American-Eurasian J. Agric. & Environ. Sci., 9 (1): 86-90, 2010
ISSN 1818-6769

Effects of Polyethylene Glycol and NaCl Stress on Two Cultivars of Wheat (*Triticum durum*) at Germination and Early Seedling Stages

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Abstract: To study on effect of polyethylene glycol (PEG) and NaCl stress on germination and early seedling stages on two genotypes of wheat, two separated experiment were laid out at laboratory, in Iran in 2010. This investigation was performed as factorial experiment under Complete Randomized Design (CRD) with three replications. Cultivar factor contains of two genotypes (Seimareh and Leucurum) and five levels of stress (0, -2, -4, -6 and -8 bar). Results indicated that significant decrease in percentage of germination, germination rate, length of radicle and plumule and radicle and plumule dry matter. On the basis of the results, NaCl as compared with PEG had more effect on germination and early seedling stage and Seimareh had more resistant than Leucurum in both stress conditions.

Key words: Wheat · Early seedling stage · Germination · PEG and NaCl Stress

INTRODUCTION

Abiotic stresses, such as drought, salinity, extreme temperatures, chemical toxicity and oxidative stress are serious threats to agriculture and result in the deterioration of the environment. Abiotic stress is the primary cause of crop loss worldwide, reducing average yields for most major crop plants by more than 50% [1]. One of the most important abiotic factors limiting plant germination and early seedling stages is water stress brought about by drought and salinity [2], which are widespread problems around the world [3]. Salinity and drought affect the plants in a similar way [4]. Reduced water potential is a common consequence of both salinity and drought [5]. Water stress acts by decreasing the percentage and rate of germination and seedling growth [6]. Germination of seeds, one of the most critical phases of plant life, is greatly influenced by salinity [7]. NaCl and polyethylene glycol (PEG) compounds have been used to simulate osmotic stress effects in Petri dish (I*in vitro*) for plants to maintain uniform water potential throughout the experimental period [8]. Stalinization is the scourge of intensive agriculture [9]. High concentrations of salts have detrimental effects on germination of seeds [10, 11] and plant growth [12]. Many investigators have reported retardation of germination and growth of seedlings at high salinity [13]. However plant species differ in their sensitivity or tolerance to salts [14]. Wheat is a major staple food crop for more than one third of the world population and is the main staple food of Asia [15]. It is originated in South Western Asia and has been a major agricultural commodity since pre historic times. The total production area in Pakistan is 8.2 mha and the average yield is 2170 kg/hectare [16]. Wheat crop is mainly cultivated under rain fed conditions where precipitation is less then 900 mm annually. Wheat is grown both as spring and winter crop. Winter crop is more extensively grown than spring. The possible cause of varietal difference most likely evolves ion transport properties and cellular compartementation [17]. Schachtmann and Munns [18] reported that sodium exclusion was a general characteristic of salt tolerance in wheat lines; where as, salt tolerant display much higher shoot sodium level than sensitive lines. Few studies have been carried out on the relative salt tolerance of various cultivars of agricultural crops of Pakistan [9, 10]. The screening of salt tolerant lines/cultivars has been attempted by many researchers on various species at seedling growth stage [19]. The relation of various seedling growth parameters to seed yield and yield component under saline conditions are important for the development of salt tolerant cultivar for production under saline conditions. The principal aim of present study was to compare the effects of drought and salt stress induced on germination and early seedling stage of two cultivars of wheat.

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MATERIALS AND METHODS

In two separated experiments, effect of drought and salt stresses induced by different osmotic potential levels [(0(control), -2, -4, -6 and -8 bar] of polyethylene glycol 6000 (PEG 6000) and NaCl treatments on germination and early seedling development of wheat were studied (Table 1).

Two genotypes of wheat including Seimareh and Leucurum were used. This investigation was performed as factorial experiment under Randomized Complete Design (CRD) with three replications. In each experiment and each level of stress, twenty grains of any cultivar were selected and sterilized in sodium hypochlorite (1%) and then washed in water for two times. The grains of both cultivars were germinated in Petri dishes on 2 layers of filter paper in an incubator maintained at 25°C. Daily, germination rate was measured and need have replaced the filter papers and add the PEG and NaCl soluble were performed. Every 24 hours after soaking, germination percentage and other traits were recorded daily. Seeds were considered germinated when the emergent radical reached 2 mm length. Rate of germination, coefficient of velocity of germination and Germination index (GI) were calculated using the following formulas:

Rate of germination = $\delta A/\delta Tt$

Coefficient of velocity of germination:

$$\frac{A_1 + A_2 + ... + A_x}{A_1 + T_1 + A_2T_2 + ...A_xT_x} \times 100$$

Mean of day germination = $\Sigma\ (Nt/\Sigma N)$

Germination index (GI) was calculated by the following formula:

$$GI = \frac{\text{Total number of seeds germinated}}{\text{Total numbr of seeds observed}} \times 100$$

Every day the number of seeds germinated (2 mm radical) recorded for 10 days continued at the eleventh day as root and coleoptiles measurements and fresh weight of root and coleoptiles measurement and into the oven at temperatures 75°C for 24 hour were placed after the mentioned period of dry samples was measured and recorded.

Table 1: Value of PEG for stress levels

NO.	PEG (g/lit)	Stress level (bar)
1	138	-3
2	189	-6
3	222	-9
4	251	-12
5	270	-15

RESULTS

Drought Stress Experiment: According to results of analysis of variance, percentage of germination and germination rate in different levels of drought stress and different varieties were significant. But the interaction between cultivars and stress level in of germination and germination rate not significant. Means results indicated that percentage of germination and germination rate in Seimareh genotype had more than Leucurum (Table 1). The effect of drought stress levels revealed that there was no significant differences in germination rate in stress level (-2 bar) but in (-4 bar), the significant decrease was observed. But, the variability trend of germination is more severe and in primary levels of stress, decrease amount is significant. Also, the interaction between cultivars and stress levels showed that maximum of percentage of germination (% 90) in Seimareh (control) as compared with Leucurum not significant (Table 2).

On the basis of ANOVA results, the effects of variety and stress levels on length of radicle and plumule were significant but interaction between cultivars and stress level in length of plumule had significant difference and on length of radicle not significant. Mean comparison results revealed that the length of radicle and plumule in Seimareh was more than Leucurum.

It can represent that Seimareh genotype was more resistant than Leucurum in stress conditions for this traits (Table 1, 2). On the basis of results, the effect of variety and stress levels and their interaction on radicle dry matter were significant but plumule dry matter only on stress levels shown significant difference and with cultivar and their interaction not significant. Results showed that rate of radicle dry matter in seimareh more than Leucurum (Table 1, 2).

Salt Stress Experiment: Percentage of germination and germination rate in different levels of salt stress and different varieties were significant but interaction between them not significant. Means results indicated

Table 1: Comparison of means simple effect of cultivar and stress levels on germination and growth

Genotypes	Germination (%)	Germination rate	Length of radicle (cm)	Length of plumule (cm)	Radicle weight (g)	Plumule weight (g)
Seimareh	76.20	6.47	3.80	1.8	0.050	0.041
Leucurum	58.30	5.87	3.40	1.4	0.030	0.032
Stress levels (Bars)						
0	92.58	11.46	6.57	3.4	0.060	0.065
-2	81.26	10.19	5.12	2.5	0.049	0.038
-4	65.24	8.51	4.16	1.2	0.034	0.019
-6	44.14	5.13	2.60	0.9	0.022	0.001
-8	0.00	0.00	0.00	0.0	0.000	0.000

Values of each column (between two horizon lines) followed by the same letter indicate no significant differences ($p \leq 0.05$) according to DMRT

Table 2: Comparison of reaction of cultivar and stress levels on germination and growth

Genotypes	Stress levels	Germination (%)	Germination rate	Length of radicle (cm)	Length of plumule (cm)	Radicle weight (g)	Plumule weight (g)
Seimareh	0	91.25	11.26	6.18	3.250	0.059	0.0670
	-2	79.46	9.80	4.56	1. 85	0.041	0.0490
	-4	51.26	6.49	3.20	0.620	0.021	0.0080
	-6	35.36	3.14	1.98	0.180	0.008	0.0007
	-8	0.00	0.00	0.00	0.000	0.000	0.0000
Leucurum	0	86.45	10.06	5.98	3.100	0.052	0.0590
	-2	75.26	8.40	5.51	1.140	0.040	0.0400
	-4	46.00	4.25	3.20	0.600	0.025	0.0100
	-6	16.50	1.59	1.60	0.140	0.003	0.0005
	-8	0.00	0.00	0.00	0.000	0.000	0.0000

Values of each column followed by the same letter indicate no significant differences ($p \leq 0.05$) according to DMRT

Table 3: Comparison of means simple effect of cultivar and stress levels on germination and growth

Genotypes	Germination (%)	Germination rate	Length of radicle (cm)	Length of plumule (cm)	Radicle weight (g)	Plumule weight (g)
Seimareh	45.76	7.10	3.10	2.14	0.034	0.045
Leucurum	39.25	5.50	2.60	1.51	0.026	0.029
Stress levels (Bars)						
0	87.14	11.02	5.34	2.49	0.039	0.057
-2	70.16	7.25	3.46	2.24	0.031	0.036
-4	29.10	3.95	2.18	1.98	0.005	0.029
-6	11.80	2.04	0.50	0.49	0.004	0.015
-8	6.20	1.14	0.20	0.30	0.002	0.010

Values of each column (between two horizon lines) followed by the same letter indicate no significant differences ($p \leq 0.05$) according to DMRT

Table 4: Comparison of reaction of cultivar and stress levels on germination and growth

Genotypes	Stress levels	Germination (%)	Germination Rate	Length of radicle (cm)	Length of plumule (cm)	Radicle weight (g)	Plumule weight (g)
Seimareh	0	91.00	15.60	4.95	2.47	0.050	0.060
	-2	70.16	9.40	3.80	2.10	0.040	0.041
	-4	33.33	5.20	1.60	1.20	0.008	0.020
	-6	26.40	4.10	1.01	1.00	0.020	0.026
	-8	14.20	2.80	0.50	0.85	0.005	0.019
Leucurum	0	88.14	12.57	6.48	3.15	0.020	0.046
	-2	62.58	8.24	4.24	2.49	0.010	0.440
	-4	22.48	3.59	2.47	1.57	0.008	0.009
	-6	11.20	1.26	1.00	0.86	0.010	0.019
	-8	0.00	0.00	0.00	0.00	0.000	0.000

Values of each column followed by the same letter indicate no significant differences ($p \leq 0.05$) according to DMRT that percentage of germination and germination rate in Seimareh was more than Leucurum (Table 3). In addition to, interaction means showed that maximum of percentage of germination (%91) in Seimareh (control) which not significant in Leucurum (Table 4). According to results, the effect of stress levels causes significant difference in length of radicle and plumule but effect of variety only in length of plumule was significant. Results shown that length of radicle in Seimareh genotype was more than Leucurum, but length of plumule in Leucurum was more than Seimareh) (Table 3, 4). The effect of variety and stress levels cause significant difference in radicle and plumule dry matter. But interaction variety and stress level only in radicle dry matter was significant. In this regards, radicle dry matter and plumule dry matter in Seimareh were more than Leucurum (Table 3, 4).

DISCUSSION

Water stress due to drought is probably the most significant abiotic factor limiting plant and also crop growth and development [20]. Drought stresses is physiologically related, because induce osmotic stress and most of the metabolic responses of the affected plants are similar to some extent [21]. Water deficit affects the germination of seed and the growth of seedlings negatively [22]. Because of germination is one of the most important traits in early stage of growth in most plants, it seems that golden west in drought stress condition had more resistant than other cultivars and had more yield potential. In according to results of the present study, it suggested that more experiments were carried out on the similar cultivars and further investigation be done on golden west. Results of the current study are in agreement with those obtained by Kalefetoglu *et al.* [23] on chickpea and Soltani *et al.* [24] on wheat. In present study, all considered traits except length of radicle and plumule in sweet corn had significant differences relative to Seimareh. Because of germination is one of the most important traits in early stage of growth in most plants, it seems that Seimareh in drought and salt stress conditions had more resistant than flint corn and had more yield potential (Figs. 1, 2).

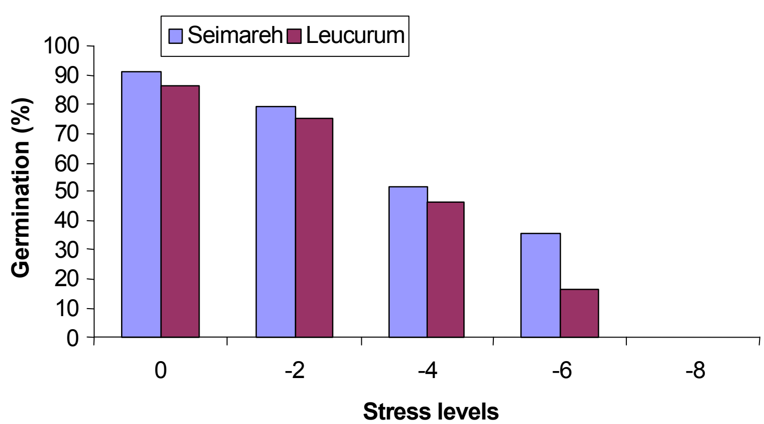

Fig. 1: Percentage of germination affected by PEG

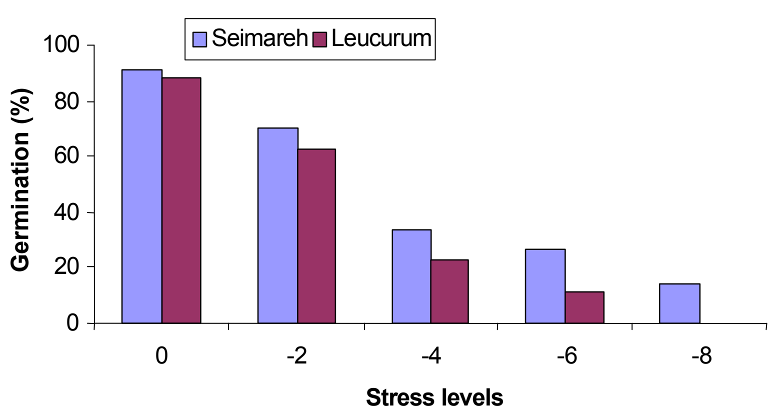

Fig. 2: Percentage of germination affected by NaCl

REFERENCES

1. Boyer, J.S., 1982. Plant Productivity and Environment" Sci., 218: 443-448.
2. Almansouri, M., J.M. Kinet and S. Lutts, 2001. Effect of salt and osmotic stresses on germination in durum wheat (*Triticum durum* Desf.). Plant Soil, 231: 243-254.
3. Soltani, A., M. Gholipoor and E. Zeinali, 2006. Seed reserve utilization and seedling growth of wheat as affected by drought and salinity. Environ. Exp. Bot., 55: 195-200.
4. Katerji, N., J.W. Van Hoorn, A. Hamdy and M. Mastrorilli, 2004. Comparison of corn yield response to plant water stress caused by salinity and by drought. Agric. Water Manage, 65: 95-101.
5. Legocka, J. and A. Kluk, 2005. Effect of salt and osmotic stress on changes in polyamine content and arginine decarboxylase activity in *Lupinus luteus* seedlings. Plant Physiol., 162: 662-668.
6. Delachiave, M.E.A. and S.Z. De Pinho,2003. Germination of *Senna occidentalis* link: seed at different osmotic potential levels. Braz. Arch. Techn., 46: 163-166.
7. Misra, N. and U.N. Dwivedi, 2004. Genotypic differences in salinity tolerance of green gram cultivars. Plant Sci., 166: 1135-1142.
8. Kulkarni, M. and U. Deshpande, 2007. *In vitro* screening of tomato genotypes for drought resistance using polyethylene glycol. Afr. J Biotechnol., 6(6): 691-696.
9. Mer, R.K., P.K. Prajith, D.H. Pandya and A.N. Pandey, 2000. Effect of salts on germination of seeds and growth of young plants of *Hordeum vulgare*, *Triticum aestivum*, *Cicer arietinum* and Brassica juncea. J Agronomy and Crop Sciences, 185: 209-217.
10. Kayani, S.A. and M. Rahman, 1987. Salt tolerance in Corn (*Zea mays L.*) at the germination stage. Pak. J. Bot., 19: 9-15.
11. Rahman, M., S.A. Kayani and S. Gul, 2000. Combined effects of temperature and salinity stress on corn cv. Sunahry, Pak. J. Biological Sci., 3(9): 1459-1463.
12. Pandey, A.N. and N.K. Thakrar, 1997. Effect of chloride salinity on survival and growth of *Brassica juncea*. J. Agronomy and Crop Sci., 185: 209-217.
13. Bernstein, L., 1961. Osmotic adjustment of plants to saline media. I. Steady state. Am. J. Bot., 48: 909-918.
14. Torech, F.R. and L.M. Thompson, 1993. Soils and Soil Fertility. Oxford University Press, New York.
15. Shirazi, M.U., S.M. Asif, B. Khanzada, M.A. Khan and A. Mohammad, 2001. Growth and ion accumulation in some wheat genotypes under NaCl stress. Pak. J. Biol. Sci., 4: 388-391.
16. Anonymous, 1999. Agricultural Statistics of Pakistan: Ministry of Food, Agriculture and livestock, Economics Wing, Islamabad, pp: 3-4.
17. Munns, R., 1988. Causes of Varietal Differences in Salt tolerance. In: International Congress of Plant Physiology, New Delhi, India, pp: 960-968.
18. Schachtmann, D.P. and R. Munns, 1992. Sodium accumulation in leaves of *Triticum* species that differ in salt tolerance. Aust. J. Plant Physiol., 19: 331-340.
19. Ashraf, M., 1999. Interactive effect of salt (NaCl) and Nitrogen form of growth, water relations and photosynthesis capacity of sunflower *(Helianthus annuus* L.). Ann. Appl. Biol., 135: 509-513.
20. Hartmann, T., M. College and P. Lumsden, 2005. Responses of different varieties of *Lolium perenne* to salinity. Annual Conference of the Society for Experimental Biology, Lancashire.
21. Djibril, S., O.K. Mohamed, D. Diaga, D. Diégane, B.F. Abaye, S. Maurice and B. Alain, 2005. "Growth and development of date palm (*Phoenix dactylifera* L.) seedlings under drought and salinity stresses". Afr. J. Biotechnol., 4(9): 968-972.
22. Van Den Berg, L. and Y.J. Zeng, 2006. Response of South African indigenous grass species to drought stress induced by polyethylene glycol (PEG) 6000. Afr. J. Bot., 72: 284-286.
23. Kalefetogllu Macar, T., O. Turan and Y. Ekmekci, 2009. Effect of water deficit induced by PEG and NaCl on Chickpea (*Cicer arietinum* L.) cultivar and lines at early seedling stage. G.U. J. Sci., 22(1): 5-14.
24. Ti da, G.E., S.O.I. Fang Gong Sui, B.A.I.L.I. Ping, L.U. Yingyan and Zh. Guang-sheng, 2006. Effect of water stress on the protective enzymes and lipid per oxidation in roots and leaves of summer maize. Agric. Sci. China, 5: 291-228.