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The effects Hydro priming on morphological traits of maize

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ABSTRACT: To examine the effect of these two trials in 2010 were conducted at the research station of Ardabil Islamic azad university, to evaluate the effects of hydro-priming, halo-priming (solutions of 1% KNO3) and osmo-priming (solutions of ZnSO4 with 10 mM Zn and KH2PO4 with 50 mM P) on seedling vigor and field emergence of maize.Analysis of variance of laboratory data showed that hydro-priming significantly improved mean germination rate, seed vigor index, shoot, root and seedling dry weights and reduced electrical conductivity of seed leachates, compared with control and other seed treatments. Germination percentage for seeds primed with KNO3, water, ZnSO4 and KH2PO4 were statistically similar, but were higher than those for unprimed seeds. Invigoration of maize seeds by priming with water and KH2PO4 resulted in higher seedling emergence and establishment in the field, compared with control and priming with KNO3 and ZnSO4. Mean Seedling emergence time was also reduced by seed priming, particularly by hydro-priming.Therefore, hydro-priming is a simple, low cost and environmentally friendly technique for improving seed germination and seedling emergence of maize.

Keywords**:** Germination, maize, seed, seed priming.

INTRODUCTION

Good crop establishment is one of the major challenges to crop production and its importance is recognized by farmers as well as researchers (Chivasa and et al, 1998). Constraints to good establishment include poor seedbed preparation, low quality of seeds, untimely sowing, combined with adverse environmental conditions after sowing (Harris, 1996). Crop production depends heavily on planting of high quality seeds. Rapid and uniform emergence is utmost important, because it is the foundation on which stand establishment is based and potential yield is determined. Absolute seed quality is controlled by genetic constitution, maturity, dormancy, purity, initial viability and vigor (Justice and Bass, 1978).Many seed priming treatments have been used to improve seed quality. Priming techniques include hydro-priming, matric-priming, bio-priming, osmo-priming, halo-priming with or without the use of plant growth regulators (Farooq and et all- Wahid and et al 2008). Priming is able to repair the age related cellular and sub-cellular damage of low vigor seeds that may accumulate during seed development (Bray, 1995). Seed priming also promotes germination by repair of the damaged proteins, RNA and DNA (Koehler and et al, 1997). Harris *et al*. (Harris and et al, 1999) promoted a low cost, low risk technology called 'on-farm seed priming' that would be appropriate for all farmers, irrespective of their socioeconomic status. On-farm seed priming involves soaking the seeds in water, surface drying and sowing on the same day. The rational is that sowing primed seeds decreases the time needed for germination and may allow the seedlings to escape deteriorating soil physical conditions. Seed priming with many organic and inorganic salts has been used for invigorating the performance of normal seeds of different crops, but very little work has been done to improve the performance of maize seeds. Thus, this research was carried out to evaluate the effects of different priming techniques on seed germination and seedling emergence of maize.

MATERIALS AND METHODS

Experiments were conducted in the Ardabil Islamic Azad University. Moisture content of the seed lot was determined as 10.9% by grinding the seeds and then drying at 130±2°C for 4 h (ISTA, 2003). Seeds were pretreated with a mixture of binomial and thiram fungicides at a rate of 3.3 g/kg, in order to control possible fungal contamination during priming. Seed sample was divided into five sub-samples. One of the sub-samples was considered as control (unprimed) and the other four sub-samples were prepared for priming treatments.

Seed priming: The sub-samples were primed by soaking the seeds in distilled water and solutions of KNO3 (1%), KH2PO4 (50 mM) and ZnSO4 (10 mM) for 18 hours. All priming treatments were performed in an incubator adjusted on 20±1°C under dark conditions. After priming, samples of seeds were removed and rinsed three times in distilled water and then dried to the original moisture level.

Germination and seedling vigor: **Four replicates of 25 seeds were**

Germinated between double layered rolled germination papers. The rolled papers with seeds were put into plastic bags to avoid moisture loss. Seeds were allowed to germinate at 15±1°C in the dark for 14days. Germination was considered to have occurred when the radicles were 2 mm long. Germinated seeds were recorded every 24 h for 14 days. Mean germination time (MGT) was calculated according to Ellis and Roberts (Ellis and Roberts, 1980) to assess the rate of seed germination where n is the number of seeds germinated on day D, D is the number of days counted from the beginning of the test. Seed vigor index (SVI) was estimated as *SVI = SDW/MGT*, where MGT is mean germination time and SDW is seedling dry weight. At the end of germination test (14 days), radicles and shoots were cut from the cotyledons and then dried in an oven at 75±2°C for 24 h. The dried radicles and shoots were weighed to the nearest mg and the mean radicle and shoot dry weights and consequently mean seedling dry weight were determined.

Conductivity test:

Four replications of 50 pre-weighed seeds of each seed lot were soaked in 250 ml deionized water in plastic containers covered with caps to prevent evaporation loss and entry of foreign material. All the containers were incubated at 20°C for 24 h. Conductivity was measured with an electrical conductivity meter (WTW 3110). The results were expressed on a seed dry-weight basis (µS/cm/g).

Field emergence

The plots were 30 m2 with six sowing rows, 5 m long. Seeds were treated with binomial at a rate of 3 g/kg before sowing. The seeds were then sown in a loam soil at a depth of about 8 cm with a density of 7 seeds/m2 (75 cm × 20 cm) during the first week of June in both years. Number of emerged seedlings in an area of 1 m^2 within each plot was counted in daily intervals until seedling establishment became stable. Seedling emergence time was calculated in accordance with the equation introduced by Ellis and Roberts (Ellis and Roberts, 1980).

Experimental design

Laboratory tests were carried out at the Seed Technology Laboratory of ardabil Islamic Azad University, Iran, using randomized complete block (RCB) design with 4 replicates. Field experiments were conducted with 4 replicates on the basis of RCB design in 2008 and 2009. Analysis of variance (ANOVA) of the laboratory data and combined analysis of variance of field emergence data were carried out, using SPSS software. Means were compared by applying Duncan’s multiple range test (DMRT) at 5% probability.

RESULTS AND DISCUSSION

Germination and seedling vigor

Seed quality parameters including germination percentage and time, vigor index and root, shoot and seedling dry weights of maize were significantly affected by priming (Table 1). Seed germination percentages increased, but mean germination time decreased as a result of priming treatments. Germination percentages for different priming techniques were statistically similar. However, the highest mean

Germination time and vigor index obtained for seeds primed with water. Seeds primed with water were significantly superior in root, shoot and seedling dry weight, compared with other seed treatments (Table 2).

Conductivity

Electrical conductivity of seed leachates was also significantly influenced by seed priming (Table 1). Conductivity of seeds primed with water was lower than that of the other primed and unprimed seeds. The highest conductivity was observed for seeds primed with KNO3 (Table 2).

Field emergence

There were significant effects of seed priming on percentage and mean time of seedling emergence (Table 3). Seedling emergence percentage and time in the field were improved by all priming techniques, but the highest improvement was obtained for seeds primed with water. Seedlings from seeds primed with water, KH2PO4, ZnSO4 and KNO3 emerged about 8, 7, 6 and 6 days earlier than those from unprimed seeds, respectively (Table 4).

Discussion

Priming seeds with water, KH2PO4, ZnSO4 and KNO3 resulted in advanced metabolic processes and higher germination rate.

Table 1. Analysis of variance (ANOVA) of the effects of seed priming on maize seed germination and vigor in laboratory

Source of Variation	Degrees of freedom	Mean of Squares						
		Germination Percentage	Mean germination time	Seed vigor Index	Electrical conductivity	Root dry Weight	Shoot Dry Weight	Seeding Dry weight
Replication	3	8.33	0.116	0.001	4.850	5/941	5.568	1.953
Priming	4	73.2**	26.541**	0.046**	1423.924**	0.327**	0.212**	0.959**
Error	12	6.533	0.087	0.001	2.325	0.004	0.002	0.050
C.V(%)		2.61	3.11	10.32	5.29	4.31	3.53	8.33

Statistically significant at P ≤ 0.01.

Table 2. Means of seed germination and vigor parameters of maize affected by priming techniques

Treatment	Germination percentage	Mean germination time	Seed vigor index	Electrical conductivity (µS/cm/g)	Root dry weight (g)	Shoot dry weight (g)	Seeding dry weight (g)
Control	90 b	13.84 d	0.132 d	27.685 b	0.9692 c	0.861 b	1.8302 b
$ZnSO_4$	99 a	8.32 b	0.356 b	16.77 c	1.627 a	1.3362 a	2.9632 a
KH_2PO_4	99 a	8.33 b	0.333 bc	27.057 b	1.6205 a	1.4062 a	2.7767 a
KNO_3	100 a	9.57 c	0.294 c	60.36 a	1.4807 b	1.3387 a	2.8195 a
Water	100 a	7.28 a	0.417 a	12.1 d	1.638 a	1.3995 a	3.038 a

Different letters in each column indicate significant difference at P ≤ 0.05

Table 3. Combined analysis of variance of the effects of seed priming on field emergence of maize

Source of variation	DF	Mean of Squares	
		Emergence percentage	Emergence time
Year	1	25.6	5.068**
R(year)	6	40.533*	0.075
Priming	4	47.6**	76.809**
Year * Priming	4	15.6	0.108
Error	24	14.533	0.081
C.V (%)		4.23	2.90

*, **: Significant at P ≤ 0.05 and P ≤ 0.01, respectively.

Percentage, compared with unprimed seeds (Table 2). This suggests that there is no toxic effect of KNO3, ZnSO4 nor KH2PO4, due to ion accumulation in the embryo (Demir, I. and Van De Venter, H. A. 1999). Pre-sowing treatment with inorganic salts not only promotes seed germination of most crops, but also stimulates faster growth, metabolic processes and, hence, ultimate crop yield (Sallam, 1999).

Table 4. Means of seedling emergence percentage and time for primed and unprimed seeds of maize (2008 and 2009).

Treatment	Seedling emergence (%)	Emergence time (day)
Control	79 c	15.04 d
$ZnSO_4$	90 b|	9.11 c
KH_2PO_4	92 ab	8.32 b
KNO_3	91 b	9.27 c
Water	98 a	7.36 a

Different letters in each column indicate significant difference at P ≤ 0.05.

When dry seeds are immersed in water, leaching of variety of solutes occurs including soluble carbohydrates, phosphates, amino acids and electrolytes (Hailstones and et al 1991). Priming of maize seeds with KNO3 caused greater EC, compared with control (Table 2). In halo-priming, ions can be accumulated by seed tissues that may leak into the water during electrical conductivity test (Muhammad and et al, 2006). Increased seed leachates were probably due to loss of ability to reorganize cellular membranes rapidly and completely (McDonald, 2000). Similar responses were reported for seeds of barley (Abdulrahmani and et al, 2007), chickpea (Ghasemi and et al, 2008) and lentil (Ghassemi and et al, 2008). Membrane integrity, as determined by electrical conductivity test, is closely related with seed vigor(Bruggink and et al, 1991). Hydro-primed seeds had the highest vigor index and produced the largest roots, shoots and seedlings, compared with the other seed treatments (Table 2). These superiorities led to rapid and high seedling emergence in the field (Table 4). Kibite and Harker (Kibite and Harker, 1991)reported seed hydration of wheat, barley and oats seeds improved the uniformity of seedling emergence. Harris *et al.(* Harris and et al, 1999*)* found that hydro-priming enhanced seedling establishment and early vigor of upland rice, maize and chickpea, resulting in faster development, earlier flowering and maturity and higher yields. The resulting improved stand establishment can reportedly increase drought tolerance, reduce pest damage and increase crop yield (Harris and et al, 1999). These results suggest that hydro-priming is a useful technique fo improving seedling vigor and establishment of maize in the field.

CONCULSION

Priming is helpful in reducing the risk of poor stand establishment under a wide range of environmental conditions. Our findings revealed that hydro-priming is a simple and useful technique for enhancing seedling emergence rate and percentage of maize. These effects can improve seedling establishment and field performance of this important cereal.

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