International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 4, No. 12, p. 73-77, 2014

RESEARCH PAPER OPEN ACCESS

The effect of salt stress on seed germination and seedling growth on four wheat (*Triticum Aestivum*) varieties

Mahnaz Sharifi[1], Marziyeh Hoseini[2], Puriya Gharavi-kuchebagh[3], Sahar Baser-Kouchebagh[1*]

[1]*Young Researchers And Elite Club, Tabriz Branch, Islamic Azad University, Tabriz, Iran*

[2]*Department of Agronomy and Plant Breeding, Tabriz Branch, Islamic Azad University, Tabriz, Iran*

[3]*Student Agronomy, Department of Agriculture and Plant Breeding, Tabriz Branch, Islamic Azad University, Tabriz, Iran*

Key words: Germination, salt-stress, seedling-growth, wheat.

http://dx.doi.org/10.12692/ijb/4.12.73-77 Article published on June 22, 2014

Abstract

The main purpose of the present study was evaluation the effects of salt stress on the seed germination and seedling growth of four wheat varieties. It was conducted in factorial experiment based on completely randomize design (CRD) with three repetitions. Factors were four wheat varieties (Soasel, Shahriyar, Zarin, and Cascogen) and four different concentrations of sodium chloride: 2 g/lit (0.05 *M*), 5 g/lit (0.12 *M*), 8 g/lit (0.2 *M*), 11 g/lit (0.28 *M*) and control. Salt treatments were applied through the water used for seeds germination, and seedling growth. Seeds were disinfected by dipping them into 5% sodium in disinfected hypochlorite solution for 3 minutes and then were rinsed three times by distilled water. Each experimental unit consisted of one Petri dish containing 25 wheat seeds which were placed in between two special papers. 7 ml of the desired solution was added to each Petri dish and then they all were placed into the growth chambers and kept at 25°C temperature for 14 days. The results of laboratory study showed that the influence of various treatments on germination percentage was significant. 2 g/lit (0.05 *M*) showed the highest positive effect on germination percentage for Zarin variety. Also, the shortest ratio of radicle/plumule were associated with Zarin type, thus Zarin was identified to be the most tolerant to salt stress as compared to the other three varieties.

* **Corresponding Author:** Sahar Baser-Kouchebagh ✉ sahar_baser@yahoo.com

Introduction

Wheat (*Triticum aestivum* L.) is most important food crop in the world. Its seed germination and seedling growth under saline condition result in higher yields. Seed germination and seedling vigor is defined as the sum total of those properties of the seed which determine the level of activity and performance of the seed or seedlot during germination and seedling emergence (Flowers, 2004). Salinity of soil and irrigation water is one of the main factors that limit plant growth and productivity. Germination process includes conveyance of stored minerals to embryo axis and initiating metabolic activities leading to its growth. Tolerance of plants in these two phases of plants life plays a significant role in their stand establishment which results in higher yields (Almasouri *et al.*, 2001). Initiation of metabolic activities for seeds germination, in the first place, requires the absorption of water. The amount of water absorbed varies depending on seed chemical composition and its seed coat permeability (Mahajan and Tuteja, 2005; Pesarrakli, 1999). Thus, there is a definite range of water potential for each plant species and beyond that the germination cannot take place (Delachiava and De-Pinho, 2003). Moreover, sensitivity of seeds to drought stress varies at different phases of germination and emergence of radicle (De and Kar, 1995). The speed and percentage of germination will be reduced and seedling growth will be declined under drought stress conditions. In arid and semi-arid regions saltiness of water and soil is considered as the most important factor which can influence stand establishment of plants. Under such conditions the amount of precipitation is usualy not enough to wash salts away from roots zone. More over, due to high evaporative power of these areas the salt content in root zone will be increased (Almasouri *et al.,* 2001; Shamsaddin-Saied *et al.,* 2007). The saltiness of soil and water not only decreases the water potential but also exerts some other negative chemical effects caused by Na^+ and Cl^- ions. Since the level of sensitivity to salt and dry stresses varies among different species (Misra and Dwivedi, 1995; Heidary *et al.,* 2007). For the first time, Strogonov (1964) proposed that salt tolerance of plants could be enhanced by treatment of seed with salt solution prior to sowing. Successful results of salt priming have been obtained for wheat, tomato, rice, melon and cucumber. This simple, low-cost, low-risk intervention also had positive impacts on the wider farming system and livelihoods and the technology has proved highly popular with farmers (Hoseini *et al.,* 2013). This study aimed at investigating the effects salt stress on seed germination and seedling growth of four cultivations of bread wheat.

Materials and methods

The germination responses of four cultivars of bread wheat to different levels of salt strees (NaCl) were examined.

Experiment Method

This study was conducted in factorial experiment based on complete randomized design (CRD) with three replications (25 seeds per replication). Four wheat cultivars including Sovasel, Shahriyar, Zarin, and Cascogen and four salt levels, 2 g/lit (0.05 *M*), 5 g/lit (0.12 *M*), 8 g/lit (0.2 *M*), 11 g/lit (0.28 *M*) of NaCl and also a control treatment were used in this study. Salt treatments were applied through the water used for seed germination, and seedling growth. Each experimental unit consisted of a petri dish 16 cm. diameters each with 25 wheat seeds between two special papers. In order to disinfect the seeds, they were dipped into 5% sodium hypochlorite solution for 3 minutes and then they were rinsed three times by distilled water. 7 ml of the desired solution was added to each petri dish and then they all were placed in incubator at 25°C temperature and 50% humidity for 14 days. Traits measured were germination percentage (GP), germination rate (GR), coefficient of speed of germination (CSG), radicle length (RL), plumule length (PL), seedling length (SL), and the ratio of radicle to plumule (radicle/plumule).

Seed Germination Percentage

To determine percent of seed germination, seeds germinated were counted daily at specific time the second day after incubation, for 14 days. Seeds considered germinated when their primary roots were at least 3 millimeters in length. Based on the data obtained, the germinating rate was (GR) calculated using the following equation, reported by Shamsaddin-Saied *et al.* (2007).

$$GR = \sum_{i=1}^{n} \frac{si}{Di}$$

Where: *Si*: indicates the number of seed germinated each day; *Di*: the number of days until n^{th} counting; *n*: total number of counting.

Statistical Analysis

Statistical analysis was made by MSTAT-C and Excel and the data were analyzed through variance analysis method and means compared by using Duncan's multiple range test at 5% probability level.

Results and discussion

Germination Percentage (GP)

Increasing sodium chloride concentration, decreased percentage of germination of Soasel and Shahriar cultivars significantly at 1% and Zarin at 5% probability levels, whereas, there was no meaningful reduction in that of Cascogen cultivar. Furthermore, the highest and lowest percentage of germination can be attributed to Shahriyar and Zarin types respectively (Fig 1).

Table 1. Mean comparison of the traits of wheat (by Duncan's multiple range test).

Radicle/Plumule (mm)	CVG	GR	SL (mm)	PL (mm)	RL (mm)	GP (%)	variety	Conc. (mg)
1.9 a	5.23 a	18.95 d	7.1 d	2.3 b	4.8 c	83.33 c	Soasel	0 (control)
1.57 a	5 b	19.8 b	10.07b	3.83 ab	6.23 b	96.67 a	Shahriyar	
1.5 a	5.13 a	19.33 c	10.9 a	4.3 a	6.6 a	86.67 b	Zarin	
1.9 a	4.7 c	21.43 a	7.13 c	2.4 b	4.73 c	76.67 d	Cascogen	
1.9 a	5.03 b	19.7 b	7.03 c	2.37 c	4.67 c	83.33 c	Soasel	2
1.9 a	5.07 b	19.37 c	7.8 b	2.8 b	5 b	83.33 b	Shahriyar	
1.6 a	5 b	20 a	10.3 a	3.93 a	6.37 a	100 a	Zarin	
2 a	5.27 a	18.8 d	6.57 d	2.2 d	4.37 d	76.67 d	Cascogen	
1.73 c	5.03 b	19.63 a	7.03 b	2.53 b	4.5 a	70 a	Soasel	5
1.9 a	5.03 c	19.73 a	6.87 c	2.23 c	4.47 a	75 a	Shahriyar	
1.6 d	5.03 d	19.67 a	10.17 a	3.83 a	6.33 a	93.33a	Zarin	
1.83 b	5.13 a	19.3 a	6.33 d	2.23 d	4.1 a	76.67 a	Cascogen	
1.8 c	5 c	19.9 a	5.57 b	2 bc	3.57 c	43.33 a	Soasel	8
1.77 c	5.53 a	18 c	6.33 b	2.23 b	4.1 b	60 a	Shahriyar	
1.9 b	5.2 b	19.07 b	8.67 a	3 a	5.67 a	80 a	Zarin	
2.07 a	5.2 b	18.93 b	5.83 b	1.93 c	3.9 bc	70 a	Cascogen	
1.63 d	5.63 a	17.6 c	5.4 b	2.3 b	3.37 d	63.33 a	Soasel	11
2.1 a	5.43 b	18.13 b	5.93 b	1.9 c	4.03 b	40 a	Shahriyar	
2.03 b	5.1 c	19.37 a	8.1 a	2.67 a	5.43 a	73.33 a	Zarin	
1.97 c	5.2 d	19.03 a	5.47 b	1.83 c	3.63 c	63.33 a	Cascogen	

Germination Rate (GR)

The results showed that each concentration level of sodium chloride affected the germination rates of cultivars differently. Considering different contents of sodium chloride a meaningful correlation between germination rate at 1% probability level for Sovasel cultivar and at 5% probability level for Zarin and Shahriyar cultivars can be observed (Table 1). Germination rate of Cascogen cultivar in different contents of sodium chloride was not significant (Fig 2). Hadi *et al.* (2007) reported that seed germinating rate will be declined when salt content increased.

When equal contents of sodium chloride were applied variation in germination rates of cultivars was observed to be negligible (Table 1). Shamsaddin-Saied *et al.* (2007) reported differential responses of canola cultivars to percent and rate of germination to salt stress.

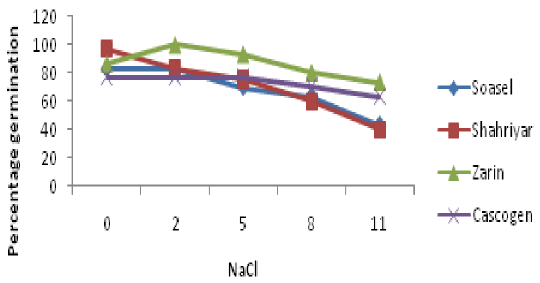

Fig. 1. Effect of NaCl on germination percentage of four wheat cultivars.

Coefficient of Speed of Germination (CSG)

Application of different contents of sodium chloride resulted in different responses of cultivars under study to coefficient of speed of germination (CVG). A significant difference was observed in coefficient of speed of germination at 1% and 5% probability levels for Sovasel and Sahriyar cultivars respectively, whereas no significant variation was observed to those of Zarin and Cascogen cultivars. The longest time span was identified in the case of Sovasel type with 11 grams concentration and the shortest one was observed in the case of Cascogen cultivars. No significant variation was observed in coefficient of speed of germination of the cultivars when equal concentrations of sodium chloride were used (Table 1).

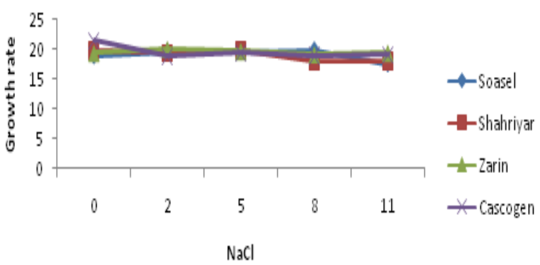

Fig. 2. Effect of NaCl on germination rates of four wheat cultivars.

Radicle, Plumule and Seedling characteristics

The effect of different concentrations of sodium chloride on radicle characteristics was a significant 1% probability level for Zarin and Cascogen cultivars and at 5% probability level for Shahriyar. The difference in the case of Cascogen and Sovasel was not significant. Valdyani *et al.* (2007) reported a significant decline in the length of radicle and plumule by increasing salt level a between these two properties in winter rapeseed. Based on the findings obtained, the largest and smallest values in terms of radicle, plumule, and seedling lengths are associated with Zarin and Cascogen types respectively followed by Sahriyar and Sovasel types in the next levels (Table 1). No significant difference was observed among cultivars the studied when equal treatments sodium chloride was applied, however, the properties of radicle length and seedling length varied significantly in 0, 8, 11 and 8, 11 concentrations (Table 1).

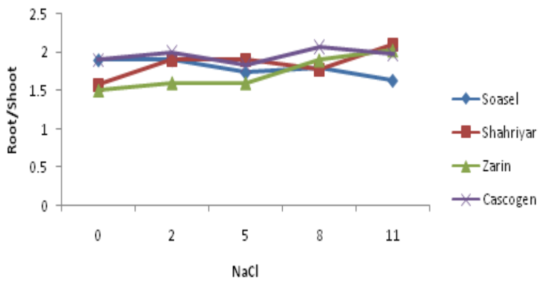

Fig. 3. Effect of NaCl on radicle/plumule ratio of four wheat cultivars.

Radicle to Plumule Ratio (Redicle/ Plumule)

The radicle to plumule ratio varied significantly in Sovasel, Zarin, and Cascogen by 5% probability level, when different salt treatments were used whereas it was not significant in the case of Shahriyar. Based on the means it can be said that radicle to plumule ratio increased in all genotypes studied except Sovasel variety. Comparing the cultivars under study having equal salt contents, no meaningful difference was observed in any level of sodium chloride (Figure 3). Comparing average values indicated that by increasing sodium chloride concentration generally reduces all of the characteristics germination percentage, germination rate, radicle length, and plumule length studied (Table 1). However, the decrease in the percent of germination did not make many problems since; there was no significant variation among 5 salt treatments (Table 1).

Valadyani *et al.* (2007) also reported similar results. The highest percent of germination, radicle, and seedling lengths belonged to control treatment and the lowest was observed in seeds treated with 11 grams of sodium chloride (Table 1).

References

Almasouri M, Kinet JM, Lutts S. 2001. Effect of salt and osmotic stresses on germination in durum wheat (*Triticum durum Desf*). Plant and Soil **231,** 243-254. http://dx.doi.org/10.1023/A:1010378409663

Delachiava MEA, De-Pinho SZ. 2003. Germination of *Senna occidentalis* Link seed at different osmotic potential levels. Brazilian Journal of Biology and Technology **46**, 163-166. http://dx.doi.org/10.1590/S15168913200300020000 4

De R, Kar RK. 1995. Seed germination and seedling growth of mung bean (*Vigna radiata*) under water stress induced by PEG 6000. Seed Science and Technology **23,** 301-308.

Flowers TJ. 2004. Improving crop salt tolerance, Journal of Experimental Botany **55 (396),** 307–319. http://dx.doi.org/10.1093/jxb/erh003

Hadi MR, Khavarinejad RA, Khosh-Kholgh S. 2007. NaCl Effects on Accumulation of Minerals (Na+, K+, Cl) and Proline in *Triticum turgidum L.* Asian Journal of Plant Science **6,** 423-426. http://dx.doi.org/10.3923/ajps.2007.379.383

Heidary M, Heidariy R, Jameai R. 2007. Evaluation of resistance for drought and salinity in four barley (*Hordeum vulgaris* L.) cultivars in germination stage. Pajouhesh & Sazandegi (In Persian) **74,** 134-142.

Hoseini M, Rahimzadeh-Khoei R, Mirshekari B. 2013. Seed Priming Techniques Improve Germination and Yield in Two Landraces of Lemon-Balm in Laboratory Experiment and Field Study. International Journal of Indigenous Medicinal Plants **29(1),** 1144-1150.

Mahajan S, Tuteja N. 2005. Cold, salinity and drought stresses: An overview. Arch Biochemistry and Biophysics **444,** 139-158.

Misra N, Dwivedi UN. 1995. Carbohydrate metabolism during seed germination and seedling growth in green gram under saline stress. Plant Physiology **33,** 33-40.

Pesarrakli M. 1999. Handbook of plant and crop stress. Marcel Decker Inc, New York.

Shamsaddin-Saied M, Farahbakhsh H, Maghsoodi-Mude AA. 2007. Effects of salt stress on germination, vegetative growth and some physiological characteristics of canola. JWSS - Isfahan University of Technology **11 (41),** 191-203.

Valadyani AR, Hassanzadeh A, Tajbakhsh M. 2007. Study on the effects of salt stress in germination and embryo growth stages of the four prolific and new cultivars of winter rapeseed (*Brassica napus* L.). Pajouhesh & Sazandegi **66,** 23-32.