Impact of Drought Stress on Germination and Seedling Growth Parameters of Some Wheat Cultivars

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Abstract: With a view to understand the parameters which can be used as a quick criteria for drought tolerance, the present investigation has been performed to evaluate eight wheat (*Triticum aestivum* L.) cultivars, four local cultivars (Madini, Kaseemi, Yamanei and Tabokei) and four introduced cultivars (Sakha 93, Giza 168, Seds 12 and Masr 1) from Agricultural Research Center, Giza, Egypt, to drought stress induced by polyethylene Glycol (PEG)6000 at different concentration 0.0, 60, 120, 180, 240 and 300 g/l PEG during germination and seedling growth stage of plant development. Five germination parameters; finally germination percentage, mean daily germination, germination index, mean germination time and coefficient of velocity of germination and eight seedling growth parameters; shoot length, root length, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight, seedling length and root number were measured under experiment conditions. Experiment units were arranged factorial completely randomized design with three replications. Mean comparison showed that the highest value for most of parameters were recorded for Sakha 93 and Madini cultivars followed by Yamanei, Kaseemi and Tabokei. With due attention to interaction cultivars x drought levels , cultivars Masr 1, Giza 186, Seds 12 under 120, 180, 240 and 300 g/l PEG6000 had the lowest value of noted parameters than other cultivars. Results of variance analysis made clear that different osmotic potential had significant effect on all parameters except root dry weight. In contrast , using all germination and seedling growth parameters, except root number, under study can used as a selectable parameters to discrimination between tolerance and sensitive cultivars under drought stress in breeding programs and laboratory experiment would appear to be suitable for screening under drought stress.

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Key words: Wheat (*Triticum aestivum* L.) . Abiotic stress. Drought. Germination. Seedling growth parameters. Polyethylene glycol.

Abbreviations: PEG - Polyethylene Glycol; FGP – Final Germination Percentage; MGT – Mean Germination Time; GI – Germination Index; CVG – Coefficient of Velocity of Germination; MDG – Mean Daily Germination

1. Introduction

Wheat (*Triticum aestivum L.*) is a staple food for more than 35% of the world population and it is also the first grain crops in most of developing countries **[1].** Bread wheat is the main food of people in many countries and about 70 % calories and 80 % protein of human is supplied from its consumption **[2].** Abiotic stress, especially drought stress is a world wide problem, seriously constraining global crop production **[3].** It is one of the major causes of crop loss world wide, which commonly reduces average yield for many crop plants by more than 50% **[4-5].**

The high yield of plant in sufficient irrigated conditions is not necessarily related to high yield under drought stress **[6].** Depending on which stage of growth a plant experiences drought stress, it reacts quite differently to the stress **[7].** Plant may be affected by drought at any time of life, but certain stage such as germination and seedling growth are critical **[8].** In most of developing countries, wheat is mainly grown on rainfed lands without supplementary irrigation. About 37% of land area in these countries consists of semiarid environments in which available moisture constitutes a Primary constraint to wheat production **[9].**

Seed germination and seedling growth characters are extremely important factors in determining yield **[10]. Dhandas *et al.*, [11]** indicated that seed vigor index and shoot length are among the most sensitive to drought stress, followed by root length and coleoptiles length. The rate of seed germination and the final germination percentage as well as the amount of water absorbed by the seeds were considerably lowered with the rise of osmotic stress level **[12].** There are many studies such as the selecting plant species or the seed treatments that are helpful for alleviating the negative effect of drought stress on plant [**13, 14, 15, 16-17].** Selection of drought tolerance at early seedling stage is frequently accomplished using simulated drought induced by chemicals like poly ethylene glycol(PEG6000).

Poly ethylene glycol (PEG6000) can be used to modify the osmotic potential of nutrient solution culture and thus induce plant water deficit in relatively controlled manner [**18, 19-20]. Lu and Neumann [21]; Kulkarni and Deshpande [22]** showed that Poly ethylene glycol molecules are inert, no-ionic, virtually impermeable to cell membranes and can induce uniform water stress without causing direct physiological damage. PEG as a factor causing drought stress by reducing water potential results in reducing growth in seed germinated and stopping seedling growth so that this effect has been observed more in the shoot than primary roots **[23-24]. Dodd and Donovan [25]** also suggested that PEG prevent water absorption by seeds, but penetrable ions by reducing potential inside cell results in water absorption and starting to germinated.

The present study was conduct to evaluate five wheat cultivars for drought resistance at germination and seedling stage. PEG-6000 was used as an osmoticum to induce stress conditions. The objective of this study was to evaluate wheat varieties for drought resistance at germination and seedling stage.

2- Material and Methods:

In order to study the effects of water stress, using polyethylene glycol, on germination indices and seedling growth parameters in wheat, an experiment was conducted in Department of Biology, Faculty of Science-North Jeddah, King Abdul-Aziz University, KSA in 2011. The form of experiment was factorial, using a completely randomized design (CRD) with three replications. In the present study seeds of eight cultivars from wheat (Madini, Kaseemi, Tabokei, Yamanei, Masr 1, Sakha 93, Giza 168 and Seds 12)were used. grains of first four cultivars were obtained from Agriculture company in KSA and the last four cultivars were obtained from Agricultural Research Center, Giza, Egypt.

Grains of eight cultivars were subjected to six stress level of PEG6000 (0.0, 60, 120, 180, 240 and 300 g/l) According to methods by **Michel and Kaufmann [26].** PEG6000 was prepared by dissolving the required amount of PEG in distilled water at 30˚C. Wheat grains were disinfected with 10% sodium hypochlorite solution for 30 seconds. After the treatment the grains were washed two times with distilled water. 10 grains from each cultivars were germinated on two layers of filter paper in 9-cm Petri dishes with respective treatment from PRG6000. The Petri dishes were covered to prevent the loss of moisture by evaporation under laboratory condition (24±2 ˚C) for 8 days.

Grains were considered germinated when they exhibited radicle extension of > 3 mm. Every 24 hours after soaking, germinated grains were made daily during the course of the experiment to determine following germination parameters. Where the number of germinated seeds was recorded 8 days after planting as Final Germination Percentage (**FGP**) according to **ISIA [27] and ISIA [28]** where **FGP= Ng / Nt x 100,** Ng=Total number of germinated seeds, Nt=Total number of seeds evaluated. Mean Germination Time (MGT) was calculated according to **Sadeghi *et al.*, [29].** The Germination Index (**GI**) was calculated as described in the Association of Official Seeds Analysts (**AOSA**) **[30]** by following formula: **GI=no. of germinated seed/Days of first count+…..+ no. of germinated seed / Days of final count.** Coefficient of Velocity of Germination (CVG) determined by a mathematical manipulation **CV=ΣNi / ΣNiTi x 100** according to **Scott *et al.*, [31].** Mean Daily Germination (MDG) which is index of daily germination was calculated from the following equation **MDG=FGP / d, FGP** is final germination percentage and **d** is days to the maximum of final germination.

The experiment was termined by harvesting seedlings 8 days after grains soaking and traits including shoot length, root length, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight, root number and seedling length were measured. The data collected was analyzed statistically using Costat software to identify significant differences among wheat varieties and among treatments. Least significant difference test was applied at five and one percentage level of probability to comparisons among means as explained by **Stell and Torrie [32].**

3- Results and Discussion:

As screening technique, the survival ability of the eight wheat cultivars to tolerate chemical desiccation by PEG during germination stage is exhibited in Figure (1) .In the present study , there was a significant two-way interaction (drought level and cultivars) ($P\leq 0.01$) for all germination parameters. Data pertaining the effect of PEG induced stress on final germination percentage, germination index, main daily germination, mean germination time and coefficient of velocity germination is shown in Table (1). In all cultivars, the final germination percentage was highest at control treatment and started to decrease as the drought level increasing using PEG. The cultivars differences in response to drought stress for final germination were highly significant (Table 2). The culivars Sakha 93 and Madini had higher final germination percentage than the other cultivars regardless of drought stress (Table 1). However, the cultivar Masr 1 generally had the lowest final germination percentage regarding of drought stress. For other germination parameters, an inverse relationship was observed between drought stress and mean germination time, daily germination time, germination index and coefficient of velocity germination. The average value for MDG, GI, CVG and MGT decreased from 4.895, 3.2329. 82.5 and 1.548 in control treatment to 0.2329, 0.2475, 21.471 and 0.7916 under 300 g/l from PEG, respectively (Table 1 and Fig. 1).

Hegarty [33] indicated that water stress at germination stage can result in delayed and reduced germination or may prevent germination completely. Also, once a grain attains a critical level of hydration it will precede with out cessation toward full germination. However, physiological changes do occur at hydration levels below this critical level that can cause an inhibition of germination. **Dodd and Donavon [25]** observed that reduction in germination percentage can result from PEG treatments that decrease the water potential gradient between seeds and their surrounding media. Different cultivar response to these osmotic stress treatments suggests a great deal of genetic variation among cultivars that could be utilized to develop new wheat cultivars adapted to arid and semiarid regions. **Alaei *et al.*, [34]; Jaijarmi [35], Bayoumei *et al*., [5] and Metwali *et al*., [1]** reported variable response of wheat cultivars for germination indices to various abiotic stress levels. Results presented here are consistent with previous finding that certain germination criteria can be used for selecting drought-resistant cultivars **[9]** .

Seedling development under laboratory conditions have been accepted an suitable growth stage for testing the drought tolerance in wheat it could be speculated that the presence of increased concentrations of PEG during the growth of seedling inhibits the developmental traits and survival of wheat seedling (Table 3). The shoot length of different cultivars differed under different osmotic potential of PEG. In normal condition the maximum value of shoot length was recorded for Yamanei cultivar (11.5 cm), while Madini cultivar recorded lowest value (9.16 cm) followed by Seds 12 (9.5 cm). With increasing concentration of the PEG decline in shoot length occurred. Under treatment with PEG (300 g/l) shoot growth was observed only in Sakha 93 and Madini cultivars, it is recorded 0.66 and 0.26 cm, respectively. Shoot growth was observed for Masr 1 and Sed 12 under 0.0, 60, 120 and 180 g/l from PEG6000, while under 240 and 300 g/l PEG6000 these cultivars were not able to generate any shoot growth.

Table 1: Effect of different drought levels on germination indices of eight wheat cultivars

Parameters	PEG (g/l)	Cultivars								Mean	LSD 0.05
		Madini	Yamanei	Kaseemi	Tabokei	Masr 1	Sakha 93	Giza 168	Seds 12		
Final Germination Percentage (FGP)	0.0	93.30	100	96.6	96.6	100	100	100	100	97.083a	6.5509
	60	100	96.9	100	93.3	93.3	100	93.3	100	97.083a	
	120	96.6	93.30	90.00	100	86.6	93.30	90.00	93.3	90.00b	
	180	76.6	73.30	76.60	73.3	80.00	86.60	86.60	73.3	78.33c	
	240	53.30	23.30	40.00	53.3	20.00	50.00	23.30	3.33	37.08d	
	300	1.00	0.00	6.66	10.00	0.00	16.6	0.00	0.00	5.41e	
Mean Daily Germination (MDG)	0.0	4.66	5.00	4.83	4.83	4.5	5.00	5.00	5.00	4.89a	0.2324
	60	5.00	4.83	5.00	4.66	4.66	5.00	4.66	5.00	4.85a	
	120	4.83	4.66	4.50	5.00	4.66	4.66	4.5	4.66	4.70a	
	180	3.83	3.66	3.83	3.50	4.00	4.33	4.33	3.66	3.81b	
	240	2.66	1.16	3.00	2.00	1.00	2.50	1.16	1.66	1.91c	
	300	0.50	0.00	0.33	0.50	0.00	0.83	0.00	0.00	0.270d	
Germination Index (GI)	0.0	3.11	3.33	3.22	3.22	2.99	3.33	3.33	3.33	3.23a	0.1685
	60	3.33	3.22	3.33	3.10	3.10	3.33	3.22	3.33	3.22a	
	120	3.22	3.10	2.99	3.33	3.11	3.11	3.00	3.40	3.12a	
	180	2.55	2.44	2.55	2.44	2.33	2.55	2.88	2.44	2.60b	
	240	1.77	0.77	1.33	1.77	0.66	1.55	1.33	1.11	1.28c	
	300	0.33	0.00	0.44	0.66	0.00	0.55	0.00	0.00	0.24d	
Coefficient Velocity Germination (CVG)	0.0	81.60	83.00	82.30	82.30	81.30	83.00	83.00	83.00	82.50a	6.5908
	60	82.30	82.30	83.00	82.00	82.00	83.00	82.30	83.00	82.45a	
	120	82.30	78.00	81.30	83.00	81.60	81.00	81.00	81.66	81.25a	
	180	82.30	84.60	87.60	84.00	70.30	81.00	63.00	72.33	78.29a	
	240	66.30	69.00	66.00	69.00	50.00	70.60	65.33	55.33	63.70b	
	300	50.00	0.00	44.00	66.00	0.00	55.30	0.0	0.000	21.47c	
Mean Germination Time (MGT)	0.0	1.21	1.20	1.22	1.22	1.15	1.20	1.20	1.20	1.54a	0.2105
	60	1.20	1.22	1.20	1.21	1.21	1.20	1.2	1.20	1.24b	
	120	1.22	1.28	1.22	1.20	1.22	1.24	1.22	1.22	1.22b	
	180	1.21	1.09	1.13	1.16	1.32	1.23	1.46	1.31	1.20b	
	240	1.50	1.44	1.49	1.55	2.00	1.41	1.57	1.38	1.20b	
	300	2.00	0.00	1.00	1.50	0.00	1.16	0.00	0.00	0.79c	

Table 2 : Analysis of variance for effect of cultivars and drought levels on germination indices of eight wheat.

SOV	df	MS				
		Final Germination Percentage	Mean Daily Germination	Germination Index	Coefficient Velocity Germination	Mean Germination Time
Cultivars	7	339.682**	0.6736**	0.3092**	800.196**	0.3324**
Drought Levels	5	34336.660**	87.4819**	37.099**	13841.31**	1.3955**
Cultivars x Drought Levels	35	203.015**	0.2724**	0.1377**	451.908**	0.4454**
Error	96	105.555	0.1267	0.0686	17.0030	0.0231
Total	143					
Coefficient of Variation (%)		15.221	10.441	11.459	6.039	12.649

SOV: Source of variance, MS: Mean Square, df: degree of freedom * and ** significant at 5 % and 1 %, respectively.

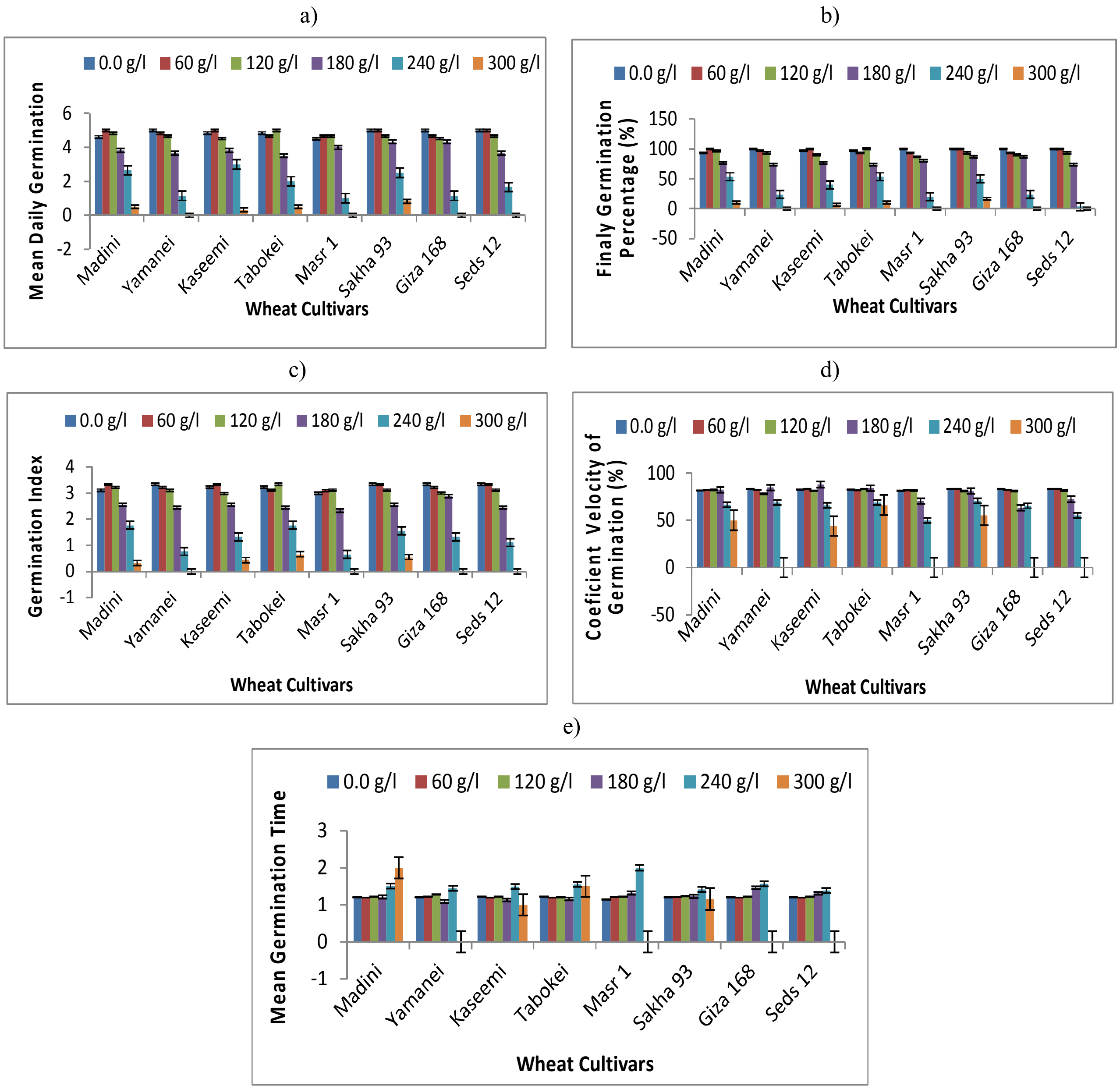

Figure (1):Interaction cultivars x drought levels (0.0, 60, 120, 180, 240 and 300 g/l) PEG6000 for a) Final germination percentage; b) Mean daily germination; c) Germination index; d) Coefficient of velocity of germination and e) Mean germination time of wheat cultivars. Bars represent standard error (±S.E) of means.

Table 3: Effect of different drought levels on growth parameters of eight wheat cultivars

Parameters	PEG (g/l)	Cultivars								Mean	LSD 0.05
		Madaini	Yamanei	Kaseemi	Tabokei	Masr 1	Sakha 93	Giza 168	Seds 12		
Shoot Length (cm)	0.0	9.16	11.50	9.83	9.66	10.50	11.66	10.83	9.50	10.330a	0.3973
	60	7.30	6.83	5.50	5.5	6.00	4.16	6.50	5.16	5.870b	
	120	4.30	4.33	5.10	4.66	3.66	4.00	4.63	3.66	4.330c	
	180	3.33	3.16	2.16	2.83	1.83	2.00	1.00	0.83	2.145d	
	240	1.93	1.00	1.46	2.03	0.00	1.76	0.0	0.00	1.037e	
	300	0.26	0.00	0.00	0.00	0.00	0.66	0.1	0.00	0.116f	
Root Length (cm)	0.0	11.83	10.00	9.00	6.50	4.33	10.16	10.00	5.66	8.645a	0.7267
	60	7.00	5.00	7.16	6.83	5.83	4.66	6.00	4.83	6.620b	
	120	8.16	7.00	7.83	4.33	5.33	5.83	7.3	6.16	6.166b	
	180	5.16	4.5	3.16	3.33	4.00	3.66	1.83	4.66	3.791c	
	240	3.66	3.00	2.16	2.00	1.36	2.16	2.00	2.00	2.283d	
	300	2.00	0.56	0.36	0.53	0.07	2.00	2.00	1.00	1.066e	
Shoot Fresh weight (gm)	0.0	1.68	1.52	1.75	1.34	1.48	2.03	1.63	1.26	1.615a	0.0315
	60	1.04	1.05	0.68	0.94	0.76	1.07	0.63	0.74	0.863b	
	120	0.45	0.23	0.25	0.23	0.17	0.46	0.28	0.32	0.303c	
	180	0.30	0.16	0.19	0.183	0.16	0.38	012	0.22	0.218d	
	240	0.24	0.100	0.13	0.30	0.00	0.24	0.00	0.00	0.138e	
	300	0.83	0.00	0.00	0.00	0.00	0.066	0.00	0.00	0.019f	
Root Fresh Weight (gm)	0.0	1.63	1.62	1.86	1.09	1.19	1.97	2.00	1.55	1.616a	0.0545
	60	0.60	0.56	0.726	0.653	0.51	0.72	0.51	0.82	0.666b	
	120	0.37	0.18	0.18	0.27	0.14	0.37	0.190	0.20	0.246c	
	180	0.22	0.12	0.16	0.14	0.12	0.31	0.1	0.15	0.206c	
	240	0.18	0.07	0.10	0.233	0.076	0.25	0.11	0.06	0.137d	
	300	0.09	0.03	0.03	0.04	0.33	0.056	0.093	0.013	0.047e	
Shoot Dry Weight (gm)	0.0	0.07	0.08	0.20	0.17	0.05	0.099	0.069	0.068	0.105a	0.0112
	60	0.23	0.06	0.05	0.06	0.06	0.06	0.04	0.04	0.052b	
	120	0.04	0.04	0.05	0.04	0.04	0.05	0.04	0.04	0.041b	
	180	0.03	0.02	0.03	0.02	0.022	0.03	0.02	0.02	0.023c	
	240	0.009	0.02	0.011	0.006	0.00	0.012	0.00	0.00	0.006d	
	300	0.006	0.00	0.00	0.00	0.00	0.028	0.00	0.00	0.004d	
Root Dry Weight (gm)	0.0	0.055	0.078	0.142	0.1106	0.050	0.078	0.069	0.056	0.077a	0.0125
	60	0.039	0.048	0.059	0.050	0.040	0.0470	0.037	0.048	0.046b	
	120	0.033	0.040	0.032	0.028	0.024	0.039	0.023	0.029	0.031c	
	180	0.07	0.019	0.017	0.016	0.013	0.017	0.016	0.0183	0.023c	
	240	0.006	0.004	0.005	0.005	0.012	0.011	0.001	0.043	0.010d	
	300	0.008	0.006	0.010	0.002	0.002	0.0173	0.003	0.0093	0.009d	
Root Number	0.0	4.00	5.00	5.00	4.00	4.00	5.00	5.00	4.66	4.666a	0.3667
	60	4.6	5.00	4.33	4.66	3.66	4.66	5.00	5.33	4.583ab	
	120	3.33	4.66	5.33	4.33	3.33	4.66	4.00	4.66	4.291b	
	180	4.33	3.00	3.00	4.00	3.00	3.00	3.66	2.66	3.333c	
	240	3.00	3.00	3.00	3.66	2.33	3.00	3.00	3.00	3.000c	
	300	2.00	2.00	1.66	2.00	0.333	1.33	1.66	1.00	1.375d	
Seedling Length (cm)	0.0	16.6	20.16	18.5	16.16	14.8	21.8	20.8	14.83	18.229a	1.1582
	60	14.16	11.83	13.00	12.3	12.8	8.83	12.50	11.00	12.083b	
	120	12.50	11.33	13.00	9.00	9.00	9.83	13.13	8.83	10.954b	
	180	8.50	6.66	5.33	6.16	5.83	5.66	2.83	5.5	5.937c	
	240	5.60	4.00	3.63	4.03	1.37	3.93	2.00	2.00	3.320d	
	300	2.26	0.56	0.66	0.533	0.06	2.66	0.76	1.00	1.033e	

Values in mean column sharing same letter are statistically no-significant at 5%.

Table 4 : Analysis of variance for effect of cultivars and drought levels on growth parameters of wheat

SOV	df	MS							
		Shoot Length	Root Length	Shoot Fresh Weight	Root Fresh Weight	Shoot Dry Weight	Root Dry Weight	Root Number	Seedling Length
Cultivars	7	3.007**	11.262**	0.214**	0.149**	0.002**	6.481^{ns}	2.0277**	17.337**
Drought Levels	5	340.95**	198.016**	0.691**	7.830**	0.034**	0.016**	38.1333**	972.55**
Cultivars x Drought Levels	35	1.777**	4.665**	0.033**	0.068**	0.001**	8.166**	0.8444**	8.200**
Error	96	0.4808	1.608	0.003	0.009	2.264	3.655	0.4097	2.623
Total	143								
Coefficient of Variation (%)		17.452	26.630	10.671	19.962	12.258	58.102	18.073	18.850

SOV: Source of variance, MS: Mean Square, df: degree of freed and ** significant at 5 % and 1 %, respectively.

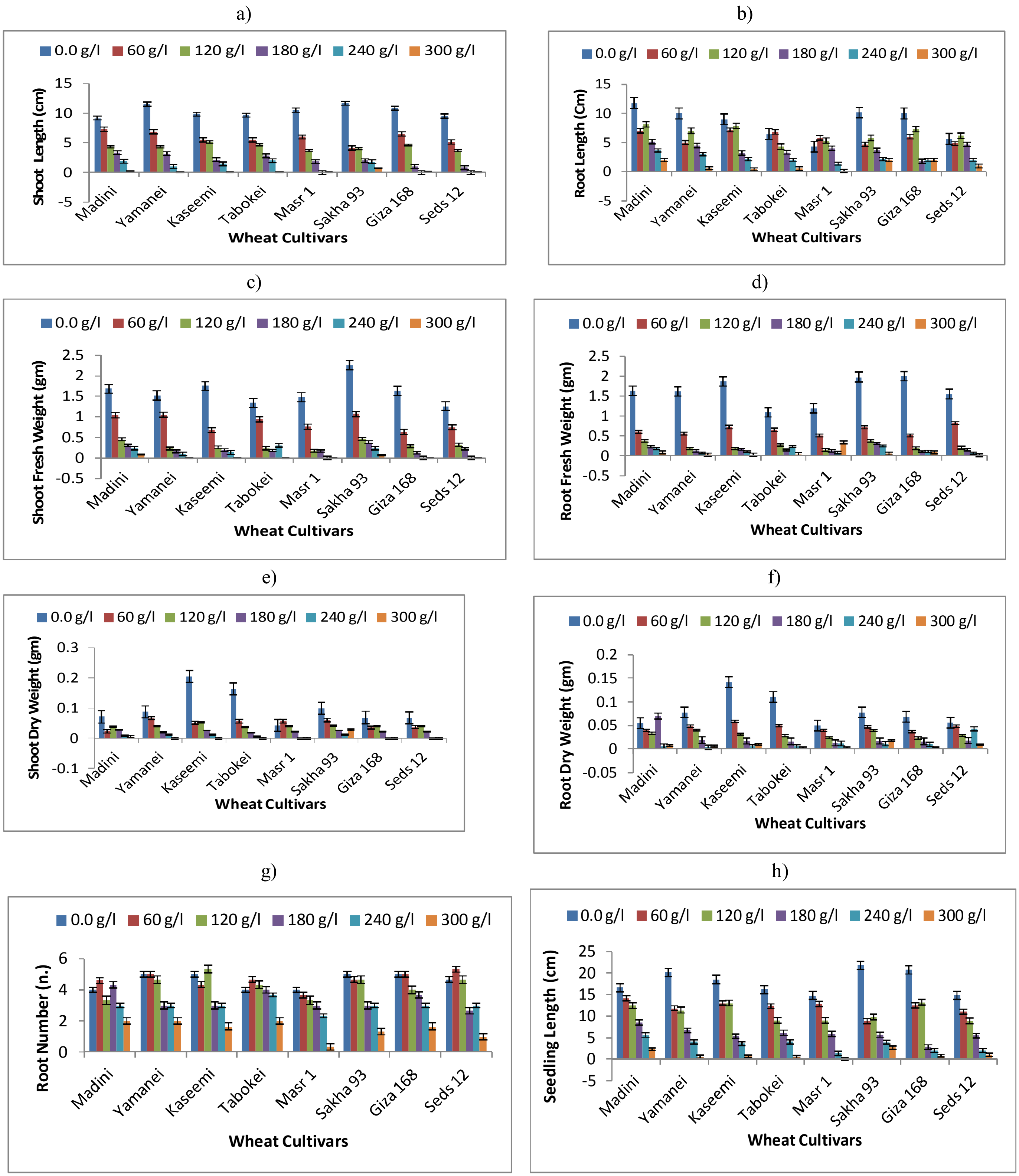

Figure 2:Interaction cultivars x drought levels (0.0, 60, 120, 180, 240 and 300 g/l) PEG6000 for a) Shoot length; b) Root length; c) Shoot fresh weight; d) Root fresh weight; e) Shoot dry weight; f) Root dry weight; g) Root number and h) seedling length of wheat cultivars. Bars represent standard error (±S.E) of means.

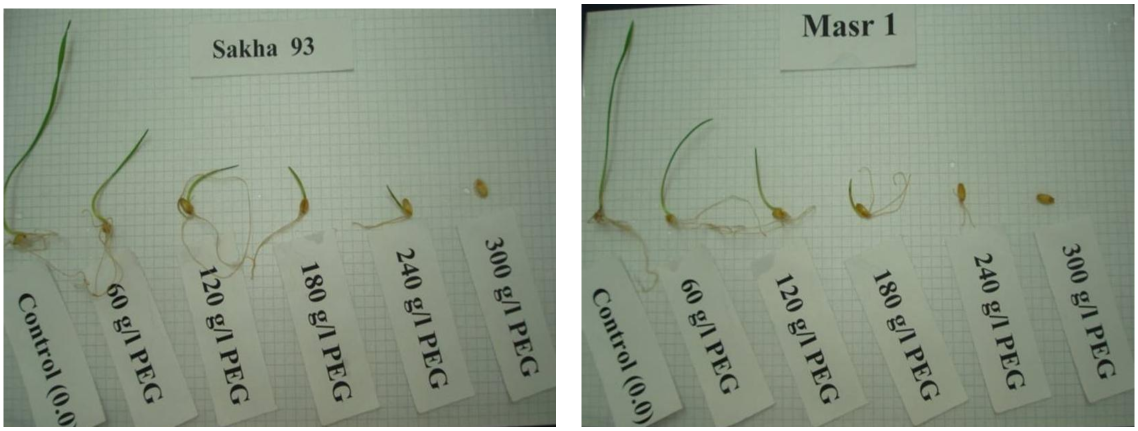

Figure 3: Effect of Different concentration of PEG on germination of Sakha 93 as a tolerant cultivars and Masr 1 as a Sensitive cultivar.

For root length parameter, there was an increase in root length associated with 120 g/l PEG6000 treatment for cultivars Madanei, Yamanei, Tabokei, Sakha 93, Giza 68 and Seds 12. This reflects on adaptive response involving an increase in root length to reach deeper water. Similar observation was reported by **Leila [36] .** In general root length was decreased significantly with increasing of PEG concentration (Table 3). **Fraser *et al.,* [37]** concluded that the reduction in the root length under drought stress may due to an impediment of cell division and elongation leading to Kind tuberization. This tuberization and the lignifications of the root system allow the conditions to become favorable again.

The PEG induced a drop in the shoot and root fresh weight which were the greatest (1.61 and 1.55 gm) under control treatment, respectively. While under 300 g/l PEG 0.0187 and 0.0472 g/l were recorded for shoot and root fresh weight, respectively. Greatest shoot and root fresh weight were recorded in Sakha 93 and Madini (Table 3). While the smallest value for shoot and root fresh weight was recorded in Seds 12 (0.0 and 0.013 gm, respectively). The reduction in shoot fresh weight was attributed to lower number and development of smaller leaves with increased PEG concentration of the growth media. It is important that drought resistance is characterized by small reduction of shoot growth under drought stressed condition **(Ming *et al.*, [38]; Moucheshi *et al.,* [39] and Saghafikhadeu [40]).**

PEG caused a greater reduction in dry weight of shoot and root at higher concentrations compared to control condition (Table 3). However, in Sakha 93, Madini, Yamanei and kaseemi, root dry weight value was increased with high concentration of PEG (300 g/l) (0.173, 0.008, 0.01 and 0.001), respectively, comparing with the concentration of PEG (240 g/l) (0.011, 0.006, 0.005 and 0.004), respectively. On the other hand, there was a progressive decrease in root number with increased osmotic stress. Higher value of root number (5) was found under control treatment for cultivars Sakha93, Kaseemi, Yamanei and Giza 168 comparing with other different concentration of PEG. No significant different was recorded between cultivars, this indicated that root number could not be useful in the studies of genetic diversity and classification of adopted cultivars, thereby the improving the efficiency of wheat breeding programs. Seedling length decreased significantly with increasing osmotic stress (Table 4).the highest seedling length under PEG (300 g/l) was related to cultivars Sakha 93 and Madini with average 2.66 and 2.26 cm, respectively; and lowest value was related to Masr 1 and Yamanei with average of 0.06 and 0.56 cm, respectively. Interaction of genotype x drought treatment was meaningful at $P \leq 0.01$ (Table 4). The tested cultivars varied significantly in their reaction to PEG for all seedling growth parameters except root dry weight. **Baddiaw *et al.*, [41]** indicated that the development of the root system in response to water deficit suggests that the expression of certain genes controlling root formation is stimulated by drought conditions. In addition to dominant alleles controlled the length of roots and the feature could be easily incorporated in breeding for drought resistance **(Vijendradas, [42]**).

4- Conclusion:

Generally, our results firstly clearly showed that different wheat cultivars differently responded to water stress at germination stage and early seedling growth. Second, the confined seedlings environmental of laboratory experiment would appear to be suitable for screening large population to improve drought tolerance prior to yield testing. Third, all other germination and seedling growth traits , except root number, under study can used as a selectable character to discrimination between resistance and sensitive cultivars under drought stress in breeding programs. Fourth, to find the best tolerant cultivar to drought condition, taking all traits into account in this study, we found that the eight cultivars can be classified into four group depends on the ability to tolerant the osmotic stress as follow: first (High resistant group) include Sakha 93 and Madini; second (resistant) include Tabokei; third (Moderat group) include Yamanei and Kassemi and fourth(sensitive group) include Seds 12, Masr 1 and Giza 168 (Figure 3). From this category, we observed that the Saudi cultivars were more tolerant than Egyptian cultivars, this may be refer to the Saudi cultivars may exposed to more natural selection for many years under semi-arid and arid conditions than Egyptian cultivars.

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