Ameliorative Effect of Seed Priming on Germination, Vigour Index and Tolerance Index against Short Term Moisture Stress in Maize (Zea mays L.)

V. Singh, M. Sharma, H. Upadhyay, A. Siddique

ABSTRACT
An experiment was carried out to evaluate the effect of seed priming with magnesium nitrate salt against the moisture stress condition induced by Polyethylene glycol-6000 on seed germination, vigour index and tolerance index in root and shoot. Polyethylene glycol-6000 was used to create short term moisture stress under laboratory conditions while the seed priming was carried out by using magnesium nitrate. The percent germination, seed vigour index and tolerance index were started to decline from T₀ to T₇ (i.e. set first 1.5 and 4.5% of PEG-6000 solution + none primed seed) while the results of second set (i.e. PEG-6000 + primed seed from T₈ to T₁₀) were also following the same decreasing trend along with improvement in every parameters. The germination was recorded highest 100 percent in T₀ (i.e. 1.5% PEG-6000+ primed seed) followed by T₇ (T₉ and T₁₀ (T₉ and T₁₀ is 2.5% and 3.5% PEG-6000 + primed seed) while the control set recorded 98.7% at final date of observations i.e. 240 Hrs. vigour index and tolerance index was also decreasing in both the set of treatments but PEG-600 + primed seed showed better results as compared to the treatments PEG-6000 + none primed. Tolerance index percent was recorded maximum in root as compare to shoot at 120 hrs. of intervals while the reverse result was recorded at 240 hrs. of intervals.

Key words: Moisture stress, PEG-6000, Seed germination, Tolerance index, Vigour index.

INTRODUCTION
Maize (Zea mays L.) is an important cereal crop for mankind having third rank in terms of production next to wheat and rice that grown under wide range of climatic condition. It is popularly known as the rich source of carbohydrate, protein, vitamins and minerals (Shah, 2016 and Sheng et al., 2018). Abiotic stresses, such as drought, salinity, low or high temperature and heavy metal toxicity are alarming threats to agriculture in respect to crop production and soil health. Among the abiotic stresses, drought is a most important environmental constraint that not only limits the growth and development but also reducing yield of crop plants; hence, it is one of the most devastating environmental stresses (Bulgari et al., 2019 and Xiong et al., 2006). Due to high economic importance of maize crop, it is grown around the world (Pranal et al., 2017). Drought affects almost every phases of growth as well as development of plant but the most devastating effect was started from seed germination and seedling growth (Anaytullah et al., 2008 and Rauf, 2008 and Khayatnezhad et al., 2010). Collective efforts of seedling emergence, establishment and synchronized growth lead to keep good foundation for future growth towards the crop yield (Finch-Savage, 2016 and Hadas, 2004). Seed priming is technique in which seeds are pre-soaked in water or in desired osmotic solution for a certain period of time. During the period of seed priming, seeds allow to imbibe water that helps to accelerate metabolic activity especially amylase activity, protease activity that help to facilitate the catabolic process of endospermic material for supply of energy for cell division at growing point. (Siddique and Kumar, 2018;}

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Anaytullah and Bose, 2007; Bose et al., 1982; Nawaz et al., 2013 and Jie et al., 2002). However, in the present lab work the effect of seed priming treatment on seed germination, vigour index and tolerance index against short term moisture stress in maize were studied to know the positive response of seed priming under short term moisture stress induced by PEG-6000.

MATERIALS AND METHODS
Maize (Zea mays L.) variety SUNNY-NMH-777 was selected to carry out a lab trial to know the effect of seed priming treatment on seed germination, vigour index and tolerance index against short term moisture stress. The experiment was comprised with nine treatments including control (i.e. T₀, distilled water + non primed seed) and three replications in CRD. Rest of the treatments from T₁ to T₉ was subject with the combinations of elevated levels of moisture stress

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and non primed / primed seed. The treatment combinations excluding control were grouped into two main set (i.e. T1 to T8, set first and T9 to T16, set second). Treatment combinations of set first were subjected with non primed seed + elevated levels of PEG-6000) while second set were subjected with primed seed + elevated levels of PEG-6000). The elevated levels of moisture ranged from 1.5 to 4.5% of PEG-6000 were the same for both set. The priming of seed was done with the help of magnesium nitrate salt for 15 hours. The fifty disinfected seeds with 0.1% HgCl2 were placed in every petridish as per the given treatment details. Thereafter, all the sets of petridishes were transferred in to growth chamber (Model number NU-151) under controlled temperature 20±1°C and relative humidity 80%. The observation about the germination percent was noted at every 24 hours till 240 hours. The final calculation for germination percent was done as per given formula.

Germination percent = (X/N) x100
Whereas, X= number of seeds germinated N= number of seeds placed in the petridish

The observations regarding the vigour index and tolerance index % was derived from the formula given by Abdul-Baki and Anderson (1973) and Iqbal and Rahmati (1992).

Seedling vigour index =
Germination (%) x Total seedling length (cm)

Tolerance index (%) =
Length of shoot or root in which treatment applied
Length of shoot or root in control plant x100

The results obtained from the present experiment were analyzed their ANNOVA followed by Duncan’s Multiple Range Test (DMRT) at P≤0.05 through SPSS 23 Version.

RESULTS AND DISCUSSION
Studies were carried out to know the effect of externally elevated levels of Polyethylene glycol-6000 (PEG-6000) and Magnesium nitrate as a priming treatment on rate of seed germination, seedling vigour index (SVI) and Tolerance index % (T.I. %) in maize seeds variety SUNNY-NMH 777. The data presented in (Fig 1a) shows that there was no appearance of seed germination in any treatment including control set up to 48 hrs. The first countable sign of seed germination appeared at 72 hours in primed seed only i.e. 6.7, 2.7 and 1.3 % in T7, T8 and T9 respectively (Fig 1b). While first countable sign of seed germination in PEG-6000 treated set was appear at 120 hours i.e. 8.0, 5.3, 4.0 and 4.0 % in T1, T2, T3 and T4 (Fig 1b). However, the same appearance was recorded at 96 hrs, in control set. Data reveal that only T-5 i.e. 1.5% of PEG-6000+ primed seed reached up to 100% of seed germination at 216 hours of intervals while the rest of treatment was unable to reached up to 100% even up to last date of observation time 240 hours (Fig 1d) which was followed by T1, T2, T3 and T4 (100, 98.7, 94.7 and 93.3%). Among the both treatment sets, it was observed that the set second (i.e. PEG-6000 + Primed seed) shows better results of seed germination as compare to sets first (PEG-6000 + none primed seed) and Control. Regarding the seedling vigour index, it was realized from (Fig 2) that a significant difference was present between T8 and T6 at 120 hours of intervals while a non-significant difference appeared at 240 hrs. The maximum seedling vigour index was recorded in T8 i.e. 179.3 and 983.3 which was followed by T6 i.e. 120, 914.5 and 76.9, 790.4% as compare to control set 61.2 and 838.1%. While the least value of SVI was recorded by T1 i.e. 9.2 and 394 at both the time of intervals. Among the time of intervals, it was also realized that the SVI was maximum at 240 hours of intervals as compare to 120 hours of intervals (Fig 2). Data pertaining in (Fig 3a and b) reflect that the tolerance index % of both shoot and root was decreased gradually as the level of moisture stress increased from lower to higher concentrations of PEG-6000 at both the times of observations while the treatments set (PEG-6000 + Primed seed) trying to overcome the effect of moisture stress induced by PEG-6000 that reflect in respect of T.I. %. The
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Fig 1c: Effect of seed invigoration treatment with Mg (NO$_3$)$_2$ on seed germination under PEG-6000 induced moisture stress in maize.

Fig 1d: Effect of seed invigoration treatment with Mg (NO$_3$)$_2$ on seed germination under PEG-6000 induced moisture stress in maize.

Note: T$_0$ = Control, T$_1$ = PEG-6000 (1.5%), T$_2$ = PEG-6000 (2.5%), T$_3$ = PEG-6000 (3.5%) and T$_4$ = PEG-6000 (4.5%), T$_5$ = PEG-6000 (1.5% + primed seed), T$_6$ = PEG-6000 (2.5% + primed seed), T$_7$ = PEG-6000 (3.5% + primed seed) and T$_8$ = PEG-6000 (4.5% + primed seed).

Fig 2: Effect of seed invigoration treatment with Mg (NO$_3$)$_2$ on seed vigour index under PEG-6000 induced moisture stress in maize.

Fig 3a: Effect of seed invigoration treatment with Mg (NO$_3$)$_2$ on Tolerance index % in shoot under PEG-6000 induced moisture stress in maize.

Fig 3b: Effect of seed invigoration treatment with Mg (NO$_3$)$_2$ on Tolerance index % in root under PEG-6000 induced moisture stress in maize.
reduction of T. I. % was recorded more drastic in root rather than shoot (Fig 3 a and b).

The results of the experiment distinctly indicated towards the positive influence of seed priming treatment not only for seed germination (Fig 1a, b, c and d) but also for seedling vigour (Fig 2) and tolerance index % (Fig 3a and d) that help to overcome from the negative influence of drought raised by PEG-6000. Liu et al. (2015) reported that moisture stress induced by PEG-6000 contrarily affect the seed germination %, seedling vigour index, seedling growth and their healthy establishment (Babu and Rosaiath, 2017; Hellal et al. 2018; Megha et al. 2017). However, it was reported by a number of worker that seed priming technique may help to overcome the influence of moisture stress induced by PEG-6000 up to certain extent (Pant et al. 2016; Tiyan et al. 2014; Siddique and Kumar, 2018; Anaytullah and Bose, 2007).

Fig 3 a and b clearly indicate that elevated levels of moisture stress induced by PEG-6000 results to reduced T.I % that directly affect the seedling vigour index and ultimately suppress the establishment of healthy seedling growth. The almost similar results were also reported by Sen and Mandal, (2016); Siddique et al. (2018); Qaiser et al. (2014). While priming treatment again trying to improves T. I. % up to certain extent as compare to rest of the treatments. Zhang et al. (2015) pointed that influence of moisture stress induced by PEG-6000 may be recovered by seed priming treatment. The similar result was also reported by Pant and Bose, (2016); Sen and Mandal, (2016). While Jhanji and Dhingra (2018) reported that seed priming with thiourea not only improved seed germination, seedling vigour index but also improving tolerance index in both root and shoot Yadav et al. (2011).

CONCLUSION
We were conducted a trial to know the devastating effect of moisture stress induced by PEG-6000 and their ameliorative effect of seed priming with magnesium nitrate salt. As per our results are concern, we noticed positive results not only for better seed germination but also for good seedling vigour index and tolerance index up to certain levels of moisture stress. On the basis of these results, we may assume that further growth of primed seed would be able ameliorate the effect of moisture stress up to certain extent in maize.

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