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INFLUENCE OF PRIMING TECHNIQUES ON SEED GERMINATION BEHAVIOR OF MAIZE INBRED LINES *(Zea mays* L.*)*

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ABSTRACT

A laboratory study was conducted to evaluate the influence of seed priming techniques on germination and early growth of tow maize inbred lines which were include of B73 and MO17. Seeds were hydroprimed for 12, 24, 36 and 48 h, osmoprimed in urea solution and in solution of polyethylene glycol-6000(PEG- 6000) for 96 h (water potential -1.2MPa). Priming techniques affected seed germination and early growth of both inbred lines. Hydropriming resulted in lower time taken to 50% germination and higher germination index, vigor index and final germination percentage in both genotypes. Maximum invigoration was observed in seeds hydroprimed for 36 h as indicated by higher germination rate, radical length. Conversely, for most germination parameters osmoprimed seeds behaved similar to or even poor than that of control.

Keywords: maize, seed, hydropriming, germination, osmopriming polyethylene glycol.

INTRODUCTION

Maize production based on FAO documents (2005) accounts for 2.8% of total cereals production in Iran, with 1.6 million tones grain production from 0.25 million hectares cultivated land, in spite of the fact that the production of hybrid seed is too low.

Breeders produce hybrid maize seeds by cross-pollinating inbred lines. Commercial hybrid production involves planting male and female inbred lines in separate rows in an isolated field where possibility of foreign pollen contamination is rare. For success in hybrid seed production, synchronization between anthesis and silking of the parental inbred lines is essential (Nagar *et al*., 1998). With regard to this point that maize is a protandrous plant (anthesis is earlier than silking), it seems that synchronization can be achieved by delaying the sowing date of male lines in company with using of some pre-sowing seed invigoration treatments to improve germination and emergence.

Technology that progress seed germination and stand establishment would enable the parental plants to capture more soil moisture, nutrients, solar radiation, and help to attain high synchronization of the reproductive stages of each parents and mature before the occurrence of cool stress in fall (Subedi and Ma, 2005). Therefore, seed invigoration treatments have been developed to improve seed performance during germination and seedling early growth.

The general purpose of seed priming is to hydrate partially the seed to a point where germination processes are initiated but not completed. Most priming treatments involve imbibing seed with restricted amounts of water to allow sufficient hydration and advance of metabolic processes but preventing the protrusion of the radicle. Treated seeds usually would exhibit rapid germination when absorb water under field conditions (Ashraf and Foolad, 2005).

There are some studies on the effect of seed priming on germination and growth rate of maize. Basra *et al.* (1989) found that priming of corn seed using polyethylene glycol or potassium salts (K_2HPO_4 or KNO_3) resulted in accelerated germination at a chilling germinator (10°C). Maize seed soaked by 2.5% KCl for 16h reduced coleoptile and radicle length, while seed soaked in 20 ppm GA_3 for 30 min improved some germination traits, but could not affect grain yield (Subedi and Ma, 2005). Significant improvement in field emergency, seedling character also high synchronization of silking and anthesis for maize genotype was achieved through the hyropriming for 24 h (Nagar *et al.*, 1998).

Earlier works showed that the success of seed priming is influenced by the complex interaction of factors including plant species, water potentiality of the priming agent, duration of priming, temperature, seed vigor and dehydration, and storage conditions of the primed seed (Parera and Cantliffe, 1994).

Although, the pervious studies indicate that some benefits are associated with pre-sowing treatments for seed vigor enhancement, but there is dearth of information about the germination performance of primed seeds of maize inbred lines. So it was imperative to develop suitable techniques in order to improve maize seed germination capacity. The present study was, therefore, carried out with objective to evaluate the effects of different priming treatments on seed germination behavior of maize inbred lines under laboratory conditions to find out the most promising technique.

MATERIALS AND METHODS

To assess the priming effects on germination parameters, response of two maize inbred lines seed soaked in water and different osmotic solution were studied under controlled conditions. The study was conducted in the laboratory of the Department of Seed Science and Technology, College of Agriculture, Tehran University, Iran. Tow maize inbred lines including B73 as female line (with cytoplasmic sterility) and MO17 as male line obtained from Seed and Plant Improvement Institute, Iran, were treated with the following seed-soaking media: (i) unsoaked seed (control); (ii) hydropriming with distilled water for 12 h; (iii) as ii but for 24 h; (iv) as ii but for 36 h; (v) as ii but for 48 h; (vi) osmopriming in urea

solution with -1.2MPa osmotic potential for 96 h; (vii) osmopriming in solution of PEG-6000 with -1.2MPa osmotic potential for 96 h. 400 g of seed of both genotype were placed in individuals nylon net bags and immersed in liquid priming media at 15 ºC. After soaking seeds were redried to original weight with forced air under shade. Thirty seeds from each of the treatments were placed on 90-mm-diameter Petri dishes on Whatman filter paper that was moistened with 13 ml distilled water. Seed was kept in germinator at 25 ºC and darkness. A completely randomized design with three replications was used. Radicle protrusion of 3 mm was scored as germination. Germination was counted in 24 hours intervals and continued until no further germination occurred. The seedlings were evaluated as described in Seedling Evaluation Handbook (AOSA. 1991).

Mean germination time (MGT) was calculated based on the following equation of Ellis and Roberts (1981):

$$MGT = \frac{\sum Dn}{\sum n}$$

Where n is the number of seed, which were germinated on day D, and D is number of days counted from the beginning of germination.

The germination index (GI) was calculated as described in the Association of Official Seed Analysts (AOSA, 1983) by following formula:

$$GI = \frac{\text{No. of germinated seed}}{\text{Days of first count}} + - - + \frac{\text{No. of germinated seed}}{\text{Days of final count}}$$

The time to 50% germination (T_{50}) was calculated according to the following formula of Coolbear *et al.* (1984) modified by Farooq *et al.* (2005):

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

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

The vigor index was calculated according to following formula,

Vigor index (VI) = [seedling length (cm) × germination percentage]

Final germination percentage (%), seedling length, coleoptile, radicle length (mm) and seedling dry weight (g) was recorded after 7 days of planting on filter paper.

For statistical analysis, the data of germinating percentage was transformed to $\arcsin\sqrt{X/100}$. Experimental data was analyzed by a statistical packet SAS, version 6.12 (1988). Treatments means were compared using least significant test (LSD) at 5% level of probability.

RESULTS AND DISCUSSIONS

Priming treatments significantly affected the germination vigor of both inbred lines. The response of both genotypes to different priming techniques approximately was similar. Earlier germination was recorded for hydroprimed seeds as indicated by lower value of T_{50} and MGT or by higher GI (Tables 1 and 2). Seeds hydroprimed for 36 h had lowest values (T_{50} and MGT), followed by 24 h and 48 h seed treatments, whereas the lowest germination rate that was indicated by higher T_{50} and MGT was observed in osmoprimed seeds which were subjected to PEG-6000 solution.

Maximum radicle length of cv. MO17 was also recorded for seeds hydroprimed for 36 h. nonetheless for cv. B73 the longest radicle was obtained from seeds hydroprimed for 24 h. followed by 36 h treatment (Tables 1 and 2). Significant ($P < 0.05$) effect of seed priming was observed on the final germination percentage in both genotypes. Maximum final germination was seen in seed hydroprimed for 36 h, which was statistically similar to seeds of cv. MO17 which was hydroprimed for 48 h and seeds of cv. B73 which was hyroprimed for 24 h (Tables 1 and 2). Maximum coleoptile length were note in seeds osmoprimed in urea solution for 96 h which followed by seeds hydroprimed for 36 h.

Priming treatments had effect on seedling dry weight only in cv. MO17. However heavier seedling was achieved by hydropriming for 48, 36 and 12 h respectively, whereas minimum dry weight was recorded for osmoprimed seeds.

Table-1: Effect of priming treatments on the germination vigor of maize inbred line; **MO17**

Treatments	**Coleoptile length** (mm)	**Radicle length** (mm)	**GI**	**Final germi-nation** (%)	**MGT** (day)	**VI**	**T_{50}** (day)	**Seedling dry weight** (g)
Control	5.65 c	98.85ab	18.53 c	78 bc	3.57 b	78.23 bc	1.86 c	0.46 c
Hydropriming 12 h	10.71 b	131.87a	21.46 bc	82 b	2.76 c	96.88 ab	1.53cd	0.58 a
Hydropriming 24 h	9.06 bc	97.41ab	23.28abc	85 b	2.39 cd	86.77 b	1.11de	0.53 b
Hydropriming 36 h	14.89 ab	122a	26.17a	93 a	2.17 d	108.67 a	1.04 e	0.59 a
Hydropriming 48 h	11.17 b	91.46ab	21.66 b	89 ab	2.56 c	80.63 bc	1.25 d	0.60 a
Osmopriming by urea for 96 h	17 a	90.62ab	17.35 c	64 d	5.22 a	69.42 d	2.84 a	0.51 b
Osmopriming by PEG-6000 for 96h	10.23 b	60.62b	12.23 d	61 d	3.33 b	61.88 d	2.15 b	0.44 c
$LSD_{0.05}$ (lnt) (12 df)	3.92	34.89	2.74	6.27	0.27	17.34	0.34	0.042

* Figures not sharing the same letters in the same column differ significantly at p< 00.05

Table-2: Effect of priming treatments on the germination vigor of maize inbred line; **B73**

Treatments	**Coleoptile length** (mm)	**Radicle length** (mm)	**GI**	**Final germi-nation** (%)	**MGT** (day)	**VI**	**T_{50}** (day)	**Seedling dry weight** (g)
Control	22.65 c	92.22 a	15.17 c	76 b	3.23 a	82.45 bc	2.64 ab	0.42
Hydropriming 12 h	32.29 bc	96.98 a	17.41 b	72 b	2.08 d	91.38 ab	2.11 b	0.48
Hydropriming 24 h	39.81 ab	109.25 a	19.97 a	81 ab	2.44 c	112.17 a	1.73 c	0.52
Hydropriming 36 h	41.33 ab	103.02 a	20.04 a	87 a	2.03 d	101.30 ab	1.59 d	0.48
Hydropriming 48 h	37.25 abc	101.41 a	19.6 a	83 a	2.60 bc	106.38 a	1.84 bc	0.49
Osmopriming by urea for 96 h	50 a	67.91 b	16.95 bc	64 c	2.94 b	73.34 c	1.88 b	0.45
Osmopriming by PEG-6000 for 96h	34.27 bc	81.98 ab	13.13 d	61 c	3.43 a	70.42 c	2.92 a	0.42
$LSD_{0.05}$ (lnt) (12 df)	13.23	22.05	1.64	7.51	0.33	16.65	0.29	n.s.

* Figures not sharing the same letters in the same column differ significantly at p< 00.05

It was revealed from this study that different priming techniques can have various effects on germination of maize seed. Results showed that, for most evaluated germination parameters, hydropriming was more effective than osmopriming treatments (PEG and urea). Generally, the performance of PEG soaked seeds was poor for most of the parameters, possibly due to low osmotic potential or long priming period. The present results are in accordance with observation of Bennett and Waters (1987) who reported that seed germination and vigor in sweet corn decreased with osmoconditioning, although germination significantly enhanced by water soaking. However, osmopriming has been shown to activate processes related to germination, for instance, by affecting the oxidative metabolic such as increasing superoxide dismotase (SOD) and peroxidase (POD) (Jie *et al.* 2002) or by the activation of ATP_{ase} as well as acid phosphatase and RNA syntheses (Fu *et al.* 1988), but it seems that osmopriming period longer than 2 days may result in remarkable decrease in germination and it is not successful with large seeded crops such as soybean and maize (Bennett and waters 1987).

The superiority of hydropriming on germination might indicate that applied hydropriming treatments did not damage seed structure or metabolic activity; on the flip side it is possible that applied osmotic potential for osmopriming treatments was lower than critical potential which is required in order to finish the first and second stages of germination without protrusion of radicle. It may be concluded from present study that priming with water for 36 h was better than other priming media tested for high vigor and rapid seed germination.

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