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Effect of Osmopriming with Polyethylene Glycol (8000) on Germination and Seedling Growth of Wheat (*Triticum aestivum* L.) Seeds under Salt Stress

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Abstract: Due to increased salinity problems, efforts are being made to develop strategies to ameliorate salt stress. This study was conducted to evaluate the effectiveness of osmopriming in ameliorating salinity stress effects in wheat (*Triticum aestivum* L.). Seeds were primed for 12 h with solutions of polyethylene glycol (PEG 8000). The osmotic potentials of the PEG solutions were-0.4, -0.8 and -1.2 MPa. The control was not treated with (PEG). The experiment was factorial based on CRD with three replications. Salinity levels were 4, 8, 12 and 16 dS m^{-1}. Results showed osmopriming by polyethylene glycol 8000 can be improved germination and seedling compared to control (non-priming) under salt stress condition.

Key words: Osmopriming, salt stress, polyethylene glycol, germination, wheat

INTRODUCTION

Soil salinity is known to suppress the growth of most crop species, but considerable differences in salinity tolerance exist between species (Mass and Hoffman, 1977). Seed priming is a pre-germination seed treatment in which seeds are held at water potential that allows imbibitions, but prevents radical extension (Bradford, 1986). Priming seeds of a number of crops has improved germination, seedling establishment and in some cases, stimulated vegetative growth and hence crop yield (Ahmad *et al*., 1998; Ashraf and Rauf, 2001; Harris *et al*., 1999; Khan, 1993). Osmopriming has increased the rate and uniformity of germination and seedling emergence, especially under sub-optimal conditions such as salinity (Pill *et al*., 1991; Weibe and Muhyaddin, 1987; Shad *et al*., 2001).

The objective of the present study was to assess the effect of osmopriming by polyethylene glycol 8000 on germination and seedling growth of wheat under salinity condition.

MATERIALS AND METHODS

Experiments were conducted in the laboratories and greenhouse of the Urmia University, Faculty of Agriculture, Department of Agronomy, during the 2006. Seed of wheat, cultivar Zarin, was used. The seed was obtained from Agriculture Research Station, West Azerbaijan, Urmia, Iran. Moisture content was determined by grinding the seeds and then drying at 130°C for 4 h (ISTA, 2003) and was found to be 11.7% on a fresh weight basis.

The osmotic potentials of PEG 8000 solutions were determined according to Michel (1983). The seeds were surface sterilized with 5% Naocl (sodium hypochlorite) for 5 min to avoid fungal invasion. Seeds were primed in aerated solution of PEG 8000 using an aquarium pump. The ratio of seed weight to solution volume was kept 1: 5 (g mL^{-1}) (Ruan and Tylkowske, 2002). After priming, seeds were given 3 surfaces washing with distilled water (Khan, 1993) and redried near to original weight under shade (Basra *et al*., 2002). The osmotic potentials of the PEG 8000 solutions were -0.4, -0.8 and -1.2 MPa. Seeds were primed for 12 h. The control was not treated with water or PEG 8000. Salinity levels were 4, 8, 12 and 16 dS m^{-1}.

Germination test: Seeds were sown in petri dishes (20 in each) between layers of moist filter paper whatman 45 at 20°C in an incubator. A factorial experiment was design and conducted in the base of completely randomized design. Germination was observed daily according to the AOSA method, (AOSA, 1990). The time to reach 50% germination (T_{50}) was calculated according to the following formulae of Coolbear *et al*. (1984) modified by Farooq *et al*. (2005) as:

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

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Where:

N : The final number of germination.

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 Ellis and Roberts (1981) as:

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

Where:

N : The number of seeds, which were germinated on day.

D and D : The number of days counted from the beginning of germination. Germination index (GI) was calculated according to the following formulae.

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 trays (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. Abnormal seedling percentages, evaluated according to Association of Official Seed Analysts Rules (AOSA, 1992).

RESULTS AND DISCUSSION

Results showed osmopriming treatments (P), salinity levels (S) and P × S interaction significantly ($p<0.01$) affected germination and seedling growth. Comparison of treatment means indicated final germination percentage (GE%), Mean Germination Time (MGT), time reach to 50% germination (T_{50}), root and shoot length, mean emergence time (MET), Germination Index (GI), root/shoot ratio and seedling fresh and dry weight were significantly ($p<0.01$) affected by osmopriming treatments in all salinity levels (Table 1 and 2). The effect of the osmopriming treatments in the all salinity levels on percentage of abnormal seedling was found significant at ($p<0.01$) (Fig. 1).

Table 1: Effect of osmopriming treatments on the germination vigor of wheat under salinity condition

Treatments	GR (%)	T_{50}	GI	MGT
S1P1	92.00bcde	2.00g	68.00e	3.40fg
S1P2	95.33ab	1.63i	81.17a	2.26l
S1P3	95.67a	1.49jk	79.80a	2.19lm
S1P4	93.83abc	1.42k	77.40b	2.07m
S2P1	90.00def	2.39d	63.37fg	3.84d
S2P2	92.00bcdf	1.69i	73.57c	2.46k
S2P3	93.67abc	1.53j	75.08c	2.56jk
S2P4	92.67abcd	1.46jk	74.67c	2.46k
S3P1	88.33f	2.54c	57.67h	3.97c
S3P2	90.00def	2.16ef	70.46d	2.67ij
S3P3	90.67cdef	1.99g	68.74de	2.77i
S3P4	89.67def	1.86h	68.80de	2.63j
S4P1	82.33g	2.85b	51.59i	4.34b
S4P2	88.67ef	2.39d	63.69f	3.30jh
S4P3	89.00ef	2.21e	62.48fg	3.26h
S4P4	90.00def	2.12f	61.11g	3.31jh
S5P1	77.00h	3.24a	47.29j	4.65a
S5P2	81.00g	2.78b	53.29i	3.52ef
S5P3	81.33g	2.56c	52.45i	3.57e
S5P4	82.00g	2.51c	51.57i	3.62e

Figures not sharing the same letters differ significantly at $p<0.1$. S1, S2, S3, S4 and S5 are salinity levels. P1, P2, P3 and P4 are priming levels

Table 2: Effect of osmopriming treatments on the germination vigor of wheat under salinity condition

Treatments	MET	Root length (cm)	Shoot length (cm)	Root/shoot ratio	Seedling fresh weight (mg)	Seedling dry weight (mg)
S1P1	6.22d	20.37g	14.55e	1.44c	37.29d	5.69d
S1P2	4.07h	23.32ab	16.23bc	1.43c	39.14a	6.07ab
S1P3	4.10h	23.04abc	16.00bc	1.40cd	39.10a	6.06ab
S1P4	4.07h	23.67a	16.35b	1.43c	38.95a	6.17a
S2P1	6.82c	19.19h	14.50e	1.30e	36.06e	5.54f
S2P2	4.51g	23.03abc	16.13bc	1.42c	38.91a	6.13ab
S2P3	4.58g	23.18abc	16.23bc	1.41cd	38.32b	6.07ab
S2P4	4.55g	22.87bc	15.70cd	1.46c	37.91c	6.05ab
S3P1	7.11 c	17.95i	13.56f	1.34de	34.25g	5.16g
S3P2	5.09f	22.60cd	15.85bc	1.45c	37.83c	6.00bc
S3P3	5.05f	22.23de	15.74cd	1.41cd	37.61cd	5.91c
S3P4	5.31f	22.16de	15.23d	1.46c	37.66cd	5.93c
S4P1	8.13b	17.31j	13.23fg	1.33e	31.13ij	5.00h
S4P2	5.16f	21.51f	14.51e	1.45c	34.97f	5.58de
S4P3	5.19f	22.08def	14.67e	1.48bc	34.33g	5.51ef
S4P4	5.22f	21.67def	14.66e	1.46c	34.16g	5.44f
S5P1	8.60a	15.31l	11.67h	1.3e	28.96k	4.51i
S5P2	5.87e	19.43h	12.76g	1.56a	31.70h	5.18g
S5P3	5.85e	19.70h	12.80g	1.55ab	31.46hi	5.02h
S5P4	5.94de	19.73h	12.90g	1.58a	30.90j	4.99h

MET = mean emergence time; S1, S2, S3, S4 and S5 are salinity levels. P1, P2, P3 and P4 are priming levels. Figures not sharing the same letters differ significantly at $p<0.1$

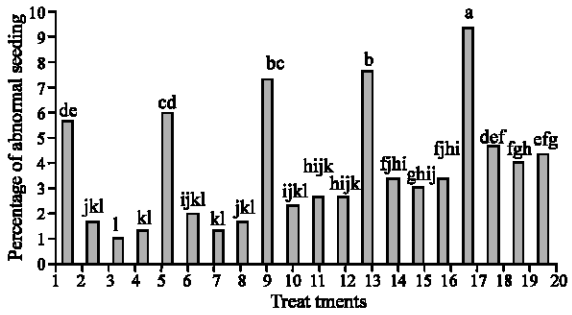

Fig. 1: Effect of osmopriming by PEG 8000 on the percentage of abnormal seedling of wheat under different salinity levels. 1 = (S1P1), …., 20 = (S5P4). Bars with the same letter are not significantly different at $p<0.1$

Our results indicated osmopriming is a successful practice for improving seed germination performance under salt stress. These findings are supported by the earlier work on improved germination by osmopriming in wheat (Basra *et al*., 2002). Faster germination rate after osmopriming may also be explained by an increased rate of cell division in the seed as previously found for wheat (Bose and Mishra, 1992). In addition to, the increase in emergence with priming might be due to initialing metabolic events in primed seed.

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