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Alleviation of Drought Stress by Seed Priming in Tall Wheatgrass (*Agropyron elongatum* (Host) Beauv.)

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Abstract

The objectives of this study were to evaluate the role of hydro and osmopriming on improvement of germination parameters of Tall Wheatgrass (*Agropyron elongatum)* under simulated drought stress by PEG. Germination was delayed by drought stress in primed and nonprimed seeds. With increasing the osmotic potential, all of the investigated traits began to decrease. Seeds were able to germinate at 0, −0.4 and −0.8 MPa concentrations of PEG but dearth seed germination was observed at −1.2 MPa. Osmopriming increased germination parameters under drought stress rather than hydropriming treatment. Finally, Tall Wheatgrass did have positive reaction in both priming treatments on germination parameters especially at lowest osmotic potentials (-1.2 MPa).

Keywords

Osmopriming, Hydropriming, Seed, Germination

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1. Introduction

Improvement in stand establishment can be obtained by advancements in seed quality and seed enhancements, genetic improvement, as well as improved seeding techniques. Seed priming is a technique of seed enhancement that improves seed performance by rapid and uniform germination, normal and vigorous seedlings, which resulted in faster and higher rate of germination and emergence, which also helps seedlings to grow in abiotic stress conditions such as drought stress. The general purpose of seed priming is to hydrate the seed partially to a point where germination processes are begun but not completed (Rouhi et al., 2011). Treated seeds are usually dehydrated before use, but they would exhibit rapid germination when re-imbibed under normal or stress conditions. Seed priming has been successfully demonstrated to improve germination and emergence in seeds of many crops, particularly seeds of vegetables, small seeded grasses (Heydecker and Coolbaer, 1978; Bradford, 1986; Rouhi et al., 2011) and for many field crops such as wheat, sugar beet, maize, soybean and sunflower (Parera and Cantliffe, 1994; Singh, 1995; Khajeh-Hosseini et al., 2003; Sadeghian and Yavari, 2004; Kaur et al., 2005; Kaya et al., 2006; Janmohammadi et al., 2009). Priming also has been shown to induce nuclear DNA synthesis in the radicle tip cells in tomato (Liu *et al.,* 1997) and several other plant species, including pepper (*Capsicum annuum*) (Lanteri et al., 1993), maize (*Zea mays*) (Garcia et al., 1995), and leek (Ashraf and Bray, 1993; Clark and James, 1991).

Various seed priming techniques have been developed, but in this study we used hydropriming (soaking in water), and osmopriming (soaking in polyethylene glycol solution). Priming can also increase the germination and growth of seedling under stressed conditions in sunflower (Kaya et al., 2006) and Brassica seeds (Rao et al. 1987). Adams (1999), reported that time to seed germination of two *Callitris*

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species was reduced by application of seed priming under osmotic stress. Murungu et al. (2002), in their research observed that with the increasing of drought stress, the germination percentage and seedling growth of corn and cotton had decrease but seed priming caused increasing in mentioned traits than control group. Moosavi et al. (2009), noted that seed priming had positive effects on germination and seedling characteristics of four amaranth genotypes.

Although the previous studies indicates that some benefits are associated with pre-sowing treatments for seed vigor enhancement, but there is dearth of information on effect of seed priming on the germination traits and growth of Tall Wheatgrass (*A. elongatum*) under drought stress condition. Therefore, the aim of present study was to examine the possibilities to overcome the effect of drought stress on seed germination and seedling growth by hydropriming or osmopriming treatment of seeds.

2. Materials and Methods

2.1. Sample Preparation

This study was carried out at the Department of Agronomy, Faculty of Agriculture, University of Tehran, Iran. Seeds of Tall Wheatgrass were used as seed material obtained from the Natural Resources Organization of Hamedan Farm (from Hamedan province, Iran). Germination and early seedling growth of the cultivar were studied by using 5 ml of distilled water in 9cm diameter Petri dishes and seeds were germinated top of double layered papers (control group). Seeds under osmotic potentials of −0.4, −0.8 and −1.2MPa, were immersed in polyethylene glycol (PEG 6000) (Michel and Kaufmann, 1973).

2.2. Seed Treatments

For osmopriming, seeds were immersed in osmotic potentials of −0.8MPa polyethylene glycol 6000 for 12h at 15 ◦C under dark conditions (Michel and Kaufmann, 1973). Thereafter, the seeds were rinsed with distilled water three times. For hydropriming, seeds were immersed in distilled water at 15 ^{o}C for 12h under dark conditions. The treated seeds were surface-dried and dried back to their original moisture content at room temperature (about 25◦C) for 24 hours. The optimal temperature and duration for hydropriming and osmopriming were determined in preliminary experiments (data not shown).

2.3. Germination Tests

Four replicates of 50 seeds were germinated with 5 ml of water in 9 cm diameter Petri dishes. These Petri dishes containing seeds were put into sealed plastic bags to avoid moisture loss. Seeds were allowed to germinate at 15-25±1◦C for 21 days (ISTA, 1996). Germination was considered to have occurred when the radicles were 2 mm long. Germination percentage was recorded every 12h until final mentioned days. Germination rate was calculated according to Ellis and Roberts's formula (1980). Seedling length and seedling dry weight were measured after the mentioned days.

2.4. Statistical Analysis

The experimental design was two factors factorial (3×4) arranged in a completely randomized design; with four replications and 50 seeds per replicate. The first factor was seed treatments (control, osmopriming and hydropriming), and the second was osmotic potential levels (0, −0.4, −0.8 and −1.2MPa). Data for germination and abnormal germination percentage were subjected to arcsine transformation before analysis of variance was carried out with SAS software. Mean comparison was performed with Duncan's test if F-test was significant at ($P < 0.05$).

3. Results and Discussion

3.1. Osmopriming Treatment

Final germination percentage and speed of germination decreased in both primed and non-primed seeds under drought condition created by PEG 6000. Priming alleviated negative effect of drought. Germination rate dramatically decreased under higher drought stress condition. Osmoprimed seeds exhibited faster germination as compared to non-primed seeds (Table 2). With increase in osmotic concentration, *A. elongatum* exhibited fast germination and smallest reduction in speed of germination (Table 2).

A. elongatum displayed good reaction in seedling length under drought stress in osmopriming treatment (Table 3). Such as germination percentage and germination rate, seedling length dramatically decreased in the higher drought stress media. Tall Wheatgrass had the acceptable reduction in seedling length (Table 3). Osmoconditioning of Bermuda grass (*Cynodon dactylon*) seed using PEG followed by immediate sowing improved germination and seedling growth under saline conditions (Al-Humaid, 2002).

Osmopriming treatments had positive effect on seedling dry weight in *A. elongatum* (primed and nonprimed). However heavier seedling was achieved by osmopriming in 0 MPa (Table 4). Hur (1991) in Italian ryegrass (*Lolium multiflorum*) and sorghum (*Sorghum bicolor*) showed that plants raised from osmoprimed seed exhibited higher dry weight in comparison with control group. Seed priming resulted in more synchronized seed germination compared to controls (data not shown).

3.2. Hydropriming Treatment

Same as osmopriming treatment, final germination percentage, germination rate, seedling length and seedling dry weight decreased with increase in PEG osmotic potentials for both primed and non-primed seeds. The reduction of non-primed seed germination percentage was more obvious than for primed seeds (Table 1). Primed seed of *A. elongatum* in -0.4 MPa exhibited the highest speed of germination among the other potentials of drought stress. At this drought stress (stimulated by PEG 6000) hydroprimed seeds of *A. elongatum* exhibited the faster germination rate and maximum amount of final germination percentage, seedling length and seedling dry weight than control group (Table 1,2,3 and 4). By increasing in PEG concentration germination synchrony decreased (data are not shown). Minimum dry weight was recorded for hydroprimed seeds and control group at -0.8 and -1.2 MPa (Table 4). This result was matched with the observation of some of the researches (Jet et al., 1996) but opposed with the observation of Afzal et al. (2002).

Primed seeds showed enhanced performance under drought stress conditions. Germination rate was increased by seed priming, but stress conditions delayed germination considerably. Primed seeds had higher final germination percentage, germination rate, seedling length and seedling dry weight than non-primed seed in the osmotic potential of PEG (Tables 1, 2, 3 and 4). Demir and Van de Vanter (1999) reported that, osmopriming of watermelon seeds caused to decrease mean germination time and increase of its percentage. For drought stress at -1.2 MPa, this species exhibited seed germination, which was higher for primed seeds. Sadeghian and Yavari (2004) showed that, seedling growth severely diminished with increased drought stress and genetic differences were found in sugar beet. Moosavi et al. (2009) reported that time to seed germination of four amaranth genotypes was reduced by application of seed priming under osmotic stress.

These results agree with Demir and Van De Venter (1999) for watermelon, Khajeh-Hosseini et al. (2003) for soybean, Kaya et al. (2006) for sunflower and Moosavi et al. (2009) for amaranth which they reported that drought or salinity may influence germination by decreasing the water uptake.

4. Conclusions

Germination rate was improved by seed priming (hydro and osmopriming) under osmotic potentials of drought stress (Table 1 and 2). Similar to final germination percentage, germination rate, seedling length and seedling dry weight were improved by priming (Table 2,3 and 4). The present study revealed that PEG had no toxic effect since all seeds germinated when PEG stress was removed. Mehra et al. (2003) and Michel (1983) indicated that PEG molecules do not enter the seed and Khajeh-Hosseini et al. (2003) and Kaya et al. (2006) found that there was no toxicity of PEG. Moreover, Tall Wheatgrass performed better under drought stress. Based on the results of this study, it is suggested that different priming techniques can have various effects on germination of this plant. Results showed that, for most evaluated germination parameters, osmopriming treatment (with PEG) was more useful technique to reduce this abiotic stress than hydropriming treatment. It seems that, osmopriming in comparison with hydropriming can preserve plasma membrane structure and cause seeds to have better response regarding to germination traits because of controlled long hydration in seed.

Table 1. Final germination percentage (%) of hydro and osmoprimed seeds of Tall Wheatgrass at different osmotic potentials of PEG (6000)

	Seed treatments under drought stress (MPa)							
	Osmoprimed				**Hydroprimed**			
Treatment	**0**	**-0.4**	**-0.8**	**-1.2**	**0**	**-0.4**	**-0.8**	**-1.2**
Primed	100a	98 ab	88 c	54 f	100a	95 b	79 d	25 f
Control group	100a	77 d	69 e	34 g	100a	85 c	67 e	16 g

Results followed by the same letter are not significantly different at the $P < 0.05$ level.

Table 2. Germination rate of hydro and osmoprimed seeds of Tall Wheatgrass at different osmotic potentials of PEG (6000)

	Seed treatments under drought stress (MPa)							
	Osmoprimed				**Hydroprimed**			
Treatment	**0**	**-0.4**	**-0.8**	**-1.2**	**0**	**-0.4**	**-0.8**	**-1.2**
Primed	0.86 a	0.70bc	0.62 c	0.45 e	0.84 a	0.63 b	0.47 cd	0.28 f
Control group	0.77 b	0.55d	0.40 ef	0.26 g	0.76 ab	0.55 c	0.40 cde	0.17g

Results followed by the same letter are not significantly different at the $P < 0.05$ level.

Table 3. Seedling length (cm) of hydro and osmoprimed seeds of Tall Wheatgrass at different osmotic potentials of PEG (6000)

	Seed treatments under drought stress (MPa)							
	Osmoprimed				**Hydroprimed**			
Treatment	**0**	**-0.4**	**-0.8**	**-1.2**	**0**	**-0.4**	**-0.8**	**-1.2**
Primed	14.1 a	12 b	9.2 d	8.1 e	13.8 a	11.2 bc	8.2 de	6.1 f
Control group	12.2 b	10.6 c	7.8 e	4.5 f	12 b	10.5 c	7.6 e	4.6 g

Results followed by the same letter are not significantly different at the $P < 0.05$ level.

Table 4. Seedling dry weight (gr) of hydro and osmoprimed seeds of Tall Wheatgrass at different osmotic potentials of PEG (6000)

	Seed treatments under drought stress (MPa)							
	Osmoprimed				**Hydroprimed**			
Treatment	**0**	**-0.4**	**-0.8**	**-1.2**	**0**	**-0.4**	**-0.8**	**-1.2**
Primed	0.096 a	0.086 b	0.065d	0.041 f	0.092 a	0.075 c	0.069 d	0.064 e
Control group	0.086 b	0.072c	0.057e	0.033g	0.084 b	0.070 d	0.055 f	0.031 g

Results followed by the same letter are not significantly different at the $P < 0.05$ level.

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