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Efeect of Osmopriming on Germination and Seedling Growth of Corn (*Zea mays* L.) Seeds

Mahdi Ghiyasi, Mohamad Reza Zardoshty, Amir Fayyaz Mogadam,
Mehdi Tajbakhsh and Reza Amirnia
Department of Agronomy, Faculty of Agriculture, Urmia University, Urmia, Iran

Abstract: Seed priming have been used successfully in an attempt to improve germination and seedling establishment of many vegetables and field crops. In this study, seeds of corn after disinfected with 0.5% sodium hypochlorite solution were primed with polyethylene glycol (PEG 8000), KNO_3 and KH_2PO_4. The osmotic potential in all solutions were -0.5, -1.0 -1.5 and -2 MPa. Seeds were primed for 24 h at 25±2°C. Measured parameters were Germination Rate (GR), time reach to 50% germination (T_{50}), root and shoot length, seedling fresh and dry weight. Analized of data showd germinatin and seedling growth significantly ($p<0.01$) affacted by osmopriming treatments.We obtained osmopriming by polyethylene glycol in -0.5 MPa osmotic potential improved germination and seedling growth compared with other treatments.

Key words: Osmopriming, germination, seedling, corn, PEG 8000

INTRODUCTION

Good seedling establishment is an important constraint to crop production in the marginal areas (Harris, 1999). Poor crop stand establishment is one of the major biotic constraints encountered by resource-poor farmers in marginal areas (Harris, 1996). This is particularly true for crops such as maize (*Zea mays L.*), which do not have the capacity to adjust to incomplete stands by tillering (Harris *et al*., 2002).

Seed priming is a process in which seeds are imbibed in water or osmotic solutions followed by drying before radical emergence (McDonald, 2000). Seed priming has been used to improve germination, reduce seedling germination time, improve stand establishment, increase emergence, earlier flowering, earlier maturing and higher grain yield (Harris *et al*., 1999, 2001, 2002; Khan, 1992; Basra *et al*., 2005; Farooq *et al*., 2005). In addition to, some metabolical and physiological changes also occur in the primed seeds, which are helpful in the later growth of embryo, e.g., apportion of the seed endosperm is hydrolyzed during priming that permits faster embryo growth. Moreover, seed priming treatments such as osmopriming are recommended for earlier DNA replication (Bray *et al*., 1989), increased RNA and protein synthesis (Fu *et al*., 1988; Ibrahim *et al*., 1983), greater ATP availability (Mazor *et al*., 1984), repair of deteriorated seed parts (Saha *et al*., 1990; Klarssen *et al*., 1989) and reduced leakage of metabolites (Styer and Cantliffe, 1983).

Primd seeds can have improved germination rate and uniformity, particularly under adverse seed bed conditions such as low temperature (Stoffela *et al*., 1988), matric stress (Akers *et al*., 1987), salinity (Pill *et al*., 1991) and heat.

Osmopriming is a most widely used type of seed priming in which seeds are soaked in aerated low water potential solutions. Examples of such osmotica used include Polyethylene Glycol (PEG), KNO_3, K_3PO_4, KH_2PO_4, $MgSO_4$, NaCl, manitol and others (Lee and Kim 1999; Basra *et al*., 2005).

MATERIALS AND METHODS

Experiments were conducted in the laboratories of the Urmia University, Faculty of Agriculture, Department of Agronomy. The design of the experiment was Completely Randomized Design (CRD) with three replications. Seed of maize *(Zea mays L.)* hybrid SC 704 was used as plant materials. The seed was obtained from Agriculture Research Station, Urmia, West Azerbaijan, Iran. Moisture content was determined by grinding the seeds and then drying at 130°C for 4 h (ISTA, 2003) and found to be 11.8% on a fresh weight basis.

The seeds were surface sterilized with 5% NaOCl (sodium hypochloride) for 5 min to avoid fungal invasion, followed by washing with distilled water. The seeds were primed by solutions of Polyethylene Glycol (PEG) 8000, KNO_3 and KH_2PO_4. During osmopriming operation, the

Corresponding Author: Mahdi Ghiyasi, Department of Agronomy, Faculty of Agriculture, Urmia University, Urmia, Iran

solutions were aerated continuously. The osmotic potential levels of the all solutions were 0.0, -0.5, -1.0, -1.5 and 2.0 MPa. Seeds were primed for 24 h at 25±2°C. After osmopriming seeds were given three surfaces washing with distilled water then redried to near original weight under shade (Khan, 1992).

Germination test: Germination experiment was conducted in germinator at 25°C in 9-cm Petri dishes (20 in each) between the layers of moist filter paper. Germination was observed daily according to the AOSA (1991). A seed was considered germinated when the radical pierced the coats up to 2 mm. Time to reach 50% germination (T_{50}) was calculated according to the following formula of modified by Farooq *et al*. (2005) as:

$$T_{50} = t_i + [(N/2 - n_i) (t_j - t_i)] / (n_j - n_i)$$

where, N is the final number of germination and n_i ,n_j cumulative number of seeds germinated by adjacent counts at times when $n_i < N/2 < n_j$

Mean Germination Time (MGT) was calculated according to the equation of as:

$$MGT = \Sigma Dn/\Sigma n$$

where, n is the number of seeds , which were germinated on day D and D is the number of days counted from the beginning of germination. Germination Index (GI) was calculated according to the following formulae of (AOSA, 1990).

GI = No.of germinated seeds / Days of first count
+. . .+ No . of germinated seeds / Days of final count

Seedling emergence: Treated and control seeds were sown in 35×35 cm plastic trayes (40 in each) having moist sand replicated three times and were placed chamber. A factorial experiment was design and conducted in the base of completely randomized design. Emergence was recorded daily according to the seedling evaluation Handbook of Association of Official Seed Analysts (1990). Mean emergence time was calculated according to the method described earlier. Root and shoot length and seedling fresh and dry weights were recorded 8 days after sowing. The data analyzed by MSTATC and Excel software and means comparisons was done by Duncan's test.

RESULTS AND DISCUSSION

The germination analysis of data (Table 1 and 2) indicates that the seed and seedling vigor were significantly affected by different osmopriming treatments during germination test. Statically minimum MGT was

Table 1: Effect of different osmopriming treatments on the germination of corn

Treatments	GR%	T_{50}	GI	MGT
KH_2PO_4				
0.0 MPa	92.00 b	4.37 b	24.24 gh	3.93 ab
-0.5 MPa	93.66 b	2.22 e	63.07 d	1.73 cd
-1.0 MPa	73.38 c	3.13 cd	32.44 f	2.66 bc
-1.5 MPa	62.91 d	4.147 b	22.37 h	3.26 abc
-2.0 MPa	47.55 e	6.29 a	17.47 j	4.34 a
KNO_3				
0.0 MPa	92.01 b	4.22 b	24.55 gh	3.89 ab
-0.5 MPa	93.75 b	2.03 e	66.13 c	1.75 cd
-1.0 MPa	71.54 c	2.81 d	31.64 f	2.67 bc
-1.5 MPa	48.47 e	6.19 a	20.03 i	2.98 abc
-2.0 MPa	35.97 f	6.32 a	16.04 j	2.16 cd
PEG				
0.0 MPa	92.30 b	4.28 b	24.90 g	3.99 ab
-0.5 MPa	96.77 a	1.05 f	93.67 a	1.08 d
-1.0 MPa	93.71 b	1.16 f	92.64 a	1.05 d
-1.5 MPa	93.44 b	1.18 f	84.62 b	2.06 cd
-2.0 MPa	73.65 c	3.07 cd	49.13 e	1.82 cd

Time to reach 50 % germination = T_{50}. Mean Germination Time = MGT. Germination index = GI,. Figures not Sharing the same letters in a colum differ significantly at $p<0.01$

Table 2: Effect of different osmopriming treatments on the seedling vigor of corn

Treatment	MET	Root length (cm)	Shoot length (cm)	Root/shoot ratio	Seedling fresh weight(g)	Seedling dry weight (g)
KH_2PO_4						
0.0 MPa	6.55 ab	27.87 e	13.53 e	2.06 a	0.64 a	0.066 a
-0.5 MPa	3.80 fgh	31.27 c	16.47 c	1.89 bcd	0.61 ab	0.061 abcd
-1.0 MPa	4.63 ef	29.40 d	16.48 c	1.78 e	0.62 ab	0.062 abcd
-1.5 MPa	5.60 cd	26.50 f	16.28 c	1.63 f	0.54 bc	0.059 abcd
-2.0 MPa	6.86 ab	24.67 g	15.12 d	1.62 f	0.46 de	0.051 cde
KNO_3						
0.0 MPa	6.57 ab	28.07 e	13.55 e	2.10 a	0.64 a	0.067 a
-0.5 MPa	3.54 h	31.33 c	16.35 c	1.92 bc	0.63 a	0.044 ab
-1.0 MPa	4.43 efg	29.17 d	16.26 c	1.79 de	0.66 a	0.067 a
-1.5 MPa	6.03 bc	25.23 g	16.40 c	1.53 f	0.46 de	0.05 de
-2.0 MPa		22.93 h	12.78 f	1.8 de	0.43 e	0.047 e
PEG						
0.0 MPa	6.63 ab	28.07 e	13.57 e	2.07 a	0.64 a	0.070 a
-0.5 MPa	3.11 h	32.23 b	17.79 a	1.81 cde	0.55 bc	0.059 abcd
-1.0 MPa	3.38 h	34.37 a	17.28 ab	1.98 ab	0.67 a	0.071 a
-1.5 MPa	3.61 gh	31.40 c	16.89 bc	1.85 cde	0.54 bc	0.051 cde
-2.0 MPa	4.79 de	26.87 f	16.72 bc	1.60 f	0.53 cd	0.054 bcde

Mean emergence time = MET. Figures not Sharing the same letters in a colum differ significantly at $p<0.01$

observed in seeds subjected to PEG 8000 (-0.05 and -1.00 MPa) osmopriming (Table 1). Highest germination percentage, maximum GI and lower T_{50} were noted in treated seeds by PEG 8000 (-0.05 MPa) (Table 1).

The osmopriming seeds by PEG 8000 (-1.00MPa) showed lowest mean emergency time (Table 2). Maximum root and shoot length were measured in osmoprimed seeds by PEG 8000 (-0.05) (Table 2). The osmopriming with KNO_3 and KH_2PO_4 did not improve germination and seedling growth except for -0.05 MPa. Delay and poor germination in seeds subjected to osmoconditioning for 24 h was probably due to KNO_3 and KH_2PO_4 toxicity, as was reported by Basra *et al.* (2002) for wheat and Basra *et al.* (2003) for rice. KNO_3 and KH_2PO_4 toxicity results in injury to the cellular organelles and membranes of wheat. But these findings are in contrast to that of Haigh and Barlow (1987) in sorghum, Nerson and Govers (1986) in muskmelon and Rivas *et al.* (1984) in study who reported higher seedling vigor and emergence rate as a result of KNO_3 priming.

CONCLUSION

In conclusion the results of the present study suggest that seed priming by PEG 8000 for 24 h is very effective tool for invigoration in maize (*Zea mays* L.) hybrid SC 704.

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