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SEED RESERVE UTILIZATION AND SEEDLING GROWTH OF TREATED SEEDS OF MOUNTAIN RYE (*SECALE MONTANUM)* AS AFFECTED BY DROUGHT STRESS

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ABSTRACT. The environmental stress such as, drought are serious obstacles for field crops in further areas of the world, especially in arid and semiarid regions. In order to investigate drought stress on seed reserve utilization and seedling growth of treated seeds of mountain rye (*Secale montanum*), an experiment was carried out. Factorial experiment was carried out in completely randomized design with three replications. The first factor was the seed treatments (unpriming, hydropriming and osmopriming) and the second factor was drought stress. To create drought stress, polyetylenglycol 6000 (PEG 6000) in osmotic levels at 0 (as control), -0.4, -0.8, -1.2 and -1.6 MPa were used. The results indicated that for these traits: germination percentage (GP), timson index (TI), energy of germination (EG), weight of utilized (mobilized) seed (WMSR), seed reserve utilization efficiency (SRUE), seedling dry weight (SLDW), and seed reserve depletion percentage (SRDP), was a significant treatment × drought interaction. Thus hydropriming and osmopriming improvement study traits in *Secale montanum* under drought stress. While in higher osmotic pressure the highest seed reserve utilization were obtained from osmopriming.

Key words: Drought; Seed reserve; Seedling; Priming; *Secale montanum.*

INTRODUCTION

Drought stress is widespread problem around the world. Seed germination negatively affected by drought stress in more crops (Davidson and Chevalier, 1987; Kiem and Krostad, 1981; Saglam *et al.,* 2010; Okçu *et al.,* 2005). Seed germination is the most sensitive stage to abiotic stress (Patade *et al.,* 2011; Redmann, 1974; Khajeh-Hossaini *et al.,* 2003). Fraction of seed reserve utilization, seedling growth and weight of mobilized seed reserve decreased with increasing drought and salt intensity (Soltani *et al.,* 2006). Seed priming can be taken

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to counteract the adverse effects of abiotic stress (Patade *et al.,* 2009. Ashraf and Foolad, 2005). Seed priming techniques have been used to increase germination, improve germination uniformity in more field crops under stressed conditions (Iqbal and Ashraf, 2007; Kaya *et al.,* 2006; Patade *et al.,* 2011; Saglam *et al.,* 2011). Seed priming increases seed reserve utilization (SRU), seedling dry weight (SLDW) and seed reserve depletion percentage (SRDP) in Persian silk tree. In monocotyledon plants like wheat (Soltani *et al.,* 2006) and mountain rye, gibberellic acid (GA) after synthesis in the scutellum migrates in to the aleurone layer. The hetrotraphic seedling growth (mg per seedling) could be quantitatively described as the product of the following two components: the weight of mobilized seed reserve (WMSR; mg per seed), and the conversion efficiency of mobilized seed reserve to seedling tissue (mg mg^{-1}) (Soltani *et al.,* 2006). Although effects of drought stress and seed priming in wheat and perisian silk tree (*Albizia julibrissin* Durazz.) are documented, no reports are available on mountain ray seeds under drought stress. Therefore, in the present study, we investigated seed reserve utilization and seedling growth of treated seeds of mountain ray (*Secale montanum*) as affected by drought stress.

MATERIALS AND METHODS

The study was conducted in the seed laboratory of Natural Resources Faculty, University of Tehran, Iran. Drought stress at osmotic potentials of 0 (as control), -0.4, -0.8, -1.2 and -1.6 MPa were adjusted using PEG-6000 (polyethylene glycol 6000 mw) according to Michel and Kaufmann (1973) before the start of the experiment.

Seed treatment. For osmopriming, seeds were immersed in osmotic potentials of −1.5MPa polyethylene glycol (PEG 6000) for 15 h at 15°C under dark conditions. Then, the seeds were rinsed with distilled water three times. The treated seeds were surface-dried to match their original moisture content at 15°C for 24 h. For hydropriming, seeds were immersed in distilled water at 15°C for 15 h in dark conditions. The treated seeds were surface-dried, back to their original moisture content at 15°C for 24 h.

Germination tests. Seeds were germinated in 9 cm petri dishes with two Whatman No. 1 filter papers moistened with the appropriate solutions or distilled water for 0MPa. Fifty seeds per dish were used for each treatment. Seeds were incubated in the dark at 20±1 ◦C in an incubator. Three replicates of 50 seeds were weighed (W1), dried at 104◦C for 24 h and then reweighed (W2). Seed water content was calculated as [(W1−W2)/W2]. The initial seed dry weight was calculated using the data for seed water content and W1. After test time expiration, some germination indexes correlating to seed vigor were evaluated such as: germination percentage (GP), timson index (TI) (Patade *et al.,* 2009) and energy of germination (EG) (Ruan *et al.*, 2002). Also, after 7 days, oven-dried weight of seedlings was determined. The weight of utilized (mobilized) seed (WMSR) reserve was calculated as the dry weight of the original seed minus the dry weight of the seed remnant. Seed reserve utilization efficiency (SRUE) was estimated by dividing seedling dry weight (SLDW) by the utilized seed reserve. The ratio of utilized seed reserve to initial seed dry weight was considered as seed reserve depletion percentage (SRDP) (Soltani *et al.,* 2006).

Experimental design. The experimental design was two factors factorial (seed treatment × drought stress) arranged in a completely randomized design with three replicates. The first factor was the seed treatments (unpriming, hydropriming and osmopriming) and the second represented by different drought stress levels (0.0,-0.4, -0.8, -1.2 and -1.6 MPa). All data were analyzed statistically by analysis of variance using MSTAT-C software. Mean comparisons were performed using an ANOVA protected least significant difference (Duncan) ($P < 0.01$) test.

RESULTS

The results indicated that across drought levels, the difference among treatments (unpriming, hydropriming and osmopriming) were significant for all traits except for seed reserve utilization efficiency (SRUE) *(Tab. 1).* There was a significant effect for drought and treatment × drought interaction for these traits: germination percentage (GP), timson index (TI), energy of germination (EG), weight of utilized (mobilized) seed (WMSR), seed reserve utilization efficiency (SRUE), seedling dry weight (SLDW), and seed reserve depletion percentage (SRDP) *(Tab. 1).* Osmopriming and hydropriming increased germination percentage (GP), timson index (TI) and energy of germination (EG) as compared to the unprimed *(Tab. 2).* Altogether, priming (hydropriming and osmopriming) improved germination percentage (GP), timson index (TI) and energy of germination (EG) in *Secale montanum* under drought stress *(Tab. 2).* The highest germination percentage (GP) [96%], timson index (TI) [37.95] and energy of germination (EG) [84.67] were obtained from osmopriming in control conditions (0 MPa). The minimum studied traits were obtained from unprimed in osmotic pressure -1.6 MPa *(Tab. 1; Fig. 1).*

Table 1 - Variance analysis of studied traits in *Secale montanum* under drought stress

s.o.v	df	Mean square						
		GP	TI	EG	WMSR	SRDP	SRUE	SLDW
Treatment (T)	2	121.13**	53.22**	102.49**	0.000018**	2.84**	0.000044ns	0.0000011**
drought (D)	4	2202.15**	1282.41**	4047.33**	0.000095**	13.23**	0.52**	0.000025**
T × D	8	56.85**	27.85**	100.27**	0.0000033**	1.08**	0.06**	0.00000036**
Error	30	4.57	1.31	16.36	3.8E-07	0.07	0.01	0.00000004

** and ns, indicate significant difference at 1% probability level, and no significantly respectively.

Table 2 - Means comparison of germination percentage (GP), timson index (TI) and energy of germination (EG) in *Secale montanum* by Duncan multiple range test (DMRT)

Treatment	Drought	GP	TI	EG
Unprimed	0	84^{c}	27.48^{d}	72^{c}
	-0.4	73.33^{d}	23.52^{e}	66.67^{c}
	-0.8	55.33^{ef}	20.66^{f}	52.67^{d}
	-1.2	46.67^{fg}	7.5^{i}	46.67^{d}
	-1.6	28.67^{h}	3.61^{j}	16^{f}
Hydroprime	0	92.67^{ab}	34.83^{b}	80.67^{ab}
	-0.4	77.33^{cd}	31.58^{c}	68^{c}
	-0.8	63.33^{e}	18.07^{g}	54^{d}
	-1.2	54^{f}	11.71^{h}	45.33^{d}
	-1.6	33.33^{h}	4.97^{j}	32^{e}
Osmoprime	0	96^{a}	37.95^{a}	84.67^{a}
	-0.4	91.33^{b}	25.60^{de}	72.67^{bc}
	-0.8	52f^{g}	18.14^{g}	46.67^{d}
	-1.2	44.67^{g}	8.13^{i}	36.67^{e}
	-1.6	34^{h}	5.72^{ji}	28.67^{e}

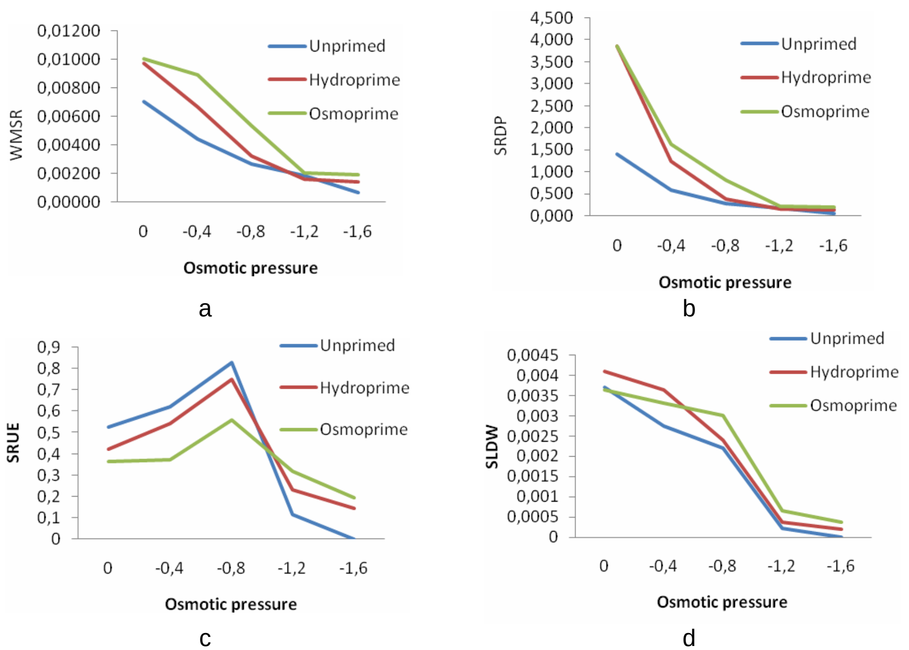

Figure 1 - Effect of priming on weight of utilized (mobilized) seed reserve (a), seed reserve depletion percentage (b), seed reserve utilization efficiency (c) and seedling growth (d) in *Secale montanum* under drought stress

Across drought osmotic pressures, osmopriming had a greater weight of utilized (mobilized) seed reserve (WMSR) and seed reserve depletion percentage (SRDP) than unprimed and hydropriming *(Fig. 1a and b).* The highest seed reserve utilization efficiency (SRUE) obtained from unprimed and – 0.8 MPa osmotic pressure. The highest seedling dry weight (SLDW) were achieved from hydropriming and minimum osmotic pressure (0 MPa) *(Fig. 1c and d)*, but in higher levels of osmotic pressures the highest seed reserve utilization efficiency and seedling dry weight were obtained from osmopriming *(Fig. 1c and d).* Thus hydropriming and osmopriming lead to improvement in mentioned traits in *Secale montanum* under drought stress.

DISCUSSION

In the present investigation, drought stress affected in *Secale montanum* percentage (GP), timson index (TI) and energy of germination (EG). The results are in agreement with the earlier study who reported the significant reduction in the germination as well as growth of Pea (Okçu *et al.,* 2005). The results of our study suggested that priming treatments caused an improvement in germination percentage (GP), timson index (TI) and energy of germination (EG). These results agree whit those of Patade *et al.,* (2009), Ashraf and Foolad (2005) and Sadeghi *et al.* (2011). Across drought osmotic pressures, osmopriming had a greater weight of utilized (mobilized) seed reserve and seed reserve utilization efficiency than unprimed and hydropriming *(Fig. 1a and b).* While weight of utilized (mobilized) seed reserve and seed reserve depletion percentage (SRDP) were declined with drought in seed treatments *(Fig. 1a and b).* Decline in weight of utilized (mobilized) seed reserve and seed reserve depletion percentage (SRDP) to drought were also reported by other researchers (Soltani *et al.,* 2006; Sedghi *et al.,* 2011). The highest seed reserve utilization efficiency and seedling dry weight were obtained from unprimed and hydropriming respectively *(Fig. 1c and d*). Decline in seedling growth and different indices of seeds under drought stress also reported for wheat (Soltani *et al.,* 2006), tomato (Bhatt and Srinivasa-Rao, 1987) and mung bean (De and Kar, 1995).

CONCLUSIONS

Osmopriming and hydropriming increased germination percentage (GP), timson index (TI) and energy of germination (EG) as compared to the unprimed. The highest germination percentage (GP), timson index (TI) and energy of germination (EG) were obtained from osmopriming in control conditions (0 MPa). Priming improved seed reserve utilization such as: weight of utilized (mobilized) seed reserve, seed reserve depletion percentage, seed reserve utilization efficiency and seedling growth in *Secale montanum* under drought stress. While in higher osmotic pressures the highest seed reserve utilization were obtained from osmopriming.

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