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Araştırma Makalesi
(Research Article)

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Effectiveness of In Vitro and In Vivo Tests for Screening of Tomato Genotypes against Drought Stress

Domates Genotiplerinin Kuraklık Stresine Tolerans Açısından Taranmasında In Vitro ve In Vivo Testlerin Etkinliği

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ABSTRACT

Objective: The aim of this study was to investigate possibilities of fast screening of local tomato genetic material against drought.

Material and Methods: In this study including *in vitro* and *in vivo* tests, seeds of 92 tomato genotypes were used and drought stress was induced by polyethylene glycol 6000 (PEG) at 4%. Firstly, seed germination test was made; and 5 genotypes with higher and 5 genotypes with lower performances were selected according to the evaluation made at 14 days. These genotypes were tested by water culture. Full drought dose was Ψs= -1.0 MPa and 48 hours after the full dose application, morphological and physiological properties of the plants were determined. The genotypes tested were classified by weighted ranking method, based on the changes in the PEG treatment compared to the control.

Results: The correlation coefficient (r: 0.824) for the relationship between the variation (%) of in vitro vigour index and the total score of weighted ranking in water culture was significant. As a result of this study; 97:TR70707, 68:TR69163 and 60: TR68515 in the genetic pool tested, were determined as the most tolerant genotypes against drought.

Conclusion: It was concluded that in vitro seed germination test can be used for pre-screening of large numbers of genotypes in response to drought stress.

ÖZ

Amaç: Bu çalışma yerel domates genetik materyalinin kuraklığa karşı hızlı bir şekilde tarama olanaklarını araştırmak amacıyla yürütülmüştür.

Materyal ve Metot: *In vitro* ve *in vivo* testleri kapsayan çalışmada, 92 domates genotipinin tohumları kullanılmış ve kuraklık stresi %4'lük polietilen glikol (PEG) 6000 ile yaratılmıştır. İlk aşamada, tohum çimlendirme testi yapılmış; 14. günde yapılan değerlendirmeye göre daha yüksek performans gösteren 5 genotip ve daha düşük performans gösteren 5 genotip *in vivo* test için seçilmiştir. Bu genotipler su kültürü tekniği kullanılarak test edilmiştir. Tam kuraklık dozu olarak Ψ_s= -1.0 MPa kullanılmış ve tam doz uygulamasından 48 saat sonra bitkilerin morfolojik ve fizyolojik özellikleri belirlenmiştir. PEG uygulamasında kontrole kıyasla meydana gelen değişim değerleri dikkate alınarak, genotipler "tartılı derecelendirme" yöntemine göre sınıflandırılmıştır.

Bulgular: *In vitro* vigor indeksindeki % değişim değerleri ile *in vivo* tartılı derecelendirme toplam puanları arasındaki korelasyon katsayısı (r: 0.824) önemli bulunmuştur. Sonuç olarak, test edilen genetik havuz içerisinde 97:TR70707, 68:TR69163 ve 60: TR68515 numaralı genotiplerin kurağa toleransının yüksek olduğu saptanmıştır.

Sonuç: *In vitro* tohum çimlendirme testinin fazla sayıda genotipin kurağa tolerans bakımından ön değerlendirmesine uygun olduğu düşünülmektedir.

INTRODUCTION

Plants are exposed to many biotic and abiotic stress factors in their life cycle. It is reported that 96.5% of arable lands worldwide has been under the influence of abiotic stress (Andjelkovic, 2018). Among abiotic stress factors, drought has increased its impact in recent years due to climate change and affects the production negatively in many plants (Özen and Onay, 2007; George et al., 2015; Sahin et al., 2016). The response of plants to drought differs in species and varieties. Therefore, cultivation of tolerant genotypes is the most effective way against drought stress (Öztürk, 2015; Basha et al., 2015).

Exposure of the plant root zone to polyethylene glycol (PEG) solution has been used as an alternative method to create drought stress (Pandey and Agarwal, 1998; Rahman et al., 1999; Meneseset al., 2011; Altunlu, 2011). PEG molecules are too large to be absorbed by plant roots, so the increased PEG concentration in the surrounding environment causes the water to not be absorbed by the stem cells and thus the plant is exposed to water stress (Mohammadkhani et al., 2008; Hamayun et al., 2010). The drought stress created by PEG can also be used for in vitro screening tests, so a large number of genetic resources can be accurately screened with less effort (Kulkarni and Deshpande, 2007; Basha et al., 2015; Esan et al., 2018; Özkaynak and Şimşek, 2018). It has been reported that PEG concentrations ranging from 4% to 12.5% are suitable for screening of tomato genotypes against drought tolerance during germination and seedling stage (Ghebremariam et al., 2013; Jokanovic and Zdravkovic, 2015).

Tomato (*Solanum lycopersicum* L.) is one of the most popular and economically important vegetable crops grown worldwide. Turkey ranks 3rd after China and India in terms of tomato production which is 12,841,990 tons in 2019 (www.tarimorman.gov.tr). Tomato is water demanding crop and its productivity has been affected seriously under limited water conditions. Therefore, this study was conducted to screen of local tomato genetic material, collected from different places of Turkey, against drought. Additionally, it was aimed to compare *in vitro* and in vivo PEG induced drought stress at seed germination stage and seedling growth stage for their effectiveness to select tolerant and sensitive genotypes against drought.

MATERIAL AND METHODS

In the study, 92 local tomato genotypes provided from the National Gene Bank in Izmir were tested (Table 1). Trials were carried out in the climate controlled plant growing room (UNITRONIKS) at Ege University Faculty of Agriculture, Department of Horticulture.

In Vitro Test (Seed germination test)

Experiment was designed according to completely randomized design with 2 replicates, total number of experimental units was 368. The seeds were surface sterilized with sodium hypochlorite 2% for 1 minute, then washed under flowing tap water and immersed in distilled water, and left to dry on paper towels. Drought stress was created with PEG 6000 at 4% (George et al., 2015). Germination test was conducted according to the ISTA rules (ISTA, 1993) using paper towels (40x40 cm) moistened with PEG 6000 solution or distilled water for drought and control treatments, respectively. Ten seeds of each genotype were placed on moistened paper towel in row, and then the paper was folded in half and rolled up and placed in an upright position in a plastic box (21.5×18.5×20.5 cm). The lids of the boxes were attached and covered with stretch film. The boxes were then placed in the plant growing room set at 25±1°C. After 14 days; the data regarding to germination percentage (GP), root length (RL) (cm), shoot length (SL) (cm) and fresh weight of seedlings (g) were recorded. The vigour index (VI) was calculated according to the formulae "VI= (RL+SL)×GP"(Hu et al., 2005).

In Vivo Test (Plant growing by water culture)

In vivo experiment was carried out by using water culture technique. The experimental design was randomized blocks with 3 replicates. Out of 92 tomato genotypes, totally 10 genotypes; 5 genotypes (60, 68, 84, 97 and 140) with higher performance and 5 genotypes (5, 25, 34, 117 and 124) with lower performance against PEG induced drought stress in seed germination test; were used. Seedlings were grown in peat filled viols in plant growing room maintained at 25°C, 80-90% relative humidity and dark for 3 days after sowing, after that 24°C and 20°C during 16 hours day/ 8 hours night and 60-70% relative humidity. The growing room was illuminated by white fluorescent lamps providing 14400 lux nominal light.

Seedlings were transferred to water culture at the stage of 2-3 true leaves. Plastic boxes (21×15×7 cm) with 6 holes on the lids were used. The roots of seedlings were cleaned from peat and then placed in the holes by supporting a sponge strip. The boxes were filled with Hoagland nutrient solution (Hoagland and Arnon, 1938) changed every 2 days in order to avoid aeration problems. The amount of nutrient solution inside each box was 1250 mL, and reduced to 1000 mL and 750 mL parallel to the elongation of the roots.

Table 1. Variations (%) in root and shoot length, germination percentage and vigour index of seedlings under osmotic stress compared to the control.

Çizelge 1. *Kontrole kıyasla osmotik stres altındaki fidelerin kök ve sürgün uzunluğu, çimlenme yüzdesi ve vigor indeksindeki değişimler (%).*

Genotype No/Code*	RL	SL	G	VI	Genotype No/Code*	RL	SL	G	VI
90: TR70425	13.7	-4.9	50	51.3	115: TR71376	-16.3	-9.1	-6.7	-17.6
91: TR70432	10.4	11.9	20	33.7	124: TR71398	-28.8	-18.2	5.6	-17.9
97: TR70707	30.1	14.1	0	19.7	82: TR69806	7.3	-17.3	-10.5	-18.1
60: TR68515	27.3	-3.0	6.3	14.2	111: TR71370	-11.5	-2.8	-15.0	-20.5
84: TR69812	8.6	-8.8	11.8	9.4	72: TR69177	-7.5	-11.1	-11.8	-20.5
38: TR61870	0.5	11.3	0	7.7	50: TR64136	14.0	13.1	-30.0	-20.6
101: TR70718	33.1	9.6	-8.3	7.5	106: TR70740	-21.6	-13.2	-5.3	-20.9
92: TR70452	12.2	3.8	0	6.8	119: TR71386	-11.5	-25.7	0	-21.1
63: TR68519	-13.9	-13.9	23.1	5.9	127: TR71510	-8.5	-14.3	-10.0	-21.2
109: TR71079	13.0	-1.8	0	3.5	121: TR71389	-31.1	-15.4	0	-21.3
140: TR75257	-2.9	-5.5	5.9	1.1	113: TR71372	-25.7	-13.8	-5.9	-23.0
28: TR52414	4.1	-10.6	5.9	0.8	77: TR69787	-10.9	-22.2	-5.6	-23.0
61: TR68516	-26.0	-18.0	26.7	-0.1	64: TR68520	13.0	1.9	-27.8	-23.6
122: TR71394	-22.1	-14.3	17.7	-2.2	9: TR43484	-32.4	-7.1	-7.1	-23.6
68: TR69163	4.0	-5.5	0	-2.2	120: TR71387	-19.6	-20.1	-5.0	-24.0
45: TR62367	11.4	3.7	-8.3	-2.8	48: TR63233	11.5	-1.8	-26.3	-24.0
56: TR66343	19.4	6.3	-13.3	-3.4	95: TR70703	-20.0	-12.1	-11.1	-24.4
44: TR62083	-25.7	-16.0	18.8	-4.2	116: TR71377	-34.9	-10.0	-5.6	-24.5
143: TR75263	-14.0	-6.6	5.3	-4.6	112: TR71371	-16.9	-7.4	-15.8	-25.1
36: TR61816	-1.6	1.6	-5.9	-5.2	123: TR71397	-19.7	-7.9	-15.0	-25.4
76: TR69785	2.9	-10.0	0	-5.5	110: TR71369	-20.9	-14.4	-10.5	-25.5
35: TR61697	-1.8	-7.6	0	-5.5	114: TR71374	-18.9	-19.4	-9.1	-26.6
79: TR69796	14.9	-0.3	-10.0	-5.6	53: TR66056	-14.3	-5.1	-21.1	-27.5
89: TR69818	-0.9	-8.4	0	-5.7	51: TR66043	-20.1	-9.4	-16.7	-27.7
81: TR69805	-25.3	-13.9	11.8	-8.1	93: TR70701	-26.3	-16.6	-10.0	-28.4
98: TR70708	9.8	-3.2	-10.0	-9.0	65: TR68521	-19.6	-25.3	-7.1	-28.9
87: TR69816	-28.9	-12.6	11.1	-9.9	25: TR52263	-41.3	-22.2	0	-29.2
96: TR70704	9.7	-12.4	-5.3	-10.0	52: TR66048	-42.4	-15.0	-5.9	-29.7
80: TR69800	-7.8	-5.8	-5.3	-11.4	67: TR68526	-19.8	-18.6	-15.0	-31.2
118: TR71384	-7.8	-13.9	0	-11.6	138: TR75242	-28.3	-17.1	-13.3	-32.2
103: TR70724	-26.0	-11.6	5.9	-11.8	117: TR71378	-31.9	-26.3	-5.3	-32.3
59: TR68513	-23.0	-4.6	0	-12.1	85: TR69813	-12.5	-14.8	-22.2	-33.1
88: TR69817	-18.2	-8.5	0	-12.1	137: TR75237	-26.5	-14.4	-17.7	-33.4
58: TR68508	21.1	-2.6	-15.8	-12.7	145: TR75275	3.3	-12.1	-30.0	-34.4
41: TR61981	-14.4	-10.9	0	-12.2	75: TR69784	-35.7	-18.9	-12.5	-34.5
49: TR64126	-18.7	-2.6	-5.0	-12.9	126: TR71402	-45.6	-22.6	-5.9	-34.8
148: TR84643	-9.6	-0.4	-10.0	-13.6	128: TR71519	-41.3	-27.6	-5.0	-35.8
99: TR70712	-5.3	-11.4	-5.0	-13.7	149: TR84651	-52.2	-20.2	-10.0	-38.5
43: TR62065	-45.8	-7.8	11.1	-13.9	8: TR42996	-32.7	-16.9	-22.2	-39.5
150: TR84669	-9.5	-10.0	-5.0	-14.3	42: TR62041	-15.6	7.8	-40.0	-40.6
29: TR52428	-15.0	-7.2	-5.0	-14.5	33: TR61592	-26.3	-17.4	-26.3	-41.5
94: TR70702	40.2	-5.2	-22.2	-14.8	5: TR40430	-39.9	-31.6	-15.8	-44.6
54: TR66059	-2.5	-10.6	-7.7	-15.0	125: TR71401	-41.4	-30.7	-15.8	-44.7
27: TR52376	-14.2	-8.9	-5.6	-15.9	141: TR75259	-30.1	-25.1	-26.3	-46.3
7: TR40478	-13.5	0.9	-13.3	-16.9	34: TR61675	-26.6	-23.3	-29.4	-46.6
146: TR75276	-0.9	-9.1	-11.8	-16.9	57: TR66628	-40.4	-33.0	-20.0	-48.5

*Genotypes are ranked according to the change (%) in vigour index.

** RL: root length; SL: shoot length; G: germination; VI: vigour index

*** Coloured lines show the selected genotypes (tolerant genotypes on the left, sensitive genotypes on the right)

Drought dose was used as Ψ_s= -1.0 MPa (78.6 g/L) and gradually increased (¼, ½, ¾ and full dose) every 48 hours from 7 days after planting. Application amount of PEG 6000 was determined according to Mitchel and Kaufmann (1973) at 25°C. Forty-eight hours after the full dose (Ψ_s= -1.0 MPa) application, morphological (number of true leaves, stem diameter, lengths of root and stem, fresh weights of roots and shoots) and physiological properties (relative water content of leaves, membrane permeability, contents of chlorophyll a, chlorophyll b, carotenoid and proline) of the plants were determined. The genotypes tested were classified by weighted ranking method, based on the changes in the PEG treatment compared to the control (Altunlu, 2011).

RESULTS and DISCUSSION

In Vitro Test

Results showed that; in PEG application compared to control; 12 genotypes increased the vigour index by 51.3% and 80 genotypes decreased vigour index by 48.5% (Table 1).

According to the results of this trial; the genotypes 97, 60, 84, 140 and 68; which change the vigour index between +19.7% and -2.2% in PEG induced drought compared to the control, were selected for *in vivo* experiment as tolerant against drought. Genotypes 34, 5, 117, 25 and 124, varying the vigour index from -46.6 to -17.9% in PEG treatment compared to control, were selected as sensitive against drought. Genotypes with germination rate below 70% in control treatment were not selected despite they were among the highest or lowest scored.

In Vivo Test

PEG induced drought stress gave rise to decrease in morphological features of plants. These reductions were higher in the genotypes selected as sensitive against drought according to the *in vitro* test results (Table 2), and average reduction values in sensitive and tolerant genotypes are -9% and -3% for leaf number, -9% and -6% in stem diameter, -148% and -2% in stem length, -24% and -21% in root length, -35% and -24% in fresh weight of shoots, -24% and -17% in fresh weight of roots.

Reduction in plant growth resulted from drought is well documented in the previous studies in several plants, for example in tomato (Kıran et al., 2014; Alp and Kabay, 2017), eggplant (Kıran et al., 2016), melon (Kuşvuran et al., 2011).

The relative water content decreased, on the other hand, membrane permeability increased in drought stress plants compared to control plants (Table 3). Average % change values in sensitive and tolerant genotypes were -29% and -12% for leaf relative water content, and 171% and 179% for membrane permeability, respectively. In the previous studies, drought stress gave rise to decrease in relative water content (Kusvuran and Dasgan, 2017; Ashrafi et al., 2018; Wang et al., 2018; Sakya et al., 2018; Farag et al., 2019) and increase in membrane permeability (Farag et al., 2019).

Table 2. Response of tomato genotypes against PEG induced drought stress in water culture: Morphological features
Çizelge 2. *Su kültüründe domates genotiplerinin PEG ile yaratılan kuraklık stresine tepkileri: Morfolojik özellikler*

Genotype No	Leaf number			Stem diameter			Stem lenght			Root lenght			Shoot fresh weight			Root fresh weight		
	PEG-	PEG+	Δ%	PEG-	PEG+	Δ %	PEG-	PEG+	Δ %	PEG-	PEG+	Δ %	PEG-	PEG+	Δ %	PEG-	PEG+	Δ %
	(No/plant)			(mm)			(cm)			(cm)			(g)			(g)		
5	7.3	7.2	-2	6.0	5.5	-9	26.5	23.7	-11	21.5	17.6	-18	16.1	11.4	-29	2.1	1.7	-18
25	7.2	5.8	-19	5.8	5.1	-12	25.5	19.9	-22	21.5	13.9	-35	16.1	8.2	-49	3.0	1.7	-43
34	8.3	6.8	-18	6.7	6.0	-11	33.1	26.7	-19	20.9	16.5	-21	20.0	12.3	-38	2.8	1.9	-33
117	8.0	8.0	0	6.2	5.6	-8	32.2	29.1	-10	20.9	15.0	-28	18.5	13.2	-29	2.5	2.1	-16
124	9.8	9.0	-8	5.7	5.3	-7	36.1	33.4	-7	19.1	15.7	-18	20.9	14.3	-32	2.6	2.3	-10
Average	**8.1**	**7.4**	**-9**	**6.1**	**5.5**	**-9**	**30.7**	**26.5**	**-14**	**20.8**	**15.8**	**-24**	**18.3**	**11.9**	**-35**	**2.6**	**1.9**	**-24**
60	7.5	7.5	0	6.9	6.0	-14	29.2	27.2	-7	20.5	15.8	-23	21.4	16.7	-22	3.6	2.8	-22
68	7.3	7.0	-5	6.2	6.0	-3	28.4	29.4	3	20.5	14.6	-29	20.0	17.4	-13	2.9	2.6	-9
84	9.2	7.5	-18	5.8	5.8	-1	29.1	26.4	-9	22.6	17.5	-22	19.5	12.5	-36	3.1	2.5	-20
97	9.5	8.5	-11	5.5	5.4	-2	34.6	37.6	9	19.9	18.6	-7	21.1	15.9	-25	3.6	3.0	-16
140	8.0	9.7	21	5.1	4.7	-8	29.0	28.0	-4	21.3	15.8	-26	15.6	11.9	-24	2.0	1.6	-19
Average	**8.3**	**8.0**	**-3**	**5.9**	**5.5**	**-6**	**30.1**	**30.0**	**-2**	**21.0**	**16.5**	**-21**	**19.5**	**14.9**	**-24**	**3.0**	**2.5**	**-17**

* Δ: Change under osmotic stress (PEG+) compared to the control (PEG-)

Proline content increased in plants grown under stress. These results support the previous studies (Kusvuran and Dasgan 2017; Wang et al., 2018; Sakya et al., 2018; Carvalho et al., 2019). Plants under drought stress synthesize and accumulate some osmolytes, proline accumulation is the first reaction of plants exposed to water stress and therefore its concentration in the plant is used as an indicator value (Anjum et al., 2011). Average proline content of drought tolerant genotypes was higher compared to sensitive genotypes under non-stress conditions, and it increased when drought stress was applied in both tolerant and sensitive genotypes.

In the experiment, the average variation values in drought stress plants compared to control were 314% and 138% in sensitive and tolerant genotypes, respectively. Increase in proline content under drought stress was the highest in genotype 5 (529%) among the sensitive genotypes and the lowest in genotype 97 among the tolerant genotypes (Table 3).

Drought stress gave rise to significant reduction in chlorophyll A, chlorophyll B and carotenoid content in sensitive genotypes. These values increased or decreased under drought stress conditions compared to control in tolerant genotypes (Table 3).

It is reported that the increase in chlorophyll values under drought stress is an indicator of the severity of stress and decreased leaf area. Plants under stress conditions reduce the transpiration area to minimize water loss from reduced leaf surface area, as a result, the total amount of chlorophyll in leaves and chlorophyll content per leaf area increases (Gholaminand and Khayatnezhad, 2011). Average variation (%) values in sensitive and tolerant genotypes were -28% and -5% in chlorophyll A, -25% and -10% in chlorophyll B, -25% and -7% in carotenoid content. When the change values in chlorophyll A were analyzed, it was determined that they ranged from -42% to 8%; except for genotypes 68 and 97, other genotypes had lower chlorophyll A content than control. While the change values of chlorophyll B varied between 7% and -45%, it was determined that genotypes except the 60 and 68 had lower chlorophyll B content than the control. Variations in carotenoid content were similar to the changes in chlorophyll B.

The "Weighted Ranking" performed for the evaluation of all the properties examined showed that the total scores of tolerant and sensitive genotypes were different. In the experiment, 25 and 5 among the sensitive genotypes had lower; 97, 68 and 60 among the tolerant genotypes had the higher total scores (Table 4).

The correlation between the % change values for *in vitro* vigour index and the total score of "Weighted Ranking" in the water culture trial was found to be significant (r: 0.824) (Figure 1.).

Table 3. Response of tomato genotypes against PEG induced drought stress in water culture: Physiological properties
Çizelge 3. *Su kültüründe domates genotiplerinin PEG ile yaratılan kuraklık stresine tepkileri: Fizyolojik özellikler*

Genotype No	Relative water Content			Membrane Permeability			Proline Content			Chlorophyll A			Chlorophyll B			Carotenoids		
	PEG-	PEG+	Δ%	PEG-	PEG+	Δ %	PEG-	PEG+	Δ %	PEG-	PEG+	Δ %	PEG-	PEG+	Δ %	PEG-	PEG+	Δ %
	(%)			(%)			(µmol/ g fresh w.)			(mg/ kg fr.weight)			(mg/ kg fr.weight)			(mg/ kg fr.weight)		
5	77.8	37.2	-52	21.9	37.5	71	0.8	4.9	529	2271	1328	-42	914	505	-45	35.8	20.2	-44
25	64.4	31.2	-52	27.3	79.0	189	1.3	5.8	354	1608	1247	-22	676	524	-22	26.4	18.5	-30
34	47.1	24.5	-48	22.8	74.6	227	2.1	5.5	156	1823	1422	-22	660	519	-21	26.1	22.2	-15
117	44.8	37.2	-17	19.5	65.3	234	2.4	6.4	165	1828	1266	-31	647	478	-26	25.9	19.3	-25
124	38.3	47.2	23	22.8	53.3	134	1.0	4.5	366	1552	1229	-21	648	580	-11	25.5	22.8	-11
Average	**54.5**	**35.4**	**-29**	**22.9**	**61.9**	**171**	**1.5**	**5.4**	**314**	**1816**	**1298**	**-28**	**709**	**521**	**-25**	**27.9**	**20.6**	**-25**
60	59.7	37.0	-38	16.4	34.3	109	3.9	7.1	85	2136	1906	-11	592	612	3	24.0	24.6	2
68	57.0	35.2	-38	18.7	66.5	255	2.7	7.3	175	1475	1594	8	574	613	7	22.7	24.3	7
84	44.7	40.1	-10	16.0	72.5	354	2.4	6.7	185	1827	1632	-11	656	532	-19	25.5	21.4	-16
97	54.8	52.6	-4	17.5	27.3	56	4.7	7.7	65	1539	1652	7	747	537	-28	29.0	25.8	-11
140	37.1	48.9	32	20.0	44.7	123	2.1	5.8	178	1725	1421	-18	590	501	-15	23.4	19.9	-15
Average	**50.7**	**42.8**	**-12**	**17.7**	**49.1**	**179**	**3.1**	**6.9**	**138**	**1740**	**1641**	**-5**	**632**	**559**	**-10**	**24.9**	**23.2**	**-7**

Table 4. Weighted ranking scores of selected tomato genotypes regarding drought tolerance
Çizelge 4. *Kurağa tolerans bakımından seçilen domates genotiplerinin tartılı derecelendirme puanları*

Genotype No	Relative scores												
	5 LN	5 SD	5 SL	5 RL	5 SFW	5 RFW	10 RWC	10 MP	15 PRLN	10 Cl A	10 Cl B	15 CRTND	100 Total
5	25	15	20	35	20	35	10	100	15	10	10	15	310
25	5	10	5	5	5	5	10	60	60	40	50	45	300
34	5	10	5	25	5	5	10	50	135	40	50	90	430
117	25	25	25	15	20	35	50	50	120	30	40	60	495
124	15	30	25	35	15	50	90	80	60	50	70	105	625
Average	**15**	**18**	**16**	**23**	**13**	**26**	**34**	**68**	**78**	**34**	**44**	**63**	**432**
60	25	5	25	25	35	25	20	90	150	70	100	150	720
68	20	45	45	15	50	50	20	40	120	100	100	150	755
84	5	50	25	25	10	30	50	10	120	70	50	90	535
97	15	45	50	50	30	40	60	100	150	100	40	105	785
140	50	25	35	20	30	30	100	80	120	50	60	90	690
Average	**23**	**34**	**36**	**27**	**31**	**35**	**50**	**64**	**132**	**78**	**70**	**117**	**697**

*LN: Leaf number; SD: Stem Diameter; SL: Stem Lenght; RL: Root Lenght; SFW: Shoot fresh weight; RFW: Root fresh weight; RWC: Relative water content; MP: Membrane Permeability; Cl A: Chlorophyll A; Cl B: Chlorophyll B; CRTND:Carotenoids; PRLN: Proline

Findings of Kıran et al., (2014), testing two genotypes (TR63233 and TR68516) included in our *in vitro* tested genetic pool, report TR63233 as sensitive and TR68516 as tolerant against drought. In our study, TR63233 ranked among the selected sensitive genotypes 124 and 25; TR68516 was between the tolerant genotypes 140 and 68. Report of Kıran et al., (2014) support our results regarding with the relationships between *in vitro* vigour index and total scores of weighted ranking in water culture.

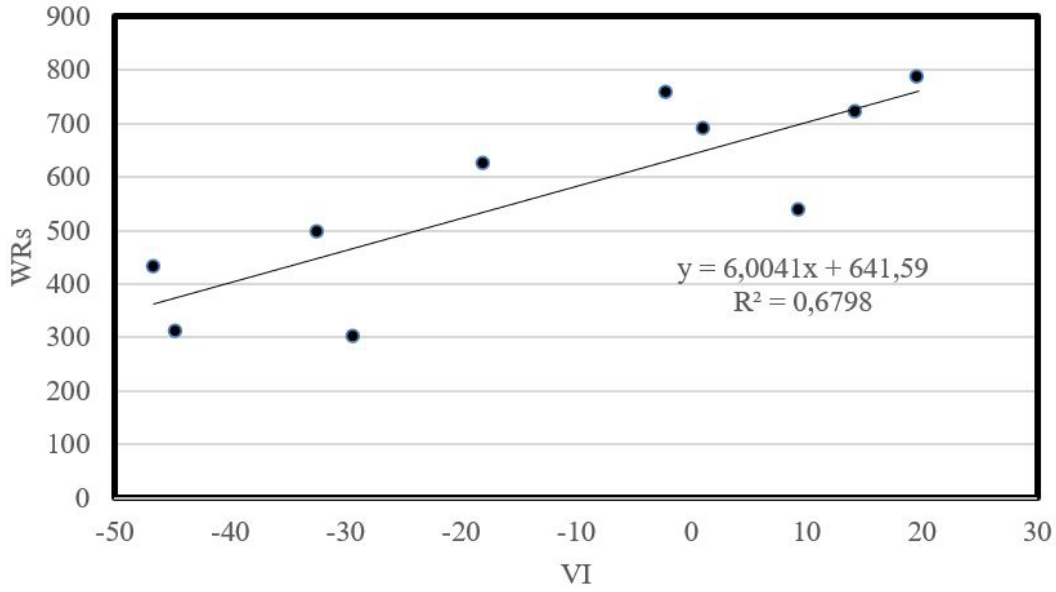

Figure 1. Correlation between the changes in vigour index (VI) and total scores of weighted ranking (WRs)
Şekil 1. *Vigor indeksi (VI) ile tartılı derecelendirmedeki (WR'ler) toplam puanlar arasındaki korelasyon*

CONCLUSION

It was determined that the response of tomato genotypes to PEG induced drought stress during seed germination and young plant stage was similar. Therefore, it was concluded that in vitro seed germination test can be used for pre-screening of large numbers of genotypes in response to drought stress. After *in vitro* test, selected genotypes should be tested by *in vivo* assays in growth chamber, and then their performances should be worked out under greenhouse and/or open field conditions.

As a result of this study, 97: TR70707, 68: TR69163 and 60: TR68515 in the genetic pool screened, were determined as the most tolerant genotypes against drought. These genotypes can be used in the breeding programs for developing drought tolerant tomato varieties. In addition, in seed germination test, other genotypes determined to increase the vigour index in PEG application compared to control can be used.

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