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Effect of hydro-priming duration on germination and early seedling growth of rapeseed under salinity stress

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A laboratory experiment was carried out to assess the possibility of decreasing the negative effects of salinity on seed germination and early seedling growth of canola by hydro-priming of seeds. A 7×5 factorial experiment based on completely randomized design was employed to compare the treatments. Seed priming comprised 0.0, 4.0, 8.0, 12.0, 16.0, 18.0 and 24.0 h seeds soaking in distilled water, and salinity stress was simulated by the solutions of 0.0, 25.0, 50.0, 75.0 and 100.0 mM NaCl. Germination percentage and uniformity, germination speed and seedling dry weight were measured as germination performance indicators. Results showed that all traits were significantly affected by salinity stress and seed priming. Germination uniformity and seedling dry weight were affected by the interaction of salinity × seed priming. Germination percentage and speed were slightly affected by the interaction of salinity × seed priming. However, it was not significant. Increasing in salinity stress from control to the highest level (125 mM NaCl) resulted in 26% reduction of germination percentage of rapeseed. However, germination speed was a trait showing higher sensitivity to the salinity stress. The difference between control treatment and the highest salinity stress in terms of germination speed was 45%. Hydro-priming improved germination percentage and speed of rapeseed seeds. The highest germination percentage and speed was observed in the treatment of 24 h which was not significantly different with 20 h hydro-priming. Germination percentage and speed of rapeseed improved 25 and 30 by hydro-priming of seeds, respectively. Generally, the length of hydro-priming solutions improved the performance of seeds and seedlings of rapeseed. Higher levels of hydro priming duration reduced negative effects of sever salinity stress, where there was no significant difference between two last salinity levels in terms of salinity.

Key words: Germination, rapeseed, salinity, seedling dry weight.

INTRODUCTION

Good characteristics such as suitable placement in crop rotation, desirable quality, high value of oil (40 to 45%) and protein (39%) that has changed rapeseed (*Brassica napus* L.) to an important crop (Ghassemi-Golezani et al., 2010). Since rapeseed do not produce tiller, its grain yield is considerably depended on plant density affecting

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by germination and seedling establishment. Rapid and uniform field emergence is an essential prerequisite to reach the yield potential, quality and ultimately profit in annual crops (Parera and Cantliffe, 1994). Out of many constraints regarding low production of oilseeds, seed quality is the prime importance. Oilseeds are deteriorated more rapidly during storage, which reduces the quality of seeds (Afzal et al., 2004). Furthermore, their germination and seedling establishment is adversely affected by suboptimal environmental conditions such as salinity stress.

Soil salinity, a common problem in rainfed areas of south-west Iran (Ghassemi-Golezani et al., 2008), is a major obstacle which may decrease the germination of seeds in two ways: by lowering external osmotic potential and by the toxic effects of Na^+ and Cl^- ions on the seeds (Khajeh-Hosseini et al., 2003). Salinity may individually or in combination with drought, adversely affect germination and seedling establishment (Cheng and Bradford, 1999). The sensitivity of rapeseed to salinity, especially during germination and early growth of seedling has been reported (Afzal et al., 2004). Therefore, if the stress effect can be alleviated at the germination stage, the chances for attaining good crop establishment would be increased.

Seed priming is a pre-sowing technique for the improvement of germination and seedling growth, and establishment of many crops. The beneficial effects of priming have been shown for many field crops including chickpea (Kaur et al., 2005) and lentil (Ghassemi-Golezani et al., 2008). Hydro-priming generally enhances seed germination and seedling emergence under both saline and non-saline conditions, although there are exceptions. Hydropriming is a low cost method with advantageous effects on many field crops, such as maize, rice, chickpea, soybean and sunflower (Ashraf and Foolad, 2005; Kaya et al., 2006). Eskandari and Alizadeh-Amraie (2014) reported that lentil germination performance was improved by hydro-priming of seeds under salinity stress which was related to faster germination.

Since seed priming has proved to be a successful strategy for reducing the adverse effects of adverse environmental conditions such as salinity stress and, thus, improvement of the germination and emergence of plants (Kaya et al., 2006), the current experiment was aimed to assess the potential of hydro-priming for overcoming salt stress, an effective factor for germination failure of rapeseed, on seed germination and primary seedling growth of rapeseed.

MATERIALS AND METHODS

This study was carried out at the seed laboratory of the Ramin University of Agriculture and Natural Resources, Iran. A 7×5 factorial experiment based on completely randomize design was employed to assess the effect of hydro-priming duration on seed germination and early seedling growth of rapeseed under salinity stress. Hydro-priming durations included 0 (unprimed or control), 4, 8, 12, 16, 20 and 24 h seed soaking in distilled water (all hydro-printed seeds soaked in distilled water).

After priming, seeds were backed to their initial humidity. Salinity treatment comprised five levels of 0.0, 25.0, 50.0, 75.0, and 100 mM Nacl started from the beginning of the germination process. Four replicates of 50 hydro-primed seeds were germinated between double layered rolled germination papers under different salinity levels. The rolled paper with seeds was put into plastic bags to avoid moisture loss. Seeds were allowed to germinate in the dark for 14 days. The seeds and seedlings kept in the salinity treatments until the germination rates were determined. Germination was considered to have occurred when the radicles were 2 mm long. During germination evaluation, seedlings with short, thick and spiraled hypocotyls and stunted primary roots were considered abnormal (ISTA, 2003) and were not included in the count for seedling growth assessment. Germination speed (GS) was calculated according to Ellis and Roberts (1980):

$$GS= [\Sigma n / \Sigma(Dn)]$$

Where n is the number of seeds germinated on day D, D is the number of days counted from the beginning of the test. At the end of germination process, germination uniformity needed time for germination of a seed) and seedlings dry weight of rapeseed under different salinity stress were measured by oven-drying of seedlings.

Analysis of variance of the data and mean comparison were carried out using MSTATC statistical software and Duncan's multiple range test, respectively.

RESULTS AND DISCUSSION

Analysis of variance of laboratory data showed that all traits were significantly affected by salinity stress and seed priming (Table 1). Germination uniformity and seedling dry weight were affected by the interaction of salinity × seed priming. However, germination percentage and speed were not significantly affected by the interaction of salinity × seed priming (Table 1).

The results of the experiment indicated that germination percentage of rapeseed was only significantly affected by the last two levels of salinity (100 and 125 mM) (Table 2). Increasing in salinity stress from control to the highest level (125mM NaCl) resulted in 26 percent reduction of germination percentage of rapeseed. However, germination speed was a rapeseed germination trait showing higher sensitivity to the salinity stress in which the second salinity stress led to significant reduction of germination speed (Table 2). The difference between control treatment and the highest salinity stress in terms of germination speed was 45 percent. In other words, the salinity level of 125 mM NaCl induced 45% reduction of germination speed.

The results revealed that hydro-priming improved germination percentage and speed of rapeseed seeds. The highest germination percentage and speed was observed in the treatment of 24 h which was not significantly different with 20 h hydro-priming. Germination percentage and speed of rapeseed improved 25 and 30 by hydro-priming of seeds, respectively (Table 2). Ghana and Schillinger (2003)

Table 1. ANOVA analysis of salinity, priming and their interaction on maximum of germination (Gmax), Germination speed, germination uniformity (GU) and seedling weight.

S.O.V	df	Means of square			
		GP	GS	GU	DM
Salinity	5	1670.832**	0.00051883**	219.7454**	0.00006558**
Priming	6	1080.508**	0.00006721**	810.9681**	0.00017981**
Salinity× priming	30	149.4095	0.00000724	297.3317**	0.00003142**
Error	84	129.0159	0.00000735	49.29836	0.00001003
CV (%)	-	14.97	11.68	12.91	27.22

** Significant at P<0.01; ns: not significant; GP: germination percentage, GS: germination speed, GU: germination uniformity, DM: seedling dry weight.

Table 2. Effect of salinity and hydro-priming duration germination percentage and speed of rapeseed.

Treatment		Germination percentage	Germination speed
Salinity (mM)	0.0	89.8[a]	0.31[a]
	25.0	81.6[a]	0.25[b]
	50.0	81.8[a]	0.23[b]
	75.0	80.0[a]	0.23[b]
	100.0	72.0[b]	0.19[c]
	125.0	59.0[c]	0.17[c]
	Mean	75.7	0.23
Hydro-priming duration (h)	0.0	66.4[c]	0.20[c]
	4.0	69.0[bc]	0.20[c]
	8.0	70.0[b]	0.20[c]
	12.0	73.8[b]	0.23[bc]
	16.0	75.5[b]	0.24[ab]
	20.0	81.5[a]	0.25[a]
	24.0	82.0[a]	0.26[a]
	Mean	75.98	0.23

Difference letters indicating significant difference at P≤0.01.

observed that germination and seedling growth of winter wheat improved by hydro-priming of seeds compatible with the finding of the current research. Mohammad and Shahza (2005) recorded higher root growth of rice with hydro-priming of seeds.

Germination uniformity (h) of rapeseed decreased with hydro priming of seeds (Figure 1). In the highest level of salinity stress, the hydro priming treatment had the lowest effect. However, in other levels of salinity stress (25, 50, 75 and 100 mM) hydro priming clearly improved germination uniformity of rapeseed. It can be concluded that hydro priming decreased the negative effects of salinity on germination uniformity of rapeseed (Figure1).

Seedling dry weight of rapeseed decreased with increasing salinity stress. However, hydro-priming of seeds improved seedling growth under salinity conditions. Under the treatments of 100 and 125 mM NaCl, hydro-priming inhibited negative effects of salt stress on seedling growth of rapeseed (Figure 2), in which no seedling dry weight reduction was observed in the 125 mM treatment.

In general, higher hydro-priming durations improved seedling dry weight of rapeseed under higher salinity stress, emphasizing the positive effects of hydro-priming on seedling growth performance under salt stress conditions. It has been reported that germination is a process occurring through cell elongation, while root growth occurs through cell division process. Thus, in germination process, salinity affects cell division more than cell elongation (Khajeh-Hosseini et al., 2002) suggesting that higher seedling growth under salinity stress induced by priming treatment is more important than germination. This results are compatible with the findings of the current research, where seedling dry

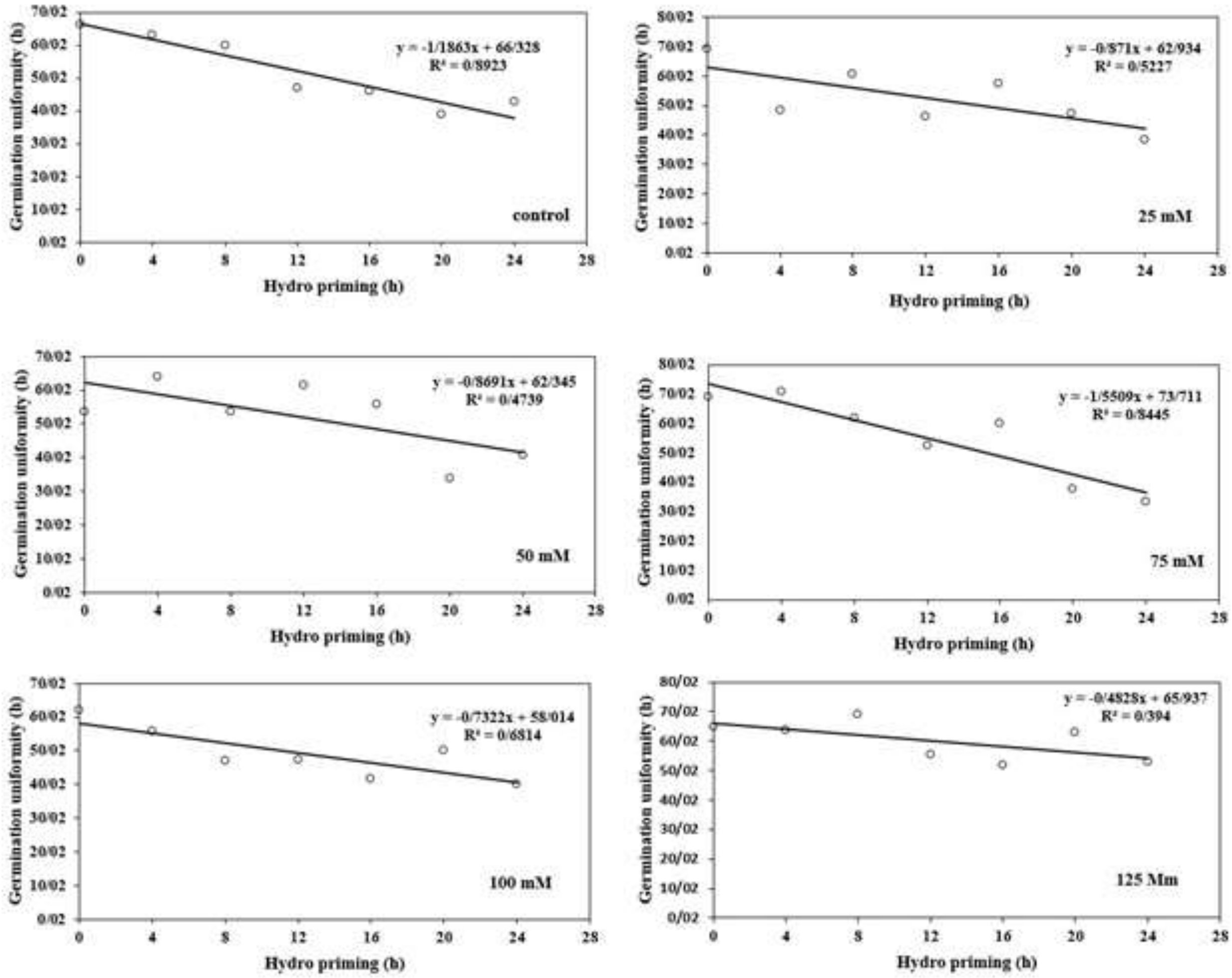

Figure 1. Effect of hydro-priming duration on germination uniformity of rapeseed under different salinity level.

weight produced by unprimed seeds decreased with increasing salinity stress (Figure 2).

However, hydro-priming inhibits negative effects of salinity stress, where there was no significant difference between seedling dry weight of 24 h hydro-primed seeds under 25 mM and 125 mM salinity stress (Figure 2). This results are in line with the findings of Salehi et al. (2010) who reported that priming improved seedling growth of rapeseed under salinity stress.

A pre-sowing treatment involving hydration of seeds in priming solutions improved the performance of seeds and seedlings of rapeseed. This improvement was reflected in higher germination and seedling dry weights. Hydropriming improved seedling vigor of rapeseed as indicated by seed germination percentage and speed and seedling dry weight (Table 2 and Figure 2). The earlier germination might be attributed to increased metabolic activities in the hydroprimed seeds (Soon et al., 2000; Basra et al., 2002). It is obvious that higher rate of seed germination can lead to the production of large and uniform seedlings.

According to McDonald (2000), primed seeds can rapidly imbibe and revive the seed metabolism, enhancing germination rate and uniformity. In many crops, seed germination and early seedling growth are the most sensitive stages to water limitation induced by salinity stress. Water deficit and salt stress may delay the onset and reduce the rate and uniformity of germination, leading to poor crop performance and yield (Kaya et al., 2006). Therefore, the beneficial effects of priming may be more evident under unfavorable rather than favorable conditions (Bradford, 1995) which was clearly showed in Figure 2 where seedling dry weight of rapeseed improved under higher levels of salinity stress compared with lower salt stress.

However, in some cases, longer hydro-priming decreased germination performance of rapeseed which is compatible with the findings of Omidi et al. (2005) who reported that priming is a technique improving germination performance of rapeseed, but higher levels

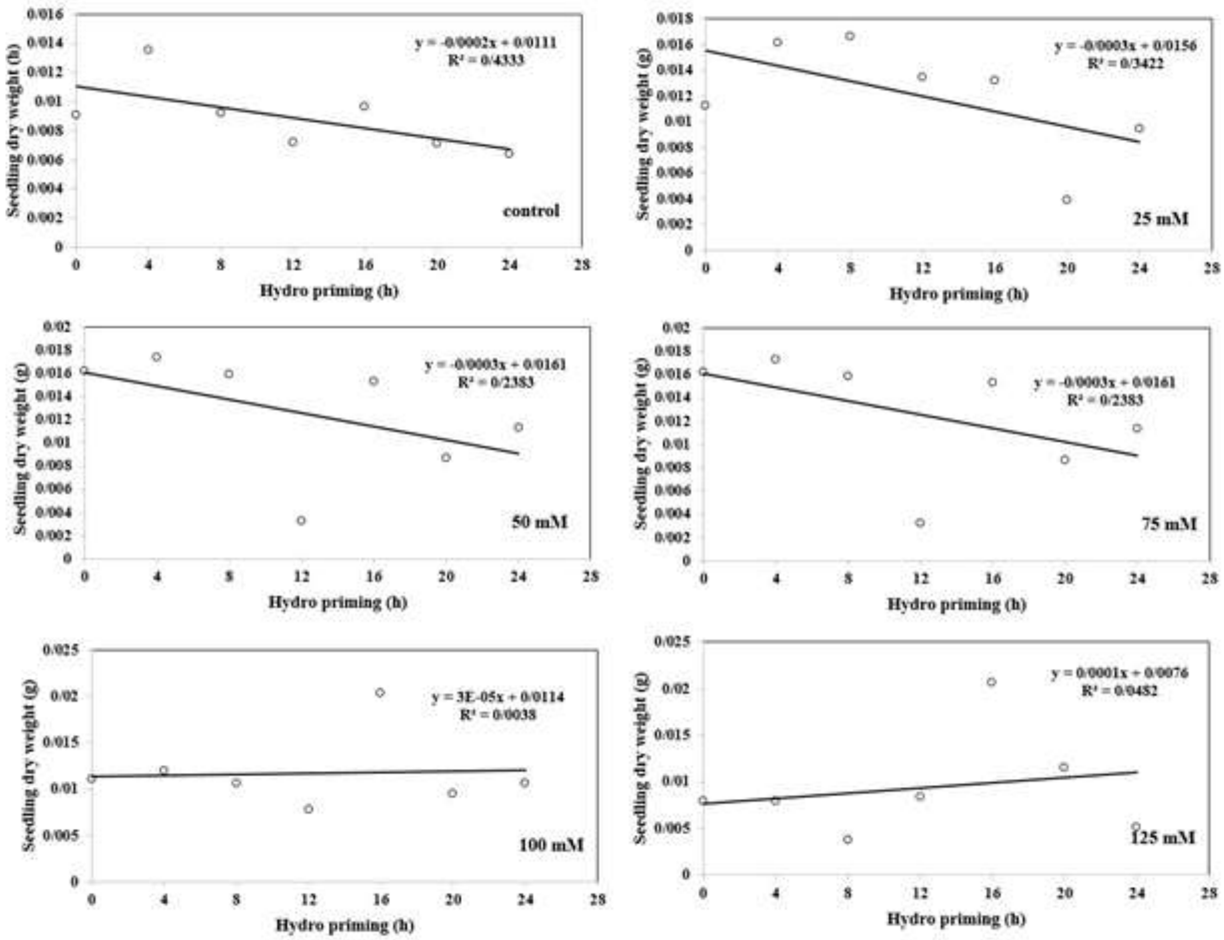

Figure 2. Effect of hydro-priming duration on seedling dry weight of rapeseed under different salinity level.

of priming may decrease seedling growth of rapeseed, confirming the findings of figure 2. It has been reported that high rate of water uptake in primed seeds accelerated their germination and enhanced germination percentage (Kaya et al., 2006).

Furthermore, during priming, the embryo expands and compresses the endosperm. The compression force of the embryo and hydrolytic activities on the endosperm cell walls may deform the tissues that have lost their flexibility upon dehydration, producing free space and facilitating root protrusion after rehydration. In this research, the fastest rate and percentage of germination was obtained by soaking seeds in water (hydro priming) compared with un-primed seeds, probably due to faster water uptake and earlier initiation of metabolism processes, which determine radicle protrusion.

Conclusion

Germination and subsequent seedling growth of rapeseed can be inhibited by adverse conditions such as salinity. Hydro-priming is a helpful method for reducing the risk of poor germination and stand establishment of rapeseed under salinity stress. The finding of the research revealed that with the simple and useful technique of hydro-priming enhanced germination and seedling growth of rapeseed will be attained which has positive effect on field performance of rapeseed under salinity stress.

Conflict of Interests

The authors have not declared any conflict of interests.

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