International Journal of Agriculture, Environment and Food Sciences ISSN:2602-246X
Research Article
www.jaefs.com
dergipark.gov.tr/jaefs

THE DROUGHT EFFECT ON SEED GERMINATION AND SEEDLING GROWTH IN BREAD WHEAT (*Triticum aestivum* L.)

Ferhat KIZILGECI[1*] Nihan TAZEBAY[2] Mihriban NAMLI[3]
Onder ALBAYRAK[4] Mehmet YILDIRIM[4]

[1] Şırnak University Faculty of Agriculture, Department of Field Crops, Şırnak,Turkey
[2] Şırnak University, İdil Vocational School, Şırnak,Turkey
[3] Şırnak University Faculty of Agriculture, Department of Holticulture, Şırnak,Turkey
[4] Dicle University, Faculty of Agriculture, Department of Field Crop, Diyarbakır,Turkey

*Corresponding Author: fkizilgeci@sirnak.edu.tr

ABSTRACT

Drought is a major abiotic stress that threating the producing and survival of many crops such as cereal. Wheat is grown on arid lands and drought often causes serious problem in wheat production on these fields. In this study, it was determined that the effect of five different drought stress (0, -0.3, -0.6, -0.9, -1.2 MPa, by using PEG 6000 solution) on the germination of 4 different bread wheat cultivars (Tekin, Pehlivan, DZT13-1 and DZT13-2). The study was carried out according to completely randomized design in factorial arrangement with four replications. In the present study, important growth parameters like germination rate (%), seedling vigor (%), coleoptile length (cm), root length (cm) and shoot length (cm) were observed. Results showed when dose of PEG increased, seedling growth was significantly affected. Increasing drought stress was resulted with a decrease on germination rate, seedling vigor, coleoptile length, root length and shoot length.

Keywords: Germination, PEG-6000, Wheat, Drought Tolerance

Received: 03.11.2017 Accepted: 20.11.2017 Published: 20.12.2017

INTRODUCTION

Wheat one of the most important cereal crops in the world, is grown in wide range of environmental conditions. Wheat yield is reduced by abiotic stresses such as salinity, drought and heat. Drought stress is probably the most important limiting factor to crop production worldwide, especially in many developing counties in arid and semi-arid regions [1]. In the limitations of world crop production drought stress has the highest percentage with 26% when the usable areas on the earth are classified in view of stress factors. Wheat often experiences drought stress at various growth stages especially during germination, tillering and early grain filling with corresponding depressions in biomass production and grain yield under rainfed conditions. Seed germination and seedling growth are critical stages in the life cycle of a plant, especially under adverse abiotic stresses. Germination percentage and seedling traits reduce with a high drought stress. Some researchers had reviewed the effects of drought on germination and seedling development in crops such as wheat [2], corn [3] and barley [4]. Polyethylene glycol (PEG) causes osmotic stress and could be used as a drought simulator [5,6]. It was evaluated four bread wheat varieties for their tolerance to drought stress at germination and seedling at changing stress level.

MATERIALS AND METHODS

The experiment was conducted at growth chamber in laboratory of Horticulture, Faculty of Agriculture, Sirnak University, Turkey. Two commercial bread wheat genotypes (Pehlivan and Tekin) and two advanced genotype were used against drought stress at germination and seedling stage under laboratory. It was laid out as completely randomized design (CRD) in factorial arrangement with five treatments (0, -0.3, -0.6, -0.9, -1.2 MPa, by using PEG 6000 solution) and four replicates.

Day and night lengths were 14/10 h, with ±25°C. Seeds were surface sterilized with 10% sodium hypochlorite solution for 10 minutes and then washed four times with distilled water. Twenty seeds of each wheat genotype were planted in each petri dishes containing filter paper. Germination rate, seedling vigor, coleoptile length, root length and shoot length determined following the method of Yildirim et al. [7].

Analysis of variance was performed using the Genstat statistic package. Means were compared according to LSD test at 0.05 probability levels.

RESULTS

The result obtained from analysis of variance revealed significant differences among different levels of drought stress (Table 1). There was decrease in germination and seedling growth with increase in drought stress.

Germination rate decreased significantly in all cultivars. The decreases were more apparent at -0.9 and -1.2 concentrations. In -0.3 MPa treatment maximum germination rate was executed by Pehlivan (75%), whereas DZT13-2 showed minimum germination rates (55%). Tekin had the highest germination rate (55%) and DZT13-2 exhibited lowest germination rate (27.5%) at -06 MPa treatment. While none of the seeds was able to germinate at-1.2 MPa of PEG. All genotypes exhibited decreases in seedling vigor as osmotic potential was decreased from 0 to -1.2 MPa (Table1). The highest seedling vigor was determined by genotype Pehlivan (90%) in control, whereas DZT13-2 showed minimum germination (11.2%) at -1.2 MPa PEG solution.

Significant reduction in coleoptile length was observed in drought stress in all genotypes. There was a slight decrease in coleoptile length associated with the -0.3 MPa and -0.6 MPa treatments. Tekin had maximum shoot length with 18.9% and 24.1% reduction as compare to control at -0.3 MPa and -0.6 MPa treatments respectively (Figure 1).The shoot length was decreased significantly with increasing of drought stress levels. The decreases were very high at -0.9 MPa and -1.2 MPa. DZT13-1 had maximum shoot length (82.34 mm) with 35% reduction as compare to control at -0.3MPa PEG stress. While it has maximum reduction (99%) was given by all genotypes under -0.9 and -1.2 PEG stress (Figure 2).An increase in PEG concentrations over -0.9 and - 1.2 MPa significantly reduced the length of root compared to control. The maximum root length was observed in control and minimum values observed in -1.2 MPa (Figure 3).

DISCUSSIONS

Our data shows that germination rate, seedling vigor, coleoptile length, shoot length and root length of all wheat genotypes decreased significantly under drought stress. Drought is considered one of the most devastating among the environmental stresses [8]. All agricultural regions will experience drought and some areas experience predictable dry seasons as some others exposed to unpredictable drought periods. Drought stress decreases the crop quality and yield up to 50% or more [9]. Due to the need of developing and identifying drought tolerant crop lines, understanding the functioning capacity of drought tolerant plants under water deficit conditions is inevitable [10].

Under drought stress, growth inhibition observed in all cultivars. The increases in the growth inhibition of the plants become more significant at high PEG concentration. Van den Bergand Zeng [4] reported that drought plays an important role not only in determining germination rates, but also influences seedling development. Significant reduction in coleoptile, shoot and root length at higher concentrations of PEG was observed as compare to control. The reason for low shoot and root length may be due to increase in osmotic potential by increasing drought, which leads to dehydration, ionic imbalance in transpiring leaves that caused reduction in meristem activity and cell elongation, consequently inhibit the growth of wheat plant [11,12,13]. Bartels and Sunkar [14] concluded that growth arrest might allow plants to preserve carbohydrates for prolonged energy supply and for sustained metabolism the reduction in the root length under drought stress. Root length is a very important trait for the plants to cope with drought environments. In this study has shown that the results are in agreement with the study Dranda et al.[15] who noticed the significant decline in the germination and seedling growth.

It is pointless to use -0.9 and -1.2 PEG stress because of the loss of the genotypic difference and almost all of the plants are died in PEG conditions in bread wheats. In this study, the drought tolerance of the varieties changed according to the severity of the drought and the traits investigated.

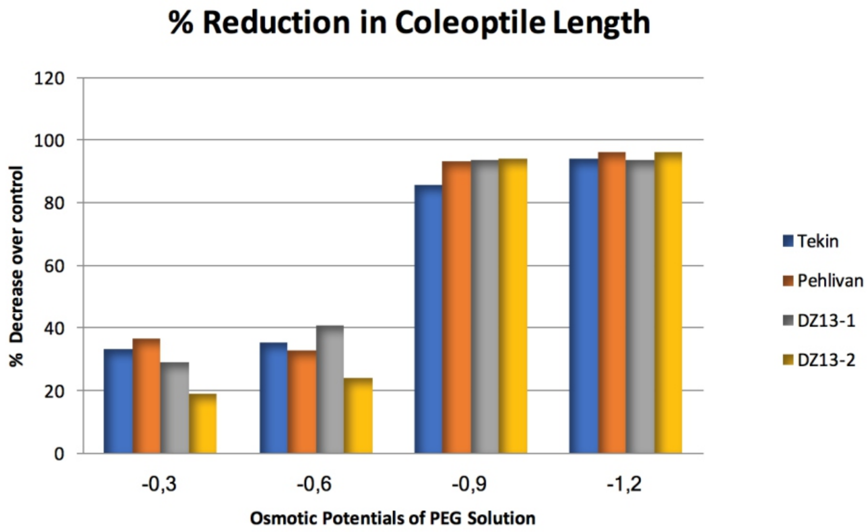

Figure 1. Percent reduction in coleoptile length of wheat genotypes at -0.3, -0.6, -0.9 and -1.2 MPa PEG stress.

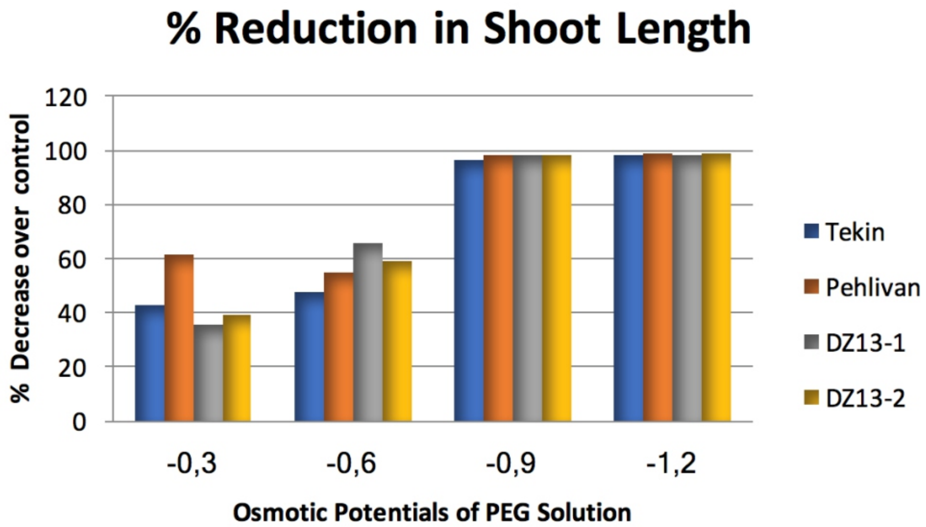

Figure 2. Percent reduction in shoot length of wheat genotypes at -0.3, -0.6, -0.9 and -1.2 MPa PEG stress.

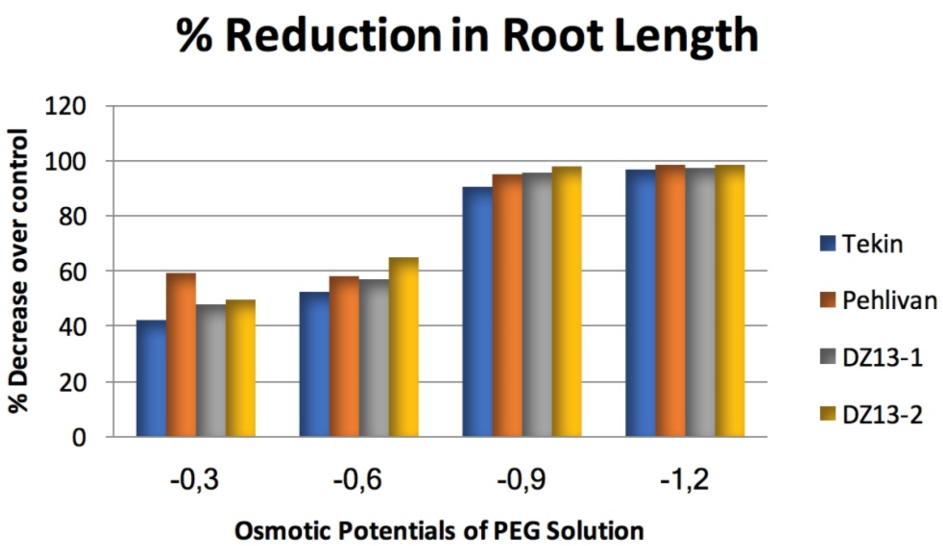

Figure 3. Percent reduction in root length of wheat genotypes at -0.3, -0.6, -0.9 and -1.2 MPa PEG stress.

Table 1. Growth responses of bread wheat genotypes under control and PEG treatments.

Treatments	Varieties	Germination Rate (%)	Seedling Vigor (%)	Coleoptile Length (cm)	Root Length(cm)	Shoot Length (cm)
0 (Control)	Tekin	67.5	88.8	2.718	11.14	10.75
	Pehlivan	75.0	90.0	3.901	14.93	14.49
	DZT13-1	62.5	85.0	3.090	13.63	12.83
	DZT13-2	60.0	78.8	3.736	16.13	14.54
-0.3 MPa	Tekin	62.5	77.5	1.811	6.46	6.15
	Pehlivan	51.2	75.0	2.478	6.12	5.62
	DZT13-1	62.5	73.8	2.187	7.14	8.23
	DZT13-2	55.0	68.8	3.030	8.09	8.81
-0.6 MPa	Tekin	55.0	70.0	1.750	5.28	5.64
	Pehlivan	50.0	62.5	2.611	6.22	6.55
	DZT13-1	42.5	62.5	1.823	5.83	4.38
	DZT13-2	27.5	56.2	2.835	5.63	5.95
-0.9 MPa	Tekin	17.5	46.2	0.390	1.07	0.39
	Pehlivan	15.0	45.0	0.260	0.77	0.26
	DZT13-1	10.0	42.5	0.193	0.61	0.19
	DZT13-2	0	41.2	0.223	0.37	0.22
-1.2 MPa	Tekin	0	21.2	0.171	0.34	0.17
	Pehlivan	0	26.2	0.149	0.22	0.16
	DZT13-1	0	18.8	0.191	0.40	0.19
	DZT13-2	0	11.2	0.146	0.24	0.15
	$Lsd_{0.05}$ stress levels	6.63	6.37	0.166	1.141	0.85
	$Lsd_{0.05}$ genotypes	5.93	5.70	0.149	1.020	0.76
Mean Square	Stress levels	13561.25***	10899.69***	31.74487***	494.947***	468.247***
Mean Square	genotypes	542.81***	276.15*	1.79517***	5.229	5.963**

*, **, *** Significant at 0.05, 0.01 and 0.001 probability levels, respectively.

REFERENCES

[1] Boyer, J. S. (1982). Plant productivity and environment. Science, 218(4571), 443-448.

[2] Rauf, M., Munir, M., Hassan, M., Ahmad, M.and Afzal, M. (2007). Performance of wheat genotypes under osmotic stress at germination and early seedling growth stage. African journal of biotechnology, 6(8), 971-975.

[3] Farsiani, A. and Ghobadi, M. E. (2009). Effects of PEG and NaCl stress on two cultivars of corn (Zea mays L.) at germination and early seedling stages. World Acad. Sci. Eng. Tech, 57, 382-385.

[4] Van den Berg, L. and Zeng, Y. J. (2006). Response of South African indigenous grass species to drought stress induced by polyethylene glycol (PEG) 6000. South African Journal of Botany, 72(2), 284-286.

[5] Ashraf, M.Y., Akhtar, K., Hussain F. and Iqbal, J. (2006). Screening of different accessions of three potential grass species from Cholistan desert for salt tolerance. Pak. J. Bot., 38:1589-1597.

[6] Turhan, H. (1997). Salinity studies in potato (Solanum tuberosum L.). Ph.D. Thesis, The University of Reading, UK. pp. 247.

[7] Yildirim, M., Kizilgeci, F., Akinci, C., and Albayrak, O. (2015). Response of Durum Wheat Seedlings to Salinity. Notulae Botanicae Horti Agrobotanici Cluj-Napoca,43(1), 108.

[8] Vinocur, B. and Altman, A. (2005). Recent advances in engineering plant tolerance to abiotic stress: achievements and limitations. Current opinion in biotechnology,16 (2), 123-132.

[9] Wood, A. J. (2007). Eco-physiological Adaptations to Limited Water Environments. Plant Abiotic Stress, Blackwell Publishing Ltd**:** 1-13.
[10] Bhardwaj, J. and S. K. Yadav (2012). Comparative study on biochemical parameters and antioxidant enzymes in a drought tolerant and a sensitive variety of Horsegram (Macrotyloma uniflorum) under drought stress. American journal of Plant Physiology, **7**(1), 17-29.
[11] Zhu, J. K. (2001). Plant salt tolerance. Trends in plant science, 6(2), 66-71.
[12] Munns, R. (2005). Genes and salt tolerance: bringing them together. New phytologist, 167(3), 645-663.
[13] Huang Y., G.P. Zhang, F.B. Wu, J. Chen and Y. Xiao. (2006).Interaction of salinity and cadmium stresses on antioxidantenzymes, sodium, and cadmium accumulation in fourbarley genotypes. J. Plant Nutr., 29: 2215-2225.
[14] Bartels D. and Sunkar R. (2005). Drought and salt tolerance in plants. Crit Rev Plant Sci., 24:23–28.
[15] Dhanda, S. S., Sethi, G. S.and Behl, R. K. (2004). Indices of drought tolerance in wheat genotypes at early stages of plant growth. Journal of agronomy and crop science, 190(1), 6-12.