Cumhuriyet Üniversitesi Fen Fakültesi
Fen Bilimleri Dergisi (CFD), Cilt:36, No: 3 Özel Sayı (2015)
ISSN: 1300-1949

Cumhuriyet University Faculty of Science
Science Journal (CSJ), Vol. 36, No: 3 Special Issue (2015)
ISSN: 1300-1949

The wheat response to drought and salinity stresses

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Received: 01.02.2015; Accepted: 05.05.2015

Abstract. Present study was conducted to investigation the influence of salinity and drought stresses on germination and growing parameters in the wheat (T. aestivum L.) Cultivar (chamran). This experiment was carried out in completely randomized factorial form with three replications in laboratory condition at the initial stage of growing. Treatments were supplied to use of sodium chloride(Na^+Cl^-) and polyethylene glycol 6000 (PEG) solutions in order to impose the salinity and drought stress, which were including control (without sodium chloride) osmotic potentials 75, 150 and 200 mmol/l and control (without polyethylene glycol) osmotic potentials -0.4, -0.8 and -1.2 bar, respectively. Results indicated that the influence of salinity and drought DOP (different osmotic potential) on the root length, Shoot length, fresh root mass and fresh shoot mass, root dry mass, shoot dry mass, compared to the control were not significant ($P \geq 0.05$).the influence of the salinity and drought DOP on germination percentage were not significant. Both of OP (osmotic potential) had no influence on germination rate.

Keywords: drought, polyethylene glycol, salinity, sodium chloride, wheat.

1. INTRODUCTION

Plants in various ecosystems are constantly exposed to the stress of living and non-living factors such as fungi, weeds, drought and salinity contributes to the development of this limiting factor in plants(Lawlor,2002). Among the factors mentioned, shortage of water is the most important in plant growth and development (Hoogenbom et al., 1987) The first and most sensitive response to water shortages are reduce an inflammation of the cell and growth (Larcher,1995). water shortages is Also cause of the drought and salinity that is due to the low level of precipitation and high evaporation. Drought and salinity are the most important environmental stresses in the world and Iran (Caramer et al.,1989). Drought is the most important limiting factor growth and yield in crop that influence 40 to 60 percent of the world's agricultural land (Bray, 2001). Drought prevents full genetic potential of the crops and reduced agricultural production. The first reaction of the plant versus to drought is increased on the growth of health that has detrimental influence on germination, seedling growth, structure of organs and their functions (Higgs & Jones,1990). The most important factors adapting of plants to dehydration and stress is regulation of osmotic potential by accumulation of organic and inorganic substances in plant cell which reduce the detrimental effects of environmental stresses (Rieger, 1995). Today, furthermore, the greenhouse and field studies, laboratory studies by the materials such as polyethylene glycol (PEG 6000) induce drought stress conditions is very important (De & Kar,1994). PEG by create the natural environment, same drought stress induced by dehydration is of the most common materials inducer of stress in plant (Zeid & El-Semary, 2001). PEG due to the high molecular weight has not capable of crossing of cell wall, it is being used to adjust the osmotic potential of water during the drought experiments (Michel & Kaufmann, 1973). The salinity inflicted irreparable damage to plants in the world (Bhatti et al., 2004). The concentration of dissolved salts in saline soils is high and if the dominant cation be, Mg or Na, the soils are alkaline, but may, in saline soils exchangeable hydrogen increases and PH is less than 4, these soils are acidic (Tanji,1995).high salinity soil is limiting factors of crop yields in around the world, especially in arid and semi-arid as one of the most fundamental problems in the agricultural sector(Munns,2002).In crop In terms of salinity stress the crop

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Special Issue: The Second National Conference on Applied Research in Science and Technology

germination stage is the most important factor. Reduced in germination and plant growth under salinity stress may be due to changes in osmotic potential affected of downward water potential and avoid of getting water in the root environment or the effects of specific ions (toxic ions Na^+ and Cl^-) (Hagighi & Milani,2009). Present investigation in order to effect of salinity and drought stresses on germination and germination parameters wheat was performed.

2. MATERIAL AND METHODS

Seeds of wheat (T. aestivum L.) Cultivar (chamran) were obtained from the Research center of Agriculture and Natural Resources of Dashtestan, Bushehr province. This experiment was carried out in completely randomized factorial form with three replications and 20 seeds were placed in the each of plastic dishes. Before seeds treatment, they were soaked in water for 2 hours and then were embedded in 2.5 percent hypo chloride solution for 15 min. Then, the seeds washed thoroughly under tap water and in the end with distilled water. In order to impose the drought and salinity was used of the (PEG 6000 and Na^+Cl^-). Four different levels of each of osmotic potentials were supplied to use of the (PEG 6000 and Na^+Cl^-), including control (without polyethylene glycol) osmotic potentials -0.4, -0.8 and -1.2 bar and control (without sodium chloride) osmotic potentials 75, 150 and 200 mmol/l respectively. Osmotic pressures were calculated according to the Van Hoff (1) and Michel and Kaufmann (2). The formula as follow:

$$\Psi S = - imRT \qquad (1)$$

The formula ΨS: Osmotic pressure versus Mega Pascal, i: mol/kg solution, m: Ionization factor, R:Gas constant, T: temperature of solution was considered.

$$OP= (-1.18 \times 10\text{-}2) \times C - (1.18 \times 10\text{-}4) \times C+ (2.67 \times 10\text{-}4) \times C\times T + (8.39 \times 10\text{-}7) \times C2T \qquad (2)$$

Where OP: the potential of osmotic stress versus time, C: concentration of polyethylene glycol, T: temperature in Kelvin (298 ° C) was considered.

The experiment was carried out in the germinator (25±1 C°, 45% relative humidity).

The germination of seeds was ended after 1 day and root exclusion criterion for germination was defined as 2 mm. After germination, root and shoot length, plant dry weight, root dry weight and decreased the germination percentage were measured. Mean germination time according to the equation of Ellis and Roberts (1981) were calculated. Analysis was carried out by SPSS software and Statistical analysis of Duncan.

3. RESULTS AND DISCUSSION

3.1. Results of drought variance

Germination in the control condition and three osmotic potentials of control (0), -0.4, -0.8 and -1.2 bars are shown in Table 1: These results showed that adaptation and resistance of this wheat cultivar under drought stress. germination was ended after 1 day and rate of germination was in the most heighten form of its. These results also showed that germination percentage of this cultivar in -0.8 and -1.2 treatments compared to control were not significant. Saidi (1384) was reported until intermediate levels under drought stress, germination percentage has not changed, this indicates the relative resistance of wheat to drought stress at the germination stage. Salehi (1389) also was reported with increasing levels of drought stress decreased plant germination percentage. Drought causes the crop to withstand that kind of stress, but a marked decrease in yield is observed**.** This makes it difficult for the farmer And thus the efficiency of the farmer must decide what level of deficit irrigation to take, When no water is applied and when it is used less water than a typical consumer To achieve maximum water efficiency and minimum cost (Condom,2002).

Table 1. Germination of (Chamran) cultivar under (Drought), control, -0.4,-0.8 and -1.2 concentrations in germinator (after 1 day).

PEG Treatment	Replication1	Replication2	Replication3
0	18	19	20
-0.4	18	17	18
-0.8	18	16	17
-1.2	17	16	16

Analysis of variances of (table 2) showed that DOPof PEG were not significant at(0.05) on fresh shoot mass, fresh root mass, total fresh mass, shoot dry mass, root dry mass, total dry mass, Shoot length and root length. Controls showed better yield on the length of the roots and the shoots than the other treatments. -0/4 Treatment on the shoot fresh weight, root fresh weight, fresh weight and dry weight parameters than the control group showed better yield on these parameters. -0/8 treatment on the root fresh weight and root dry weight showed better yield than the other treatments. -1/2 on the total dry weight than the control parameters showed better yield (Jaafarzade,2006; Geravand,2006).

Table 2. Analysis of variance (growing parameters in drought).

Parameters	Different levels of PEG6000 (Bar)			
	0	-0.4	-0.8	-1.2
fresh shoot mass	**0/33±0/03** ^{c}	**0/23±0/12** ^{a}	**0/19±0/05** ^{b}	**0/07±0/03** ^{c}
fresh root mass	**0/34±0/05** ^{b}	**0/26±0/06** ^{a}	**0/17±0/07** ^{a}	**0/09±0/04** ^{c}
total fresh mass	**0/67±0/08** ^{b}	**0/49±0/18** ^{a}	**0/36±0/12** ^{b}	**0/16±0/07** ^{c}
shoot dry mass	**0/0313±0/0008** ^{b}	**0/02±0/01** ^{a}	**0/022±0/005** ^{bc}	**0/012±0/004** ^{c}
root dry mass	**0/029±0/006** ^{b}	**0/028±0/005** ^{b}	**0/027±0/009** ^{a}	**0/021±0/003** ^{c}
total dry mass	**0/0603±0/0068** ^{d}	**0/048±0/015** ^{b}	**0/049±0/034** ^{a}	**0/033±0/007** ^{c}
Shoot length	**6/87±0/57** ^{a}	**6/37±0/51** ^{b}	**2/39±0/45** ^{bc}	**2/93±0/48** ^{c}
root length	**4/20±1/38** ^{a}	**3/006±0/148** ^{c}	**6/53±0/66** ^{d}	**5/28±0/6** ^{b}

Indicate the standard error ±

Columns with a letter in common are not significantly different by Duncan test at 5% probability level

3.2. Result of salinity variance

In the table 3 are showed that germination of seeds in condition of salinity including, control,75, 150 and 200 mmol/l. significant differences was not observed between the treatments of 75 and 150, and the control on germination percentage. Treated with 200 also have acceptable germination compared to control. The growth of wheat seedlings under salinity in the greenhouse was accomplished and stated that with increasing salinity levels seedling growth was faced with a significant decrease (Avalbaev et al.,2009).

Table 3. Germination of (Chamran) cultivar under (Salinity), control,75,150 and 200 concentrations in germinator (after 1 day).

NaCl treatment	Replication1	Replication2	Replication3
0	19	18	19
75	17	16	17
150	16	17	18
200	17	15	14

Analysis of variance in Table 4 showed that NaCl treatments on fresh shoot mass, fresh root mass, total fresh mass, shoot dry mass, root dry mass, total dry mass, shoot length and root length were not significant at(0.05). Controls in all parameters compared to other treatments have better yield (except shoot length).150 compared to control were not significant on fresh root weight.200 compared to control and other treatment has better yield on shoot length.75 compared to 150 were not significant on total fresh weight.150 and 200 on dry root weight and 150 with control on shoot length were not significant. One of the effective indices of salinity tolerance is maintaining cellular inflammation (kaffe & Stuart,2001).

Table 4. Analysis of variance (growing parameters in salinity).

Parameters	Different osmotic pot Osmotic potentials of NaCl			
	0	75	150	200
Fresh shoot mass	**0/25±0/15^{a}**	**0/03±0/05^{b}**	**0/04±0/01^{c}**	**0/007±0/002^{d}**
Fresh root mass	**0/28±0/02^{a}**	**0/14±0/01^{b}**	**0/14±0/03^{a}**	**0/09±0/01^{b}**
Total fresh mass	**0/53±0/17^{a}**	**0/49±0/06^{b}**	**0/18±0/04^{b}**	**0/097±0/012^{c}**
Shoot dry mass	**0/024±0/006^{a}**	**0/002±0/003 ^{b}**	**0/008±0/001^{c}**	**0/0019±0/0007^{d}**
Root dry mass	**0/024±0/007^{a}**	**0/013±0/001 ^{c}**	**0/019±0/005^{b}**	**0/015±0/004^{b}**
Total dry mass	**0/048±0/013^{a}**	**0/015±0/004 ^{b}**	**0/027±0/006^{b}**	**0/0169±0/007^{b}**
Shoot length	**2/46±0/42^{c}**	**0/88±0/78^{b}**	**2/57±0/51^{c}**	**1/3±0/6^{a}**
Root length	**5/81±1/20^{a}**	**2/72±0/14^{d}**	**4/02±0/30^{b}**	**2/91±0/18^{c}**

Indicate the standard error ±

Columns with a letter in common are not significantly different by Duncan test at 5% probability level

Studies showed that this cultivar under the drought has a better yield compared to salinity and reduction in germination parameters is the lowest. Present study indicates that could use of this cultivar of wheat under salinity and drought. Further tests on the wheat cultivar under salinity could determine the best threshold of tolerance.

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