The Effect of Hydropriming and Halopriming on Germination and Early Growth Stage of Wheat (*Triticum aestivum* L.)

Hamid Abbasdokht, Mohammad Reza Edalatpishe, Ahmad Gholami

Abstract—In order to study of hydropriming and halopriming on germination and early growth stage of wheat (*Triticum aestivum*) an experiment was carried out in laboratory of the Department of Agronomy and Plant breeding, Shahrood University of Technology. Seed treatments consisted of T1: control (untreated seeds), T2: soaking in distilled water for 18 h (hydropriming), T3: soaking in -1.2 MPa solution of CaSO₄ for 36 h (halopriming). Germination and early seedling growth were studied using distilled water (control) and under osmotic potentials of -0.4, -0.8 and -1.2 MPa for NaCl and polyethylene glycol (PEG 6000), respectively. Results showed that Hydroprimed seeds achieved maximum germination seedling dry weight, especially during the higher osmotic potentials. Minimum germination was recorded at untreated seeds (control) followed by osmoprimed. Under high osmotic potentials, hydroprimed seeds had higher GI (germination index) as compared to haloprimed or untreated seeds. Interaction effect of seed treatment and osmotic potential significantly affected the seedling vigour index (SVI).

Keywords—Wheat, hydropriming, halopriming, germination

I.  INTRODUCTION

Salinity is one of the major and increasing problems in irrigated agriculture in Iran, particularly in wheat grown areas. The areas affected by varying degrees of salinity are reported at around 6.3 M ha within Canal Command areas, of which half is cultivable or cultivated to some extent [15]. Ghassemi et al. [10] estimated about 14% of irrigated land to be badly affected by salinity in Pakistan.

The adverse effects of high concentration of salts for plants are due to the osmotic retention of water and to specific ionic effects on the protoplasm. Water is osmotically held in salt solutions, so as the concentration of salt increased water becomes less and less accessible to the plant. Poor germination and seedling establishment are the results of soil salinity. It is an enormous problem adversely affecting growth and development of crop plants and results in to low agricultural production [9].

Wheat is grown on all type of soils and is classified as a moderate, salt tolerant crop [14]. Yield losses on salt affected soils of Iran average about 64%. Seed priming was defined as pre-sowing treatments in water or in an osmotic solution that allows seed to imbibe water to proceed to the first stage of germination, but prevents radicle protrusion through the seed coat. The most important priming treatments are Halopriming and hydropriming. Halopriming is a pre-sowing soaking of seeds in salt solutions, which enhances germination and seedling emergence uniformly under adverse environmental conditions. Hydropriming involved soaking of seed in water before sowing. Previous work [2,4,6,16] suggested that the adverse and depressive effects of salinity and water stress on germination can be alleviated by various seed priming treatments. Although the effects of priming treatments on germination of some seed crops has been studied, but relatively little information is available on the invigorating of wheat seed under salt stress.

The aim of the study was to evaluate whether priming with water and salt solution (CaSO₄) results in enhancement of seed vigour in wheat (cv. Darab) under a range of osmotic potentials due to NaCl and PEG, respectively. Further to realize whether responsible factors for failure of wheat seed germination under saline condition is an osmotic blockade or is due to toxic effects of NaCl.

II. MATERIAL AND METHODS

In order to study of the effect of hydropriming and halopriming on germination and early growth stage of wheat (*Triticum aestivum*) an experiment was carried out an experimental design as factorial with three factors based on completely randomized design (CRD) with three replications. First factor was solution (NaCl and PEG), the second factor was seed treatments (control, hydropriming and halopriming) and third factor was osmotic potential levels (0, -0.4, -0.8, -1.2 MPa). Seeds of wheat (*Triticum aestivum* L.) cv. Darab were used for this study.

The study was conducted in laboratory of the Department of Agronomy and Plant breeding, Shahrood University of Technology. Seed treatments consisted of T1: control (untreated seeds), T2: soaking in distilled water for 18 h (hydropriming), T3: soaking in -1.2 MPa solution of CaSO₄ for 36 h (halopriming).

Both priming treatments were conducted at 20°C in the dark separately and redried up to original weight with forced air under shade following Basra et al. (2005a).Germination and early seedling growth were studied using distilled water (control) and under osmotic potentials of -0.4, -0.8 and -1.2 MPa for NaCl and polyethylene glycol (PEG 6000), respectively. NaCl concentrations had the electrical conductivity (EC) values of 3.7, 12.3, 17.4 and 21.8 ds/m³, respectively. Referred osmotic potential of NaCl solution (-...
0.4, -0.8 and -1.2 MPa) were prepared by using of 5.25, 10.5 and 15.75 grams of NaCl per liter. Osmotic solution of PEG was prepared by using of 161, 241 and 302 gram of PEG per liter, respectively for -0.4, -0.8 and -1.2 MPa. Three replications of 50 seeds were germinated in 12 cm diameter glass Petri dishes at 25±1 °C in a dark growth chamber with 45 % relative humidity. 10 ml osmotic solution was added to each Petri dish and a seed scored germinated when root length reached 2 mm. Germinating seed were counted daily, and terminated when no further germination occurred.

Seedling vigour index (SVI) was calculated following modified formula of Abdul-Baki and Anderson [1]:

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SVI = \text{[seedling length (cm) \times germination percentage]}
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The germination index (GI) which expressed as speed of germination was calculated as described in the Association of Official Seed Analysts [3]. Mean shoot and root lengths at the end of germination were measured per replication. Dry weights of seedlings were taken with the help of an electric balance after drying each replication at 70 °C in the oven to get the constant weight [2].

For comparison of control (untreated seeds) in stress and normal conditions the reduction percentage of germination (RPG) was calculated according to the formula of Madidi et al., [13]. For statistical analysis, the data of germinating percentage were transformed to arcsin \(X^\prime/100\). Data were subjected to analysis of variance (ANOVA) procedures SAS program [18] and LSD test was applied at 5 % probability level to compare the differences among treatment means.

III. RESULTS AND DISCUSSION

Results showed that there is a significant three way interaction (seed treatment \(\times\) solution\(\times\) osmotic potential) for germination percentage. Germination percentage showed the significant reduction with decrease in osmotic potential. Hydoprimed seeds achieved maximum germination especially during the higher osmotic potentials (i.e. 0 and -0.4 MPa). Minimum germination was recorded at untreated seeds (control) followed by osmopriming. At both seed treatments greater reduction in germination percentage due to PEG compared to NaCl was recorded (Figure 1).

A significant interaction of seed treatment \(\times\) solution was found for seedling dry weight. Maximum seedling dry weight was attained from hydroprimed seeds under saline condition, while halopriming could not improve this character under all condition as compared to control (Figure 2).

There was a significant interaction of seed treatment \(\times\) osmotic potential on both root length and shoot length (Figure 3A, B).
Fig. 3. Effect of different seed priming treatments (control, hydropriming and halopriming) on (a) root length, (b) shoot length averaged from wheat (cv. Darab) under different levels of osmotic potential during germination test. The vertical bars with different alphabets are statistically different (at p=0.05) indicating interactive effect of seed priming treatments and osmotic potential.

The root and shoot length of seeds that were subjected to hydropriming significantly differed from those subjected to halopriming and control, especially in high osmotic potentials (i.e. 0 and -0.4 MPa). Interaction of seed treatment and osmotic potential for germination index (GI) showed that under high osmotic potentials (i.e. 0 and -0.4 MPa), hydroprimed seeds had higher GI as compared to haloprimed or untreated seeds (Figure 4).

Interaction effect of seed treatment and osmotic potential significantly affected the seedling vigour index (SVI). Hydropriming significantly increased SVI, mainly at high osmotic potentials. Averagely SVI of hydroprimed seeds was higher than untreated seeds (Figure 5a). Interaction of solution (NaCl or PEG) and seed treatment was significant for SVI. In the similar way hydropriming could improve this parameter while maximum value was recorded from the saline conditions (Figure 5b).
germinated better in NaCl than PEG at the equivalent water potential, possibly due to the uptake of Na+ and Cl- ions by the seed, maintaining a water potential gradient allowing water uptake during seed germination. With no toxicity effect of PEG reported [12], the lower germination percentage obtained from PEG compared with NaCl suggests that adverse effects of PEG on germination were due to osmotic effect rather than specific ion accumulation.

Results showed significant improvement in germination and early growth of wheat (cv. Darab) due to hydropriming treatment. Soaking seeds for 36 h resulted in invigoration of germination under salinity and drought stress as well as normal conditions. This study also revealed that at equivalent osmotic potentials drought stress induced by PEG had more drastic inhibitory effects on germination. Thus, it is concluded that under salinity stress the osmotic effect is rather important than toxic effect in loss of seed germination. Generally our results suggested that hydropriming could be as suitable, cheap and easy seed invigoration treatment when for wheat.

**REFERENCES**


