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RESEARCH ARTICLE

Effect of polyethylene glycol (PEG) 6000 on seed priming in drought tolerant and sensitive barley (*Hordeum vulgare* L.) seeds

■ **NARAYANI SHUKLA, YASHODHARA VERMA, P. K. SHUKLA AND PRAGATI MISRA**

SUMMARY

Barley (*Hordeum vulgare* L.) is a grain cereal in dry land farming systems of semi-arid areas. Effect of polyethylene glycol (PEG)-6000 on seed priming was assessed and germination percentage and seedling vigour index were studied in drought tolerant and drought sensitive barley seedling. Two levels of PEG-6000 *i.e.*-1.5 and -3.0 bars osmotic potential that were imposed to study seed priming by polyethylene glycol (PEG)-6000. Result showed that the germination percentage and seedling vigour index were significantly affected by osmotic potentials. At an osmotic potential value -3.0 bars induced by of PEG-6000, germination percentage and seedling vigour index showed an higher reduction than induced by -1.5 bars osmotic potential.

Key Words : Barley, Polyethylene glycol (PEG), Germination percentage, Seedling vigour index

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Agriculture has been being affected by environmental stresses such as drought, salinity,extreme temperatures, chemical toxicity and oxidative stress which reduce crop yield fifty per cent, approximately and water stress that is caused by salinity and drought is a prevalent problem in the world. However, plants are affected by drought and salinity similarly (Khayatnezhad *et al*., 2010). Abiotic stress may delay seed germination and reduce the rate of germination as well (Patade *et al*., 2011; Rouhi *et al*., 2011 and Ansari and Sharif-Zadeh, 2012). Scientific soaking for crop seeds and pre-treating with diverse regulatory substances are of great importance for

obtaining high germination rate and uniform seedlings with good quality, which are the pre-reqisite for higher production of crops (Shao *et al*., 2003). Seed germination has a very important role in determining final plant density and sufficient plant density can be calculated when the seeds germinate fully and with an appropriate rate (Baalbaki *et al*., 1990).The non-toxic PEG solution is used because of high molecular weight, which cannot enter into cell through plant cell wall (Emmerich and Hardgree,1990; Kaydan and Yagmur, 2008) as compared mannitol, having low molecular weight to enter into cell and causes toxicity. Water absorption under optimal conditions, after breaking the seed dormancy (if any) leads to the activation of metabolic processes which result in germination. The presence of compounds with osmotic properties which results in decreasing osmotic potential often leads to disturbance in germination of seeds (Ungar, 1996) and limits the water source. Seed germination and early stage seedling growth is considered as the most critical phase for establishment and crop (Pratap and Sharma, 2010). Therefore, the study aimed to determine the effect of seed priming treatment on the germination of barley seeds under drought stress.

MATERIAL AND METHODS

Six varieties of barley (*Hordeum vulgare* L.), which include three drought sensitive (K-551, K-572, K-287) and three drought tolerant (K-603, K-560, K-125), were used for present investigation. The seeds were obtained from *Rabi* Cereal Section, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur.

Two different concentrations of polyethylene glycol (PEG)-grade 6000*viz*.100 g/kg soil 150g/kg soil, equivalent to -1.5bars (T_1) and -3.0bars (T_2) of osmotic potentials, were used as priming agent for 24 hrs at 15^0C. The barley seeds were surface sterilized with sodium hypochlorite 20 per cent for 5 minutes prior to inoculation. PEG treated seeds were inoculated in Petriplates with cotton pads under aseptic conditions with Hoagland's solution. Hoagland's solution alone without PEG was treated as control (T_0).

After test time expiration, germination percentage and seedling vigour index were evaluated. The germination percentage was estimated according to the formula outlined by Krishnasamy and Seshu (1990):

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Number of tested seed}} \times 100$$

The seedling vigour index (VI) of the seedlings was estimated according to fomula by Abdul-Baki and Anderson (1973) :

Seedling vigour index (SVI)= germination (%)× (root length (cm) + shoot length (cm)

Data collected were subjected to statistical analysis using software WASP 2.1 (Web Agri Stat Package) for interpretation of results and interferences.

RESULTS AND DISCUSSION

Analysis indicated that seed priming had significant ($p > 0.05$) effect on germination percentage of barley varieties. Increasing the concentration of PEG-6000 decreased the germination percentage of primed seeds. At -1.5bars (T_1) osmotic potential, germination percentage of drought sensitive varieties of barley showed less germination percentage than drought tolerant varieties in comparison to control whereas at -3.0 bars (T_2) osmotic potential, germination percentage of drought sensitive varieties was very less as compared to drought tolerant varieties in response to control (Table 1 and Fig. 1). The priming of spinach seeds with PEG enhanced drought tolerance in germinating seeds and

Table 1 : The effect of PEG on germination percentage and seedling vigour index

	Characters treatments									
	Germination percentage (%)			Root length			Shoot length			Seedling
Varieties	T_0	T_1	T_3	T_0	T_1	T_3	T_0	T_1	T_3	vigour index
V_1	80.3	52.3	21.0	10.1	8.5	3.4	14.5	10.2	6.1	1978.0
V_2	83.0	51.3	19.7	10.3	8.6	3.5	14.6	10.2	6.2	2063.4
V_3	82.3	54.7	22.7	11.1	8.9	3.8	14.7	10.3	6.2	2122.5
V_4	84.3	55.0	24.3	11.5	9.1	5.4	14.9	11.8	8.3	2229.6
V_5	85.3	56.3	26.3	11.8	9.3	5.3	15.1	11.9	8.3	2302.2
V_6	86.0	57.3	29.3	12.1	9.5	5.5	15.3	12.0	8.9	2359.0
C.D.(P=0.05)	3.0	3.0	2.6	0.1	0.3	0.4	0.1	0.0	0.0	
CV	2.0	3.1	6.1	0.3	0.3	4.6	0.2	0.3	0.3	

$p > 0.05$

primed seeds exhibited improved germination rate and final germination percentage at drought stress (Chen *et al*., 2010). At all drought stress potentials, the priming increased the germination rate of the barley seed. At -6 MPa drought stress, the germination rate of primed seed with -10 and -14 MPa was not different and greater than those of 0 and -7 MPa priming treatment. At drought stress of -9 MPa, the germination rate of primed seed with -14 MPa was the highest and other priming treatments were not significantly different (Amini,2013). Khazayi *et al.* (2008) in their study concluded that negative potentials between -0.4 and -0.8 MPa are the best condition for studying germination features of different genotypes of plants under drought stress. The results are in agreement with the earlier study Ansari and Sharif-Zadeh (2012) who reported the significant reduction in the germination as well as growth of Rye. Also, earlier reports (Patade *et al*., 2011; Ansari and Sharif-Zadeh, 2012 and Rouhi *et al*., 2011) have shown positive effect ofpriming in relation to seed performance, germination percentage and seedling indices.

The seeds were subjected to extensive levels of drought stress of -1.5 bars and -3.0 bars of induced by polyethylene glycol-6000. Effect of PEG-6000 was found significant ($p > 0.05$). It was observed that at -3.0bars (T_2) of osmotic potential clearly affected the vigour index as compared to the control (T_0). Vigour index was greater at -1.5 bars (T_1) than -3.0 bars (T_2) osmotic potential of polyethylene glycol-6000. Drought tolerant varieties of barley showed greater value of vigour index in comparison to drought sensitive varieties (Table 1 and Fig. 2). Root and shoot length reduced by PEG and mannitol induced drought and similar findings have been reported by many scientists (El-Midaoui *et al*., 2003 and Parmar and Moore, 1965). The seedling vigour index was greatly hampered at -.15 (111.35) and -0.20 (21.66) MPa levels over control

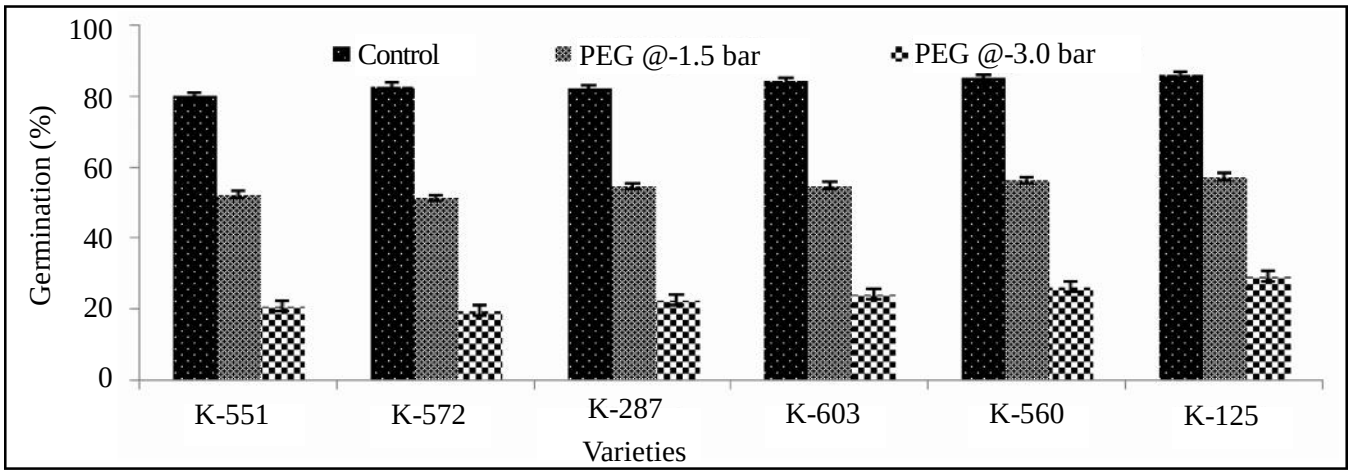

Fig. 1: The effect of PEG (control,-1.5 and -3.0 bars) on germination percentage of barley (*Hordeum vulgare* L.) seedlings

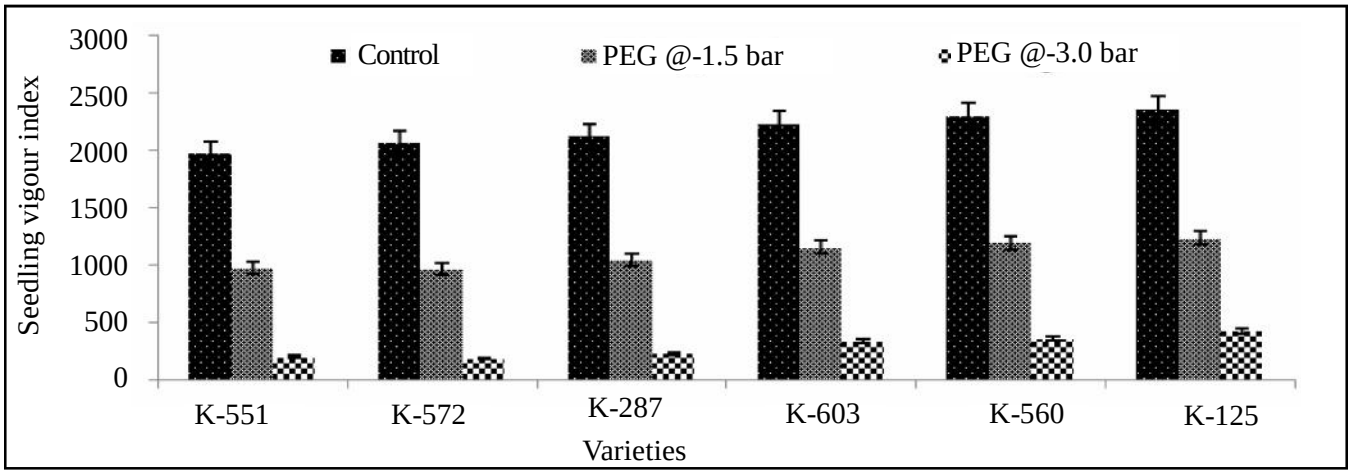

Fig. 2: The effect of PEG (control,-1.5 bars and -3.0 bars) on seedling vigour index of barley (*Hordeum vulgare* L.) seedlings

(308.85) (Rahamare *et al*., 2014). Moreover, improved germination and radical growth under osmotic stress also were observed in sorghum bicolor seeds primed with PEG (Patane *et al*., 2009).

Conclusion :

As results of this study, it could be concluded that the germination percentage and seedling vigour index was inhibited at different osmotic potential at polyethylene glycol (PEG) 6000. Significant decrease was shown at -3.0 bars osmotic potential of polyethylene glycol. It was observed that drought tolerant seedlings gave better result than drought sensitive seedlings of barlery.

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