to compare differences among treatment means.

RESULTS

Analysis of variance of factors showed that significant differences existed in radicle DW, G%, FW and GR but not in radicle length (**Table 1**). The best seed priming treatment was 3% $FeSO_4$, which improved GR, G% and radicle DW (0.126 g). 0.09 g of DW was observed in 1% $CaCl_2$ while it was 0.12 g in 3% $FeSO_4$. There was no significant difference between other treatments and the control (**Table 2**). 3% $FeSO_4$ resulted in the highest G% (~70%). All treatments except for 3% KNO_3 were significant different to the control (**Table 2**). The maximum GR was in 3% $FeSO_4$ (5.07%). There were significant differences between this treatment and other treatments. The lowest GR was observed in the control and KNO_3: 0.83 and 1.1, respectively (**Table 2**). The highest radicle FW was observed in $FeSO_4$ and NaCl (0.37 and 0.33 g, respectively) while the lowest radicle FW (0.143 g) was observed in the control.

DISSCUSION

Between treatments, $FeSO_4$ significantly improved DW, G% and GR in pepper cv. 'California Wonder'. All treatments compared to the control resulted in a higher germination rate. These findings are in agreement with the findings of Demir and Mavi (2004) who determined that salt priming can increase watermelon emergence. Demir and Van de Venter (1999) reported that seed priming treatments using salts such as KNO_3 effectively improved watermelon germination at low temperatures. According to Hagiwara and Imura (1993), ferrous iron, Fe (II) is one of the factors responsible for the suppression of seedling emergence of rice. KNO_3 also improved the radicle FW of pepper; similarly, Amjad *et al*. (2007) also reported KNO_3 to be better than

Table 1 Analysis of variance traits under study.

SV	DF	M.S				
		GP	LR	DW	FW	GR
Treatment	4	498.426**	96.848 ns	0.0018**	0.0233*	8.609**
Error	10	54.01	81.584	0.0002	0.0068	0.415

Ns: no significant
**: significant at the 0.05 level of probability according to LSD test
DW, dry weight of radicle; **FW**, fresh weight; **LR**, length of radicle; **GP**, germination percentage; **GR**, germination rate

Table 2 The effect of seed priming on GP, GR, DW, LR and FW *Capsicum annuum* var: 'California Wonder'.

Treatment	GP	GR	DW	LR	FW
$FeSO_4$	72.01 a	5.07 a	0.126 a	9.47 a	0.37 a
$CaCl_2$	58.86 ab	2.77 b	0.093 b	19.98 a	0.25 ab
KNO_3	50.61 ab	2.20 bc	0.086 bc	16.00 a	0.28 ab
NaCl	55.45 ab	1.10 cd	0.070 bc	16.24 a	0.33 a
Control	36.52 c	0.83 d	0.063 c	5.94 a	0.14 b

Different letters indicate significant difference between treatments at 5% levels according to LSD test
DW, dry weight of radicle; **FW**, fresh weight; **LR**, length of radicle; **GP**, germination percentage; **GR**, germination rate

other treatments by decreasing time to 50% germination, increasing root and shoot length, seedling FW and vigour. Lanteri *et al*. (2000), using molecular markers to study seed priming in *C. annuum* reported a relationship between osmoconditioning effects and the activation of DNA replication as well as the accumulation of β-tubulin, a constitutive element of microtubules, in the embryo root tips after priming in PEG 6000 solution, at the osmotic potentials of −1.1 and −1.5 MPa. Patade *et al*. (2011) treated *C. annuum* 'California Wonder' seeds with various chemical priming agents like calcium chloride (50 mM), hydrogen peroxide (1.5 mM), potassium nitrate (300 mM), abscisic acid (ABA, 100 µM), PEG 6000 (16.7 mM), thiourea (1.3 mM), NaCl (50 mM) and copper sulphate (5 mM) for 24 h pre-germination. They reported primed seeds in general exhibited faster germination and better seedling establishment and also imparted tolerance to subsequent exposure to cold (4°C) stress than the control. Barlow and Haigh (1987) used K_2HPP_4 and KNO_3 (−1.25 MPa) solutions for 12 days at 15°C to prime *Lycopersicum esculentum* var. 'UC 82B' seeds over two growing seasons. They reported that primed seedlings emerged 4-5 days earlier than unprimed seeds when sown early in the season and 1-2 days earlier when sown in mid-season.

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