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RESEARCH ARTICLE

Germination Parameters of some bread wheat Genotypes under Drought stress conditions.

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Abstract: The experiment was conducted in the Agronomy Department, Faculty of Agriculture, Sohag University, Egypt in winter season of 2019/2020 to identify the most appropriate wheat genotypes to water stress. Ten bread wheat genotypes (3 Egyptian cultivars and 7 imported accessions) were screened under osmotic stress with three drought stress treatments induced by PEG-6000 (polyethylene glycol) i.e. control, 5% and 10% PEG-6000 solutions. The analysis of variance indicated significant differences among treatments for all recorded germination parameters (GP, GIT, GMT, GDT, SP, MDG, MTG, GC, GV and GVI). Where GP, SP, GC, GV and GVI were decreased under low water potential, while the drought stress caused retarding of germination process, continued in long period, acted in increasing of GIT, GMT, GDT, MDG and MTG.Significant interactions revealed that wheat genotypes responded variably to osmotic stress treatments. Hence, that is provided better opportunity to select drought tolerant cultivars at germination stage. Tow genotypes; G3 and G10 (Misr 1) were very good tolerant to drought stress at 5% PEG and ranked as 1st and 2nd order, respectively. They produced the highest germination vigor, so the seedling will be in regular growth. In the severe stress induced by 10% PEG treatment, the genotype G3 was more superior more than the others in all germination parameters. In the end we can recommend the genotypes G3 and G10 (Misr1) for drought stress conditions with modify their seeding rates ((100/GP in stress conditions) x optimal seeding rates).

Keywords: *Triticum aestivum*, Bread wheat, Seed germination, Osmotic potential, Drought stress

Introduction

Recently, Egyptian government has moved seriously to reclaim desert lands to increase agricultural production and reduce the food gap between production and consumption. However, the heat, drought and salinity stresses in such areas hinder the process of reclamation and agriculture productivity. Drought stress is the main limited factor of crop productivity and occurs for multi reasons, such as insufficient soil moisture, salinity, low and high temperature and high intensity of light, all these factors are exist in the reclaimed desert lands .(Bruce *et al*. 2002). So, finding out crop genotypes tolerant to such obstacles is an important factor toward production sustainability.

Bread wheat (*Triticum aestivum* L.) is an important food crop, which its harvested area and production is unfavorably affected by drought in major parts of the world. In most cases, yield is the target of the breeding program and the great integrator of genetics and environment. The final expression of

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yield under drought stress is a complex integration of constitutive plant traits and stress-responsive processes which depend on stress intensity, duration and timing with respect to growth stage (Mohamadi *et al*., 2012).

The most important factor for crop productivity is the optimal number of plants per unit area, which depend on proportion, speed and regularity of germination process (Almansouri *et al.,* 2001).The important requirements for seed germination beside seed quality are sufficient moisture, ventilation and optimal temperature.Soil water deficiency lead not only to poor stand count, but also cause postponed seedlings emergence, reducing germination speed and irregularity. Thus reducing the agricultural value of seeds and altimetry affects growth quality and productivity (Shehzad *et al*., 2012, Al-Taisan 2010, and Worku *et al*., 2016).Polyethylene Glycol (PEG)compound have been used widely to simulate osmotic stress effects in vitro for plants to maintain uniform water potential throughout the experimental period (Misra and Dwivedi, 2004, Al-Taisan2010).

This investigation aimed to: 1) Determination of drought stress related parameters in germination phase of some diverse bread wheat genotypes. 2) Identify the most bread wheat genotypes, which tolerant the drought stress conditions in early stage. And 3) suggest some solutions for germination problems under some environmental stress conditions, which hamper the cultivation of wheat in newly reclaimed land.

Materials and methods

This investigation was conducted under room temperature (20 ^{0}C) stabilized by air condition in the seeds and seed test lab., Agronomy Department, Faculty of Agriculture, Sohag University, Egypt during the first half of November 2019. Ten bread wheat genotypes comprised of 3 Egyptian cultivars (Giza168, Sids 12 and Misr1) and 7 accessions were imported in 2010 from Nordic Genetic Resource Center (Nord Gen) and adapted under Sohag conditions (Table 1). These genotypes were subjected to three drought treatments simulated by using Polyethylene glycol (PEG-6000) with concentration of 0, 5, and 10% PEG).The used folia dishes (17 x 13 x 2.5 cm) were filled with 350 g sterilized sand each. The experimental design was a split-plot arranged in a randomized complete block design (RCBD) with three replications.

Table 1: The names and location of studied bread wheat genotypes

Genotype	Code	Name	Country
G1	NGB6404	Balady 16	unknown
G2	NGB6406	COLA	unknown
G3	NGB10893	ASOSAN X FEDERATIENBC3	Denmark
G4	NGB11099	AUS10894	Denmark
G5	NGB9955	DACKE	Sweden
G6	NGB6681	DIAMANTII	Sweden
G7	NGB8950	CATRIA	unknown
G8		Giza 168	Egypt
G9		Sids 12	Egypt
G10		Misr 1	Egypt

The drought treatments distributed randomly in the main plots (10 dishes each) and wheat genotypes were laid out in the sub units. Seed surface sterilized by soaking in 1% sodium hypochlorite for 2 minutes, followed by three successive washings with distilled water. Fifteen seeds were sown in each dish in 3 rows with 5 seeds each (2.5 cm spaced between seeds). The dishes were irrigated with 75 ml of the solution two times at sowing and with 25 ml of the solution after 48 hours. After that 25 ml of distilled water applied per dish every 48 hours for all dishes until the end of experiment. The germinated seeds counted daily started at 4th day and the final count has been done at 14th day after planting to calculate germination parameters (Table 2) as follow.

Table 2: The abbreviations, units of germination parameters and their calculation equations used.

No.	Parameters	Ab.	UNIT	Equation	References	Effect
1	Germination Percentage	GP	%	GP = (No. of germinated seed / Total sown seeds)x100	Scott *et al*., 1984, Gairola *et al*., 2011	+
2	Germination initial time	GIT	Day	GIT = The number of days of first germinated seed	AI-Mudaris, 1998	+
3	Maximum germination time	MTG	Day	MGT = Number of days until the highest germination seeds	AI-Mudaris, 1998	-
4	Germination duration time	GDT	Day	GDT = MTG - GIT		-
5	Mean daily germination	MDG	%	MDG = GP/MGT	Gairola *et al*., 2011, Fetouh and Hassan 2014	+
6	Mean Germination time	MGT	Day	MGT = $(\sum n_i \times d_i)/N$	Matthews &Khajeh-Hosseini, 2007, Gairola *et al*., 2011, Zewdie and welka 2015	-
7	Speed of Germination	SP	Seed / Day	SP = $\sum(n_i/d_i)$	Gairola 2011, Zewdie and welka 2015, Souza 2017	+
8	Germination coefficient	GC	%	GC =$(N/(\sum n_i \times d_i))$x100	Yulan *et. Al*, 2016	+
9	Germination value	GV	-	GV= PVxMDG	Gairola *et al.*, 2011	+
10	Germination vigor index	GVI	mg	GVI = N x SDW (mg)	Vashisth and Nagarajan, 2010	+

1- **Germination percentage** (GP) = (*n* /*N*) x 100
Where *n* is the number of germinated seed and *N* is the number of Sown seeds in each experimental unit.

2- **Germination Initial Time** (GIT) : The number of days at first germinated seed

3- **Maximum germination time** (MGT): Number of days until the highest count of germinated seeds.

4- **Germination Duration time** (GDT): The interval from GIT to MGT.

5- **Mean daily Germination** (MDG) = GP/MGT

6- **Mean Germination time** (MGT): the count days until reached to 50% of germinated seeds. MGT = $(\sum n_i \times d_i)/\sum n_i$, Where n is the number of grains that germinated on the day (i); d_i is the number of days counted from the beginning of germination

7- **Speed of Germination rate (SP):** The average of seed numbers germinated in one day. SP = $\sum(n_i/d_i)$

8- **Germination Coefficient** (GC) = **(**N/($\sum n_i \times d_i$))x100

9- **Germination value (GV)**: This combines both SP and GP. GV= PVxMDG, where PV is the Peak value, (PV = highest seed germinated/Number of days). Gairola *et al*., 2011

10- **Germination Vigor Index** (GVI) **=** *N x SDW* (mg), where *N* is total germinated seeds and SDW is shoot dry weight of seedling (mg).

Statistical analysis

Data were analyzed by analysis of variance (ANOVA) technique using Proc GLM procedure (SAS version 9.1, SAS Institute 2003). Treatment means were significantly compared using least significant difference (LSD) test at 0.05 probability level according to Gomez and Gomez, 1984.

Results and discussions

Divers germination parameters of wheat genotypes to drought stress are represent an indicator for drought tolerance of wheat genotypes at germination and seedling stages. Analysis of variance in Table 3 showed highly significant differences among the drought stress treatment, wheat genotypes and their interaction for all germination parameters, except the interaction for germination duration time (GDT) was significant at 5%. Theses finding indicated that the drought stress induced by PEG-6000 affected on the water absorption rate by seeds as well as the genetic diversity between bread wheat genotypes in their tolerance to stress at germination and seedling stages.

Increasing the stress levels from 0 to 5% to 10% PEG caused adecrease in germination percentage (GP) and Maximum germination time (MGT) in all wheat cultivars (Table 4). Qayyum *et al*., (2011) observed relationship between osmotic stress level and both GP and MGT. They found that Germination percentage decreased from 100% in the control to 59.25% in -8 bars osmotic stress treatment.

Germination percentages% (GP):

Germination percentages declined progressively under stressed condition than the control. Significant differences among wheat genotypes, between osmotic potentials and Genotype x treatment interaction were found (Table 4). In control treatment, germination percentages ranged from 74.44 to 100%. These finding may be due to the insufficient water absorption by seed under osmotic stress. These results are agreement with those obtained by Aflaki *et al*., (2017) under salt stress, and Kizilgecl *et al*. (2017) revealed that the germination rate was decreased with increasing water stress induced by

Table 3: Analysis of variance of germination parameters under three drought stress induced by PEG-6000

S.O.V		Rep	T	$E_{(a)}$	G	TxG	$E_{(b)}$
df		2	2	4	9	18	54
Germination Parameters	GP	78.64^{Ns}	386.09**	13.09	322.15**	510.79**	77.0
	GIT	1.54^{Ns}	241.94**	3.48	5.93**	5.50**	1.5
	MGT	0.40^{Ns}	186.23**	2.08	6.77**	8.05**	2.1
	GDT	3.01^{Ns}	114.68**	5.13	6.69**	8.01*	3.6
	MDG	0.14^{Ns}	820.30**	5.02	33.58**	28.61**	3.5
	MGT	0.92^{Ns}	224.91**	1.19	4.87**	4.64**	1.0
	SP	0.14^{Ns}	32.02**	0.22	0.81**	0.81**	0.13
	GC	5.66^{Ns}	415.45**	4.84	16.96**	21.05**	2.5
	GV	11.73^{Ns}	5746.28**	32.99	361.24**	484.45**	21.4
	GVI	239.9^{Ns}	2065.5**	722.3	1518.9**	9815.5**	98.02

***,**:Significant at 0.05 and 0.01 levels of probability,respectively, Ns = Insignificant differences.**
GP: Germination %, **GIT**: Germination initial time (day), **MGT**: Maximum germination time (day), **GDT**: Germination duration time (day), **MDG**: Mean daily germination (%), **MGT**: Mean germination time (day), **SP**: Speed of germination (seed/day), **GC**: Germination Coefficient (%), **GV**: Germination value, **GVI**: Germination vigor index (mg).

PEG-600. The highest GP were observed in G1, G2, G3, G4, G5 and G7, while the lowest GP were observed in G8 and G9. Germination percentage of bread wheat genotypes under 5% PEG treatment were varied from 13.33 % in G2 to 66.67 % in G10. Meanwhile the GP ranged from 13.33% in G2 and G6 up to 33.33 % in G3 and G8 under 10% PEG. Mean germination percentage of genotypes graduated from 42.22% to 59.26%, Whereas the highest percentages were obtained in G3, G5, G7, G8 and G10. These results are in harmony with those obtained by many authors. Germination percentage has been decreased due to deficiency of free water to the kernels under PEG treatments (Nariman *et al*., 2017).Ouzturk *et al*., (2016) found significant differences in germination percentages of wheat genotypes and their interactions with treatments under low water potential conditions (-5 and -10 bar) induced by 5% and 10% PEG. While the average GP was 94.9% in the control treatment, the value significantly decreased under –5 bar osmotic potential and it was as low as 67.7%. Saha *et al*., (2017) found relative decline of germination rate under drought stress induced by PEG-6000 compared with control.

The data in Table (4) and represented in Figure (1_A) showed tha the significant differences of germination percentages among treatments, herein the GP were 91.67, 42.67 and 21.78% at control , 5% PEG and 10% PEG, respectively These results due to the osmotic potential induced by PEG treatments lead to decreasing water uptake by grains instead of reserve transport, these results are in agreement with those obtained by Almansouri *et al.,* (2001) in durum wheat genotypes and Ouzturk *et al.,* (2016) in bread wheat genotypes. Al-Taisan, (2010) found that Germination percentage decreased significantly by increasing the

Table 4: Means of germination parameters of 10 bread wheat genotypes under control, 5% and 10% PEG

Genotypes	GP %				GIT (day)				MTG (Day)				GDT (Day)			
	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean
G1	100.00	36.67	20.00	52.22	4.00	5.67	9.67	6.45	5.00	12.00	13.67	10.22	1.00	6.33	4.00	3.78
G2	100.00	13.33	13.33	42.22	4.00	6.00	12.00	7.33	5.00	11.33	14.00	10.11	1.00	5.33	2.00	2.78
G3	100.00	50.00	33.33	51.11	4.33	6.00	6.67	5.67	6.33	11.33	10.00	9.22	2.00	5.33	3.33	3.56
G4	100.00	26.67	22.22	49.63	5.33	7.00	11.00	7.78	8.33	14.00	13.33	11.89	3.00	7.00	2.33	4.11
G5	100.00	33.33	24.44	52.59	5.33	4.33	8.67	6.11	8.33	12.33	13.33	11.33	3.00	8.00	4.67	5.22
G6	82.22	40.00	13.33	45.18	5.33	5.33	13.00	7.89	9.33	10.67	14.00	11.33	4.00	5.33	1.00	3.44
G7	100.00	46.67	20.00	55.56	5.00	4.67	9.67	6.45	9.00	12.67	13.33	11.67	4.00	8.00	3.67	5.22
G8	77.78	53.33	33.33	54.81	6.33	4.67	8.33	6.44	10.67	11.33	12.33	11.44	4.33	6.67	4.00	5.00
G9	74.44	60.00	8.89	47.78	5.67	5.67	12.67	8.00	12.00	13.33	12.67	12.67	6.33	7.67	0.00	4.67
G10	82.22	66.67	28.89	59.26	6.33	4.00	10.00	6.78	11.33	11.00	14.00	12.11	5.00	7.00	4.00	5.33
Mean	91.67^{A}	42.67^{B}	21.78^{C}	52.04	5.17^{B}	5.33^{B}	10.17^{A}	6.89	8.53^{C}	12.00^{B}	13.07^{A}	11.20	3.36^{B}	6.67^{A}	2.90^{B}	4.31
LSD 5%	T	G	TxG		T	G	TxG		T	G	TxG		T	G	TxG	
	2.59	8.19	14.18		1.34	1.16	2.01		1.03	1.34	2.32		1.62	1.77	3.06	

Table 4: econtinued

Genotypes	MDG %				MGT(day)				SP (seed/day)				GC%			
	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean	T1	T2	T3	Mean
G1	20.00	7.59	1.47	9.69	4.47	8.48	12.11	8.35	3.40	1.72	0.25	1.79	22.40	11.86	8.28	14.18
G2	20.00	8.33	0.95	9.76	4.64	8.02	13.00	8.56	3.29	1.84	0.16	1.76	21.62	12.54	7.79	13.99
G3	16.39	8.80	2.56	9.25	5.13	8.09	9.90	7.71	3.05	1.88	0.52	1.82	20.09	12.82	10.15	14.35
G4	12.26	5.87	1.66	6.60	6.31	9.84	12.92	9.69	2.43	1.31	0.26	1.33	15.91	10.22	7.77	11.30
G5	12.26	7.94	1.83	7.34	6.87	7.48	11.56	8.63	2.25	2.11	0.35	1.57	14.70	13.58	8.72	12.33
G6	9.03	8.36	0.95	6.11	7.77	8.23	13.50	9.84	1.66	1.72	0.15	1.18	12.97	12.84	7.41	11.07
G7	11.20	7.56	1.49	6.75	6.78	7.38	11.81	8.66	2.32	2.18	0.26	1.59	14.95	13.56	8.47	12.33
G8	7.48	7.44	2.55	5.82	7.87	7.78	10.21	8.62	1.57	1.83	0.50	1.30	12.84	13.30	9.79	11.98
G9	4.26	6.18	0.71	3.72	9.16	8.33	12.67	10.05	0.88	1.67	0.11	0.89	10.93	12.23	7.91	10.35
G10	7.41	9.29	2.06	6.25	8.29	6.37	12.11	8.93	1.55	2.38	0.37	1.43	12.09	15.75	8.26	12.03
Mean	12.03^{A}	7.74^{B}	1.62^{C}	7.13	6.73^{C}	8.00^{B}	11.98^{A}	8.90	2.24^{A}	1.86^{B}	0.29^{C}	1.47	15.85^{A}	12.87^{B}	8.45^{C}	12.39
LSD 5%	T	G	TxG		T	G	TxG		T	G	TxG		T	G	TxG	
	1.61	1.75	3.02		0.78	0.94	1.64		0.33	0.34	0.59		1.58	1.49	2.58	

T: Treatments of PEG, G: bread wheat genotypes, TxG: the interaction between treatments and genotypes.

osmotic potential of PEG especially at (-0.6 and-0.8 MPa).

Germination initial times (GIT), maximum time germination (MTG) and germination duration time (GDT):

The data in Table 4 showed the significant differences between bread wheat genotypes with each treatment separately. In the control treatment mean values of GIT ranged from 4 up 6.33 day in non -stress conditions, from 5 to 12 days in MTG and from 1 up to 6.33 days for GDT. Regardless the genotypes G1, G2 and G3 started to germinate in the 4th and completed their germination in the 5th and 6thdays, so germination process of G1 and G2 genotypes distributed in on day and in 2 days for G3.While the G8 and G10 started their germination after 6 days (6.33) and finished at 10.67 and 11.33 days, so their germination process continued 4.33 and 5 days, respectively. In addition, the G9 started in germination late (5.67 days) and continued to germinate till 12thdays.That is mean it takes long germination period more than 6 days (6.33), this lead to irregular seedling establishment and growth. In 5% PEG treatments the lowest and highest values were obtained in G5 and G4 (4.33 and 7 days), and MTG ranged from 11 days in G10 to 14 days in G4. The lowest value of GDT (5.33 days) was found in G2, G3 and G6, while the highest value (8 days) in G5 and G7, that is indicated irregularly germination in G5 and G8. The severe drought stress treatments (10% PEG) retarded germination and decreased germination percentage, where the G3 started to germinate earlier than the other genotypes (5.67 days) and completed their germination also faster than the others (9.22 days), that’s mean their germinated seeds distributed in 3.56 days and characterized with regular seedlings.

In general average the genotypes are affected significantly by water stress treatments in GIT, MGT and GDT. Figure 1 (B, C and D) showed the significant differences between drought stress treatments, where the germination in control and 5% PEG treatments started in 5.17, 5.33 days, and completed at 8.53, 12 days, distributed in 3.36 and 6.67 days. Furthermore the third treatment (10 % PEG) started so late (10.17 day) and completed at 13.37 days (GDT = 3.2 days), here the shortage periods of GDT may be due to the low germination percentage (21.78 %) illustrated in figure 1_A.

Mean Daily germination % (MDG) and mean germination time (MGT:)

In the PEG treatments, the **MGT**delayed by stress conditions. Water stress not only affects seed germination but also increases MGT in crop plants (Willenborb *et al.,* 2004 and Khodarahmpour 2011). Alebrahim *et al*., (2008) stated that with a decrease in the osmotic potential in PEG and NaCl solutions, the MGT in maize lines of MO17 and B73 increased.

The data shown in Table 4 indicated that drought stress during seed germination phase decreased significantly the MDG, the MDG were found to be 12.03, 7.74 and 1.62 % of total seed in control, 5% and 10 % PEG treatment, respectively (Figure 2_A). The wheat genotypes differed and interacted significantly on their MDG, the highest percentages were found 20% in G1, G2 and 16% in G3 under control condition, while G9 and G6 exhibited that the worst percentage (0.71 and 0.95%) when subjected to 10% PEG treatment. On the other hand the G1, G2 and G3 were exhibited the highest percentages (9.69, 9.76 and 9.25 %) as average for the three conditions and differed significantly from the grand total percentage (7.13%).

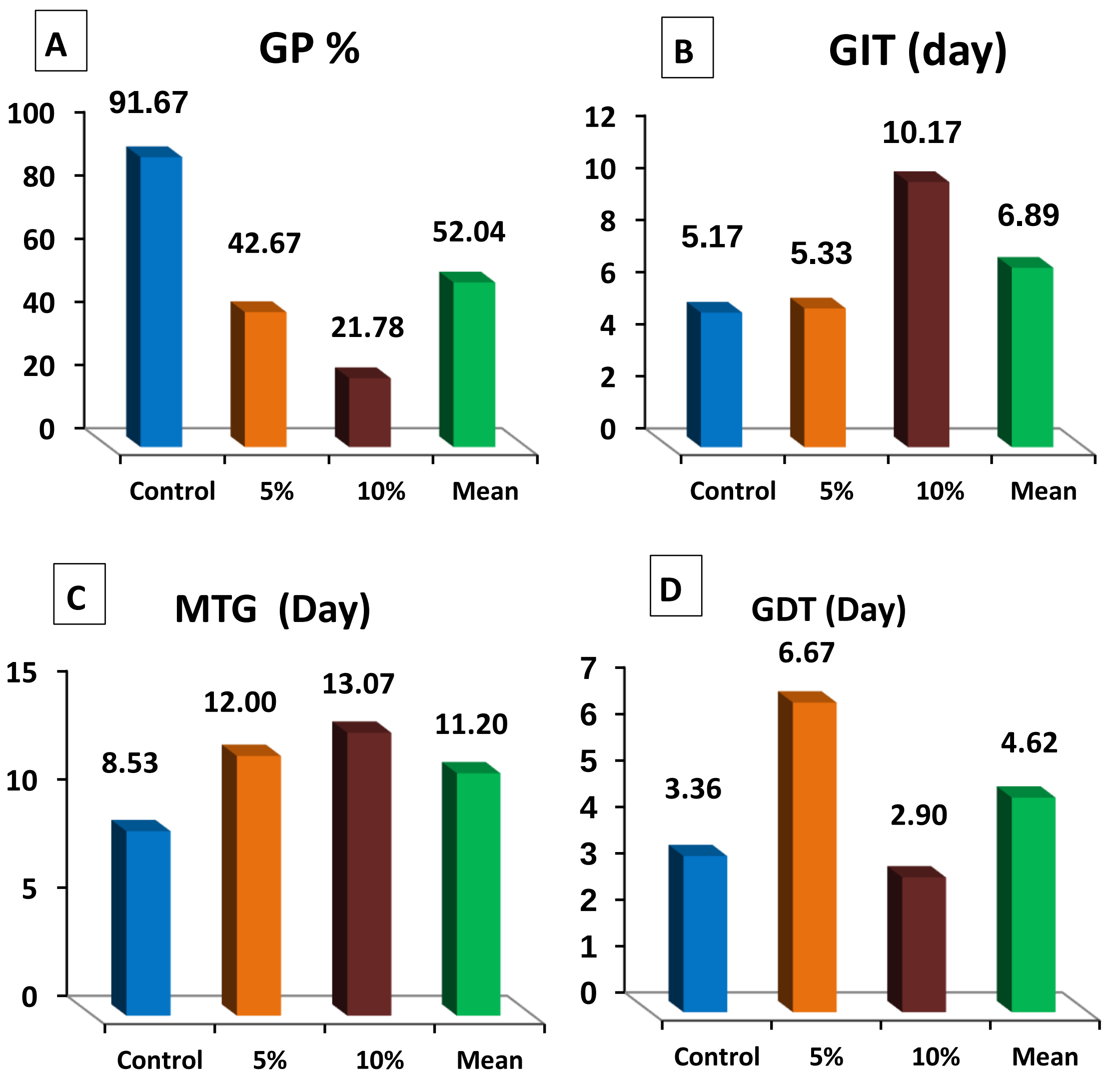

Figure 1: Effects of drought stress treatments on germination percentage (GP), Germination initial time (GIT), Maximum time germination (MTG) and Germination duration time (GDT).

Qayyum *et al.*, (2011) found that in his study on bread wheat genotypes, MGT decreased from 17.10 with control to 5.69 under -8 bars osmotic stress. Khodarahmpour (2011), in his study of drought stress induced by polyethylene glycol (PEG) on germination indices in corn (*Zea mays* L.) found increasing the MGT significantly with increase PEG concentration and he regarded to the significant differences among maize hybrids.In contrast the drought stress induced by PEG increased the mean required time to 50% germination. The MGT values 6.73, 8 and 11.98 days found with control, 5% and 10% PEG treatments, respectively illustrated in Table 4 and Figure 2B.Similar results were found by Aflaki *et al*., (2017) in their investigation on germination indices under salinity stress, where they revealed to increasing mean germination time with increasing the salt stress.The MGT values ranged from 4.47 to 9.16 days in the normal condition, from 6.37 to 9.84 in the second stress condition and from 9.9 days in G3 to 12.67

Table 4. Continued

Genotypes	GV				GVI (mg)			
	T1	T2	T3	Mean	T1	T2	T3	Mean
G1	60.00	0.63	0.32	20.32	328.57	97.77	7.90	144.74
G2	60.00	1.50	0.14	20.55	179.43	115.53	11.00	101.99
G3	41.70	7.64	1.17	16.84	239.20	116.23	43.17	129.53
G4	23.02	1.68	0.42	8.37	213.63	226.90	22.07	154.20
G5	23.02	3.37	0.71	9.03	178.10	134.17	33.47	115.24
G6	12.77	5.35	0.14	6.08	77.27	85.70	12.60	58.52
G7	18.99	4.20	0.35	7.85	262.70	109.70	16.83	129.74
G8	9.10	5.44	1.37	5.30	75.30	86.10	24.67	62.02
G9	2.73	4.18	0.09	2.33	27.80	61.10	13.40	34.10
G10	8.77	9.91	0.67	6.45	264.73	128.53	9.07	134.11
Mean	26.01 ^{A}	4.39 ^{B}	0.54 ^{C}	10.31	184.67 ^{A}	116.17 ^{B}	19.42 ^{C}	106.42
LSD	T	G	TxG		T	G	TxG	
	4.12	4.31	7.47		60.92	93.56	163.37	

days in G9 when subjected to 10 % PEG. Significant differences were found between wheat genotypes for MGT at different levels of PEG 6000 (Nariman *et al* 2017). In the same line Al-Taisan (2010), in his study on *Pennisetum divisum* found that the germination was delayed for 2, 3 day under PEG -0.6 and -0.8 MPa, respectively.

Speed of germination rate (seed/day) and Germination coefficient:

The speed of germination rate is indicator for short period germination and irregular seedlings and the high of germination coefficient regards to high germination percentage and faster seed germinate. So far, both of these parameters are considered as indicator to drought resistance in the most sensitive phase of wheat growth and productivity. The data in Table 4 showed the significant differences between genotypes and their interaction with drought stress conditions, where the highest values of SP (3.4, 3.29 and 3.05 seed/day) found in G1, G2 and G3 under non stress conditions and the lowest values (0.11, 0.15 and 0.16 seed/day) were appeared in G9, G6 and G2 when subjected to 10% PEG treatment. While the highest speed as average of three conditions (1.82) was found in G3, this value was higher than some genotypes such as G6, G8, G9 and G10 under control. The same trend was found in the GC parameter in Table 4, the highest values of GC (22.4, 21.62 and 20.09) in G1, G2 and G3, respectively under non stressed condition and the lowest values (7.79, 7.77, 7.41 and 7.91) in G2, G4,G6 and G9 under the 10% PEG treatment. As general the speed of germination decreased dramatically with drought stress (Figure 2C). These results are in line with those obtained by Aflaki *et al*., (2017) under salt stress. The lowest germination coefficient was

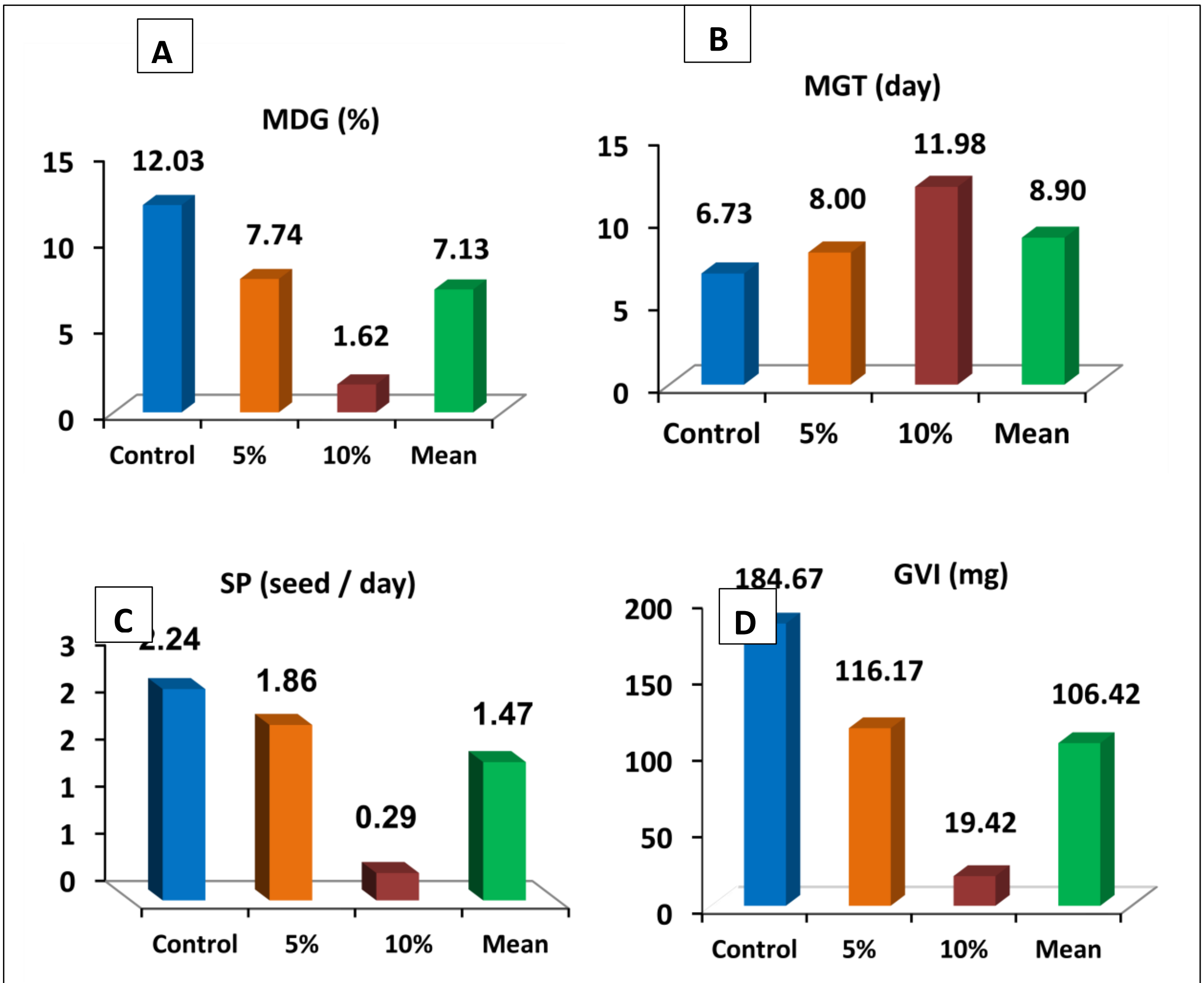

Figure 2: Effects of drought stress treatments on Mean daily germination (MDG), Mean germination time (MGT), Speed of germination (SP) and Germination vigor index (GVI).

observed for control treatment and it was increased with the increased drought stress (Nariman *et al* 2017).

Germination value (GV) and Germination Vigor Index (GVI):

Germination value is combined of SP and GP, and its higher values represented as an indicator for a good germination percentage and faster germinate (Djavanshir and Pourbeik, 1976). Also the germination vigor index regard to the ability to produce dry matter and promise for better seedlings growth and complete their life cycle.The data presented in Table 4 showed that significant differences have been found between the genotypes, intra drought stress treatments and their interactions. GV varied from 2.73 to 60.0, 0.63 to 9.91 and 0.09 up to 1.17 in the control, 5% PEG and 10% PEG, respectively. The genotypes G1, G2 and G3 exhibited the higher values of GV (20.32, 20.55 and 16.84) as average of the drought stress levels.In Table 4, it is clear the significant differences of germination value between control (26.21), 5% PEG (4.39) and 10% (0.54). These results were similar with those obtained by Xu *et al.*, (2016), in their study on germination and early seedling growth of *Pinus densata* Mast and with those obtained by Purwantoro, 2017, in his study on seed germination and seedling growth of *Chiococca javanica*. The germination vigor index (GVI) was decreased significantly by drought stress, whereas GVI reduced by 37.1 and 89.5 % at 5% and 10% PEG conditions respectively (Figure 2D and Table 4). These result are in line with those obtained by Kizilgecl *et al*. (2017), where they revealed that the seedling vigor decreased with increasing water stress induced by PEG-600. Additionally Aflaki *et al*., (2017) reported decreasing seed vigor under salt stress. Furthermore in our text the germination vigor index ranged from 27.8 to 328.57 mg in the non-stress conditions, from 61.1 to 226.9 in 5% PEG and from 7.9 to 43.17 in 10% PEG treatment, whereas the highest values of GVI were found in the genotypes G1, G2 and G7 in the normal condition, G3 and G10 in 5% PEG and G3 and G8 in 10% PEG.

Saha *et al*., (2017) were found significant reduction among wheat genotypes in vigor index more at 25% PEG than that of 15% PEG treatment. The summarized data in Table 5 represent scaling of bread wheat genotypes and their performance under low water potential (5% PEG). Then priority of validity to reclaimed desert soil, whereas the ten genotypes ranked from 1 to 10 according the germination parameters in drought stress induced by PEG. The worst two genotypes were G4 and G2, ranked as 9^{th}and10^{th} due to lower GP than the average, although the lower germination duration in G2 and highest germination vigor in G4. The genotypes G3 (imported genotype) and genotype G10 (Egyptian cultivar Misr1) were very good and ranked as the first and second order due to their higher GP in both than the average, lower germination duration 5.33 and 7days,respectively that meaning the seedlings establishment would be regular growth. Furthermore they characterized by higher germination vigor, and we suggest that when we used these genotypes in similar stress conditions with modify the seed rates (100/GP x recommended seed rate) with early sowing dates in G3 or pretreated by water soaking and without any seed priming for G10. The other genotypes ranged from fair to good and they needed to modify of seeding rates. Worku*et al.,* (2016) were used water, fermented cow urine as priming materials, also they used Dynamic, Disco and Genius coat as coating materials and found that higher germination percentage (93.75%) and speed of germination (34.27) was recorded by primed seeds with water. However, vigor index (3852.5) of bread wheat was higher for seeds coated with Dynamic + Disco.

Table 6 summarized the investigation results and represent the scaling of bread wheat genotypes and their performance under low water potential (10% PEG), then priority of validity to reclaimed desert soil, whereas the ten genotypes ranked from 1 to 10 according the germination parameters in drought stress induced by PEG. Here the studied genotypes evaluated from very bad to very good. G2, G6 were very bad and G9 was bad due to their degradation in all germination parameters, so these genotypes do not tolerant severe drought stress and unfavorable in these conditions. While the genotype (G3) was very good and ranked with the 1^{st} order due to high germination percentage than the total average, germinate faster and complete its germination process in short time (3.33 days), so its seedling will be more uniformity and with highest germination vigor. Herein we can recommend this genotype for severe drought stress conditions with modify the amount of seeding rates to compensate the decreasing of GP.The genotypes G8, G10 and G4 were evaluated as good under these conditions and ranked as 2^{nd} , 3^{rd} and 4^{th} , respectively and needed to modifying the seeding rates and we can pretreated as priming before sowing. Worku *et al.,* (2016) concluded that Primed seed with water was found to be promising

Table 5: Scaling of 10 bread wheat genotypes based on germination Parameters under low water potential at 5 % PEG Treatment (T2)

Gen.	GP %	GIT (day)	MTG (day)	GDT (day)	MGT (day)	SP seed/day	GC %	GV	GVI	Evaluating	Sowing date	seed rate	Rank
G1	**36.67**	**5.67**	**12.00**	**6.33**	**8.48**	**1.72**	**11.86**	**0.63**	**97.77**	**fair/bad**	**Normal**	**(100/GP)x Seed rate**	**6**
G2	**13.33**	**6.00**	**11.33**	**5.33**	**8.02**	**1.84**	**12.54**	**1.50**	**115.53**	**very bad**	**-**	**-**	**10**
G3	**50.00**	**6.00**	**11.33**	**5.33**	**8.09**	**1.88**	**12.82**	**7.64**	**116.23**	**Very good**	**early / soaking**	**(100/GP)x Seed rate**	**1**
G4	**26.67**	**7.00**	**14.00**	**7.00**	**9.84**	**1.31**	**10.22**	**1.68**	**226.90**	**bad**	**-**	**-**	**9**
G5	**33.33**	**4.33**	**12.33**	**8.00**	**7.48**	**2.11**	**13.58**	**3.37**	**134.17**	**fair/bad**	**Normal**	**(100/GP)x Seed rate**	**8**
G6	**40.00**	**5.33**	**10.67**	**5.33**	**8.23**	**1.72**	**12.84**	**5.35**	**85.70**	**good**	**Normal**	**(100/GP)x Seed rate**	**4**
G7	**46.67**	**4.67**	**12.67**	**8.00**	**7.38**	**2.18**	**13.56**	**4.20**	**109.70**	**fair/bad**	**Normal**	**(100/GP)x Seed rate**	**7**
G8	**53.33**	**4.67**	**11.33**	**6.67**	**7.78**	**1.83**	**13.30**	**5.44**	**86.10**	**good**	**Normal**	**(100/GP)x Seed rate**	**3**
G9	**60.00**	**5.67**	**13.33**	**7.67**	**8.33**	**1.67**	**12.23**	**4.18**	**61.10**	**fair**	**Normal**	**(100/GP)x Seed rate**	**5**
G10	**66.67**	**4.00**	**11.00**	**7.00**	**6.37**	**2.38**	**15.75**	**9.91**	**128.53**	**very good**	**Normal**	**(100/GP)x Seed rate**	**2**
Mean	**42.67**	**5.33**	**12.00**	**6.67**	**8.00**	**1.86**	**12.87**	**4.39**	**116.17**				

Table 6: Scaling of 10 bread wheat genotypes based on germination Parameters under low water potential at 10% PEG Treatment (T2)

Gen.	GP %	GIT (day)	MTG (day)	GDT (day)	MGT (day)	SP seed/day	GC%	GV	GVI	Evaluating	Sowing date	seed rate	Rank
G1	20.00	9.67	13.67	4.00	12.11	0.25	8.28	0.32	7.90	fair/bad	early/soaking	(100/GP)xSeed rate	7
G2	13.33	12.00	14.00	2.00	13.00	0.16	7.79	0.14	11.00	bad	-	-	8
G3	33.33	6.67	10.00	3.33	9.90	0.52	10.15	1.17	43.17	Very good	early / soaking	(100/GP)xSeed rate	1
G4	22.22	11.00	13.33	2.33	12.92	0.26	7.77	0.42	22.07	good	early / soaking	(100/GP)xSeed rate	4
G5	24.44	8.67	13.33	4.67	11.56	0.35	8.72	0.71	33.47	fair/bad	early / soaking	(100/GP)xSeed rate	5
G6	13.33	13.00	14.00	1.00	13.50	0.15	7.41	0.14	12.60	bad	-	-	9
G7	20.00	9.67	13.33	3.67	11.81	0.26	8.47	0.35	16.83	fair/bad	early / soaking	(100/GP)xSeed rate	6
G8	33.33	8.33	12.33	4.00	10.21	0.50	9.79	1.37	24.67	good	early / soaking	(100/GP)xSeed rate	2
G9	8.89	12.67	12.67	0.00	12.67	0.11	7.91	0.09	13.40	very bad	-	-	10
G10	28.89	10.00	14.00	4.00	12.11	0.37	8.26	0.67	9.07	good	early / soaking	(100/GP)xSeed rate	3
Mean	21.78	10.17	13.07	2.90	11.98	0.29	8.45	0.54	19.42				

for early emergence otherwise Dynamic + Disco coated seeds is better to improve bread wheat seed vigor.

Conclusion

The germination stage showed different responses to water stress induced by PEG. Germination process was more sensitive in the severe drought stress at 10% PEG than at 5% PEG. In addition the genotypes were differed significantly in all germination parameters in the three treatments including the non-stress condition due to the wide genetic differences among them (3 Egyptian genotypes and 7 imported and adapted in different regions).The genotype G3 (NGB10893) appeared as superior genotype under both of stress levels and more validity for similar conditions especially for the reclaimed desert soil.Its superiority is due to high germination percentages, low germination duration, higher germination value and vigor advantages. The G10 (Misr1) was very good under the drought stress at 5% PEG. Because of its advantage with low germination duration, high mean daily germination and good germination vigor index under drought stress.

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