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COMPARISON AMONG TWELVE EXOTIC ACCESSIONS OF TOMATO *(SOLANUM LYCOPERSICUM L.)* FOR ROOT AND SHOOT DEVELOPMENT UNDER POLYETHYLENE GLYCOL INDUCED WATER STRESS

[a,b]Fakhra Shamim*, [a]Khalida Khan,[b,c]Sana Khalid

[a]*Centre for Integrated Mountain Research, University of the Punjab, Lahore, Pakistan.*
[b]*Institute of Agricultural Sciences, University of the Punjab, Lahore, Pakistan.*
[c]*Lahore College for Women University, Jail Road, Lahore, Pakistan.*

ABSTRACT

The aimof study was carried out to evaluate the detrimental effects of polyethylene glycol (PEG)induced water stress both on seed germination and early seedling growth stages in twelve exotic accessions of tomato.The experiment included increasing levels of PEG_{8000}(2.5%, 5.0% and 7.5% *w/v*) and compared with control treatment (nutrient solution only). The data was recorded on various seed and seedling parameters *viz*. seed germination percentage, rate of germination, shoot and root length, fresh and dry biomass and leaf relative water content. No significant difference was recorded for these parameters upto 5.0% PEG_{8000} concentration in contrast to 7.5% level. Noteworthy decrease was recorded in shoot length, root length, fresh and dry biomass for the accessions Ailsa Craig, Edkawi and M-82 on the other hand wild tomato *viz*., '*Solanum pennellii*', '*Solanum chilense*' and '*Solanum pimpinellifolium*'showed their resilient character towards water stress. A strong positive correlation of rate of seed germination was computed with both seed germination percentage and shoot fresh weight. Current results provided useful data in screening of water stress tolerant germplasm using PEG_{8000} and more pronounced results were obtained at 7.5% of PEG_{8000} treatment, which is therefore, could be used for further research.

Keywords: Wild tomato; Polyethylene glycol (PEG_{8000}); Germination,Leaf water content

INTRODUCTION

Abiotic stresses like flood, drought, cold, frost, heat not only affect the plant growth but also alter its metabolic activities. Plants safeguard themselves from the hostile effects of stresses includingdrought which depends upon both genetic and adaptive mechanisms of plant for example maintenance of low leaf water potential at low soil water potential. (Hsieh *et al*., 2002; Mittova *et al*., 2014).Plants tolerant to stress successfully maintain their metabolic homeostasis with minimum stress injuries during growth in contrast to sensitive plants which failed to regulate metabolic activities lead to reduction in growth or even in death (Jogaiah *et al*., 2013).Though *Solanum lycopersicum* has been reported as water demanding crop but its new varieties are reported as more water loving as compared to drought tolerant or wild verities. Hence drought tolerance potential of specific variety of *S. lycopersicum* may change with its growth stage during its life cycle but ideal varieties would show tolerable level of drought tolerance at as many as possible life stages thus may be utilized in breeding programs to improve drought tolerance potential with increased yield (Zhou *et al*., 2015).Selection can change the frequencies with which various genes or combination of genes occurs and genes not previously present can be introduced into the population by breeding. Moreover it requires genetically stable variation for a desired character and reliable method for assessment of material for variation in tolerance that is inexpensive, reliable, repeatable, having capacity of processing large numbers of genotypes. The method of screening used in this study is highly inexpensive and rapid so that it was possible to screen

* Corresponding Author:
Email: fakhra_dr@yahoo.co.uk

seeds of the variable material within a few days.Considerable research efforts have been made in past while using in vitro screening experiments to screen plant germplasm including tomatoin order to explore their drought tolerance potentialwhile using polyethylene glycol (PEG), particularly when it comes to early stages of their life cycle (Yaniv*et al*., 1983; Zgallai *et al*., 2005; Aazami *et al*., 2010; George *et al*., 2013; Jatoi *et al*., 2014; Basha *et al*., 2015).PEG has been frequently used as external drought inducing agent as reports indicate that it is a better chemical than others like mannitol due to more molecular weight of PEG. Moreover, polymers of PEG enjoy non-ionic and inert water resistant chains which did not infiltrate through cell wall or apoplast so less absorbed by plant tissues, thus use of PEG with higher molecular weight like 8000 are justified in screening experiments (Lu and Neumann, 1998; Willenborg *et al*., 2004). Nonetheless PEG_{8000} has been reported to decrease water potential of the cell as it extract the water both from cell and/or cell wall which hinder the solutes filtration across the lignified cell walls. Therefore PEG_{8000} dissolved innutrient solution has been reported to develop least physiological damages and makes uniform osmotic potential in the solution (Carpita*et al*., 1979; Verslues *et al*., 1998).Nonetheless in order to distinguish or rank the tolerant or susceptible genotypes while using PEG, its various upsurge concentrations has been reported as informative while these concentrations also vary for different germpalsm. But it depends on different factors like total genotypes and their number used, divergence and origin, growth stage, type and duration of the study. In order to increase the tomato crop yield it is imperative to identify such genotypes/accessions that may tolerate deficient soil moisture which can be achieved by exploring the drought tolerance potential of germplasm.Therefore, current experiment was designed to search out quick and simple method to screen thetwelveexotic tomato accession with high tolerance to water stress under low water potential induced by PEG_{8000}. To accomplish this goal different concentrations of PEG_{8000} were used and data for various parameters like total seed germination percentage, rate of seed germination, dry and fresh biomass of seedlings was computed. This study also useful in optimizing the suitable concentration of PEG_{8000} to perform quick screening of large number of tomato germplasm on the basis of their potential to tolerate early induced drought which could be used in breeding programme.

MATERIALS AND METHODS

Seed germination and seedling evaluation were performed using PEG_{8000} (Sigma-Aldrich Co., Life Science. 2KG- Avg. Molecular Weight 8000) at Department of Botany, PMAS-Agriculture University Rawalpindi, Pakistan.

Plant Material and Screening Assays: Seeds of 12 accessions of tomato were kindly provided by the Tomato Genetics Resource Center, California, USA*viz*. 'Ailsa Craig' (LA2838A), 'Floradade' (LA3242), 'Condine Red' (LA0533), 'New Yorker' (LA2009), 'Pennheart' (LA0020), 'Hotset' (LA3320), 'Edkawi' (LA2711), M-82 (LA3475), 'VC-82' (LA1706), '*Solanum pennellii*' (LA0716), '*Solanum chilense*' (LA0722) and '*Solanum pimpinelli folium*' (LA0458). Different concentrations of PEG_{8000} were used to screen the tomato germplasm *viz*. T1 = control (nutrient solution only); T2 = (2.5% of PEG_{8000}*w/v*); T3 = (5.0% PEG_{8000}*w/v*) and T4 = (7.5% PEG_{8000}*w/v*) in Hoagland's nutrient solution to assess the drought tolerance potential of the exotic germpalsm (Hoagland and Arnon, 1950).

Seed Germination Experiment: After sterilization in 3% solution of sodium hypochlorite for 10 minutes, seeds were rinsed with water and 15 seeds of each accession were spread in Petri dishes lined with filter paper (Whatman No.1).The seeds were examined daily and five ml of appropriate treatment solution was applied on alternate days for 14 days to each Petri dish after pipetting out the earlier solution. Numbers of seeds germinated were observed and counted and germination data was recorded daily until the completion of two weeks (ISTA, 1996). A seed was considered germinated when both plumule and radicle has emerged $\geq$ 5 mm (Chartzoulakis and Klapaki, 2000). Untransformed data was used to calculate the rate of germination (1/t50, where t50 is the time to 50% of germination). Total germination was expressed as percent of that in control treatment for each tomato accession and then data were arcsine transformed for the statistical analysis.

Seedling Experiment: Moreover, plastic containers having height and width;200 × 100 cm with 25 cm depth were used to assess the drought tolerance potential of the pre-germinated seedlings. Above mentioned treatments were also employed to induce water stress in hydroponic study (Hoagland and Arnon, 1950). Seven biometric traits*viz*. shoot fresh weight (mg), root fresh weight (mg), shoot dry weight (mg), root dry weight accession was recorded after two weeks of stress at seedling stage.Data for mean plant fresh and/or dry weight was expressed as relative fresh and dry (mg) and leaf relative water content (%) of each weight by using the equation (1) while leaf relative water content were computed by following the equation (2):

$$(1)\text{Relative plant fresh or dry wt.} = \frac{\text{Plant fresh or dry weight at PEG8000 concentration}}{\text{Plant fresh or dry weight at control treatment}} \times 100$$

$$(2)\text{Relative water content (\%)} = \frac{\text{leaf fresh weight} - \text{leaf dry weight}}{\text{leaf turgid weight} - \text{leaf dry weight}} \times 100$$

STATISTICAL ANALYSIS

Both Petri plates and containers were arranged in completely randomized design (CRD) in triplicate with four treatments of PEG_{8000} (2.5%, 5.0% and 7.5% *w/v*). Data for various morphometric traits was analyzed according to Steel and Torrie (1980). Drought tolerance indices were computed according to Zeng *et al.* (2002) by dividing the mean values of water stressed accessions by the mean digits of their particular non water stress accessions. The means of treatments were compared by using Duncan's multiple range test at 5% probability. These accessions were then ranked according to their means.

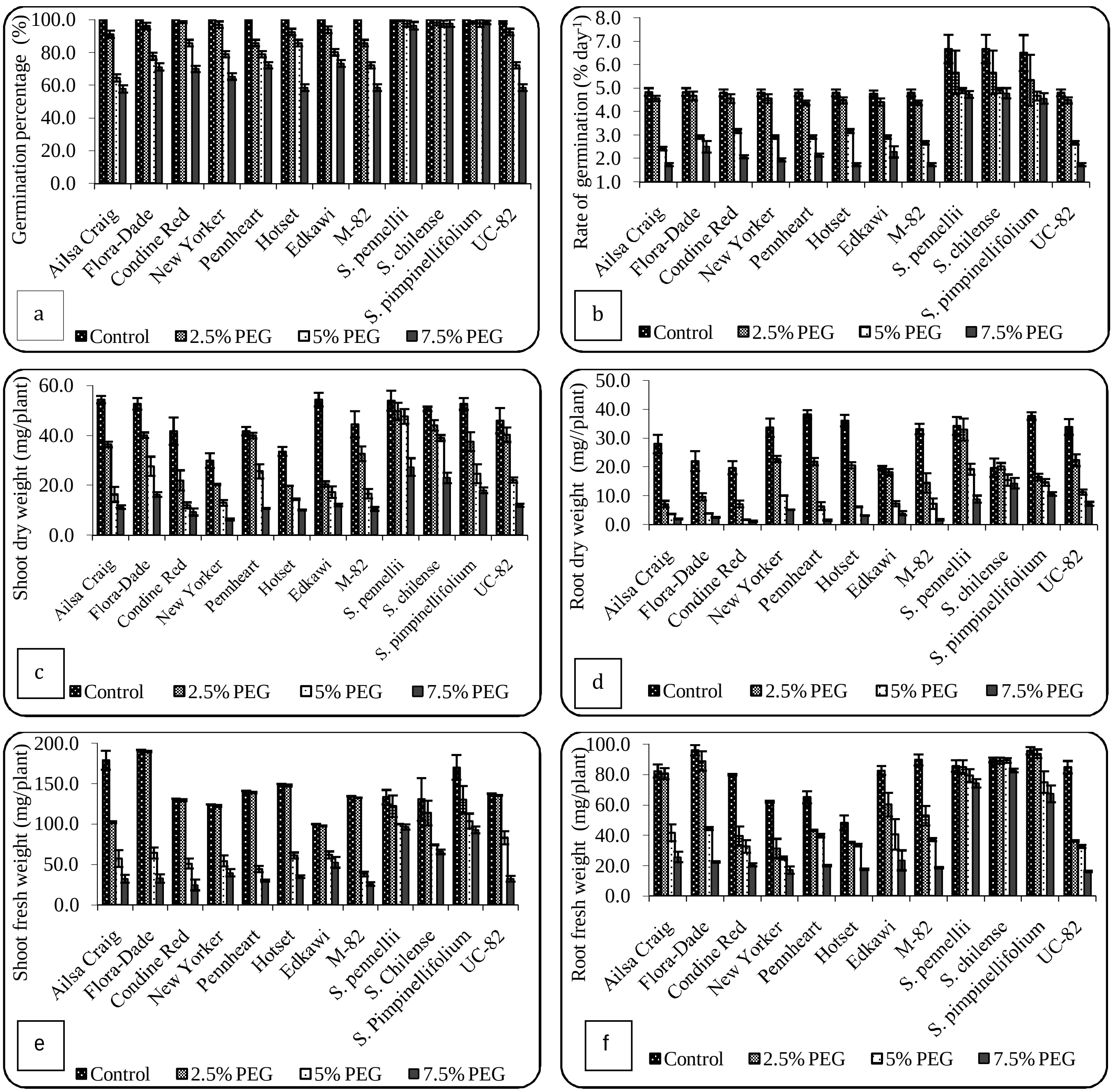
RESULTS

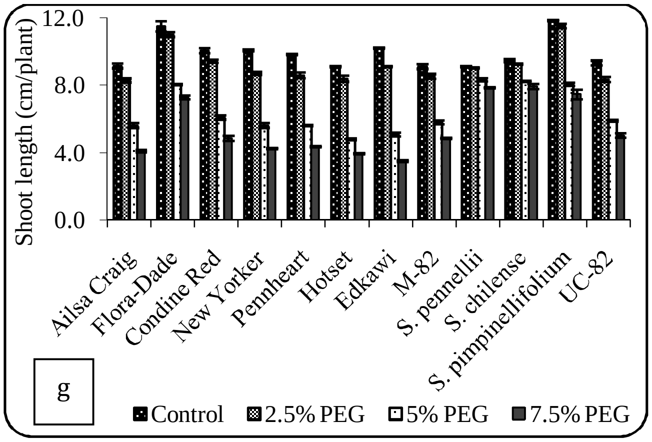
In order to maintain, evaluate and utilize germplasm efficiently and effectively under drought stress conditions, it is imperative to explore the extent of genetic variability. To achieve this target ninebiometric traits *viz.* total seed germination percentage (percent of control), rate of seed germination (% day^{-1}), shoot dry weight (mg), root dry weight (mg), shoot fresh weight (mg), root fresh weight (mg), shoot length (cm), root length (cm) and leaf relative water content (%) of each accession was recorded.A great magnitude of variation was observed in the set of tomato germplasm for drought tolerance for all measured parameters. Analysis of the variance of above listed biometric traits showed that upsurge in concentration of PEG_{8000} had significant inhibitory effects on these parameter ($P \leq 0.05$). Significant results were also recorded between accessions and treatment at different levels of water stress. Similarly, comparison among mean value of treatment inferred that all the four means of treatments varied significantly from one another and maximum values were observed under T1 while it was minimum at highest concentration of PEG_{8000} (T4). All the tomato accessions assessed were ranked on the basis of their performance under stress condition imposed by different levels of PEG_{8000}both at seed germination and seedling stages.

Seed Germination and Rate of Germination: Significant decrease wasrecorded both for seed germination percentage and rate of germination under various levels of PEG_{8000} induced water stress whilstunder T1 (non-stress)maximum reading was recorded Figure $1_{a,b}$.All accessions were ranked on the basis of mean value revealed that wild tomato material *viz. S.pennellii*, *S. chilense*and *S. pimpinellifolium* proved their resilience towards drought even at higher concentration of PEG_{8000} whereas the accessions Ailsa Craig, M-82 and UC-82 showed their susceptible behaviorhence significant reduction in both traits was computed (Table 1).Nevertheless, data for total germination percentage (percent of control) and rate of germination presented in Table 2 showed that some accessions have consistent relationship between data for total germination percentage and rate of germination. Similarly, information regarding the seedlings growth attributes also showed significant decrease in all the traits like shoot and root length, fresh and dry biomass and water content of leaf but more reduction was recorded in shoot length as compared to root length.

Dry and Fresh Biomass: Under control and different concentration of PEG_{8000} all the tomato accessions exhibited substantial reduction in treatment means of both shoot and root dry biomass (46.35, 33.60, 23.04 and 13.92 mg for shoot dry weight; 19.7, 20.3, 15.4 and 14.34 mg for root dry weight at T1, T2, T3 and T4 respectively as shown in Figure $1_{c,d}$) and shoot and root fresh biomass (143.6, 130.2, 66.1 and 46.6 mg for shoot fresh weight; 80.2, 61.3, 47.6 and 33.8 mg for root fresh weight respectively as shown in Figure $1_{e,f}$). On the other hand the relative transformed values of dry and fresh biomass depicted in Table 2 shows that these attributes significantly affected by all the stress treatments. Wild accessions *S. pennellii* and *S. chilense*were ranked as 1st and 2nd whilst Ailsa Craig was at 12th position for root dry weight and 10th in shoot dry weight. Nonetheless, the accession Edkawi was again ranked 12th for shoot dry weight and wild accessions were ranked at top position.

Shoot and Root Length: Similarly PEG_{8000} simulated water stress also reducedshoot and root length of seedlings as shown in Figure ($1_{g,h}$)but drastic decrease was recorded for sensitive tomato accessions. On the basis of means of exotic accessions presented for shoot length presented in Table 1 wild germplasm got top positions both for shoot and root length, Flora-Dade was 4th and Edkawi was 12th in ranking for shoot length while Ailsa Craig was at 12th position for root length.





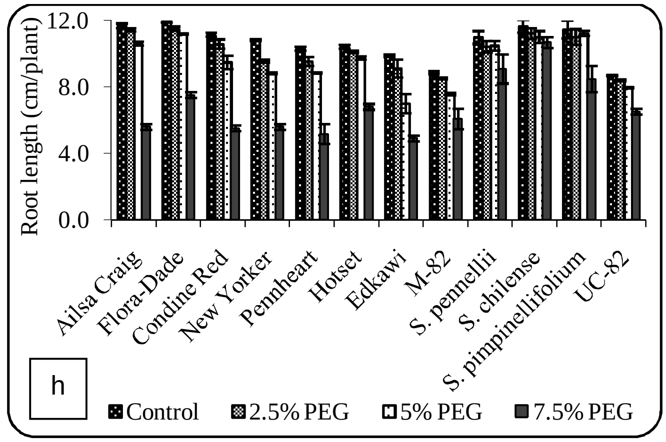


Figure 1: Effect of PEG_{8000} induced water stress (2.5%, 5.0% and 7.5%) with respect to control on (a-b) total seed germination percentage and rate of germination (c-d) shoot and root dry weight (e-f) shoot and root fresh weight and (g-h) shoot and root length on 12 exotic tomato accessions under PEG_{8000} concentrations.

Leaf Relative Water Content: Data presented in Figure 2 depict that water stress imposed by various concentrations of PEG_{8000}also significantly reduced leaf water content of all tomato accessions (81.6, 74.8, 64.8 and 44.8% respectively at T1, T2, T3 and T4). All the tomato accessions were ranked on the basis of their performance for leaf relative water content under water stress condition induced by different levels of PEG_{8000}. *S. chilense* and *S. pennellii* were ranked as 1st and 2ndrespectively followed by *S. pimpinelli folium*; on the other hand M-82 and UC-82 were ranked as 11th and 12th for this trait (Table 3). The correlation analysis also exhibited positive significant relation among various growth attributes under drought. Significant and positive correlation was recorded between germination percentage, rate of germination, shoot fresh weight and leaf relative water content and water stress condition induced by PEG_{8000} (Table 4). Nevertheless, significant positive correlation of leaf relative water content was noted with almost all the attributes of growth. The data indicated that the accessions which performed better and scored good positions were tolerant to drought stress. It can be concluded that classification of the accessions on the basis of their transformed data exhibited tremendous variability in their growth pattern in relation to drought.

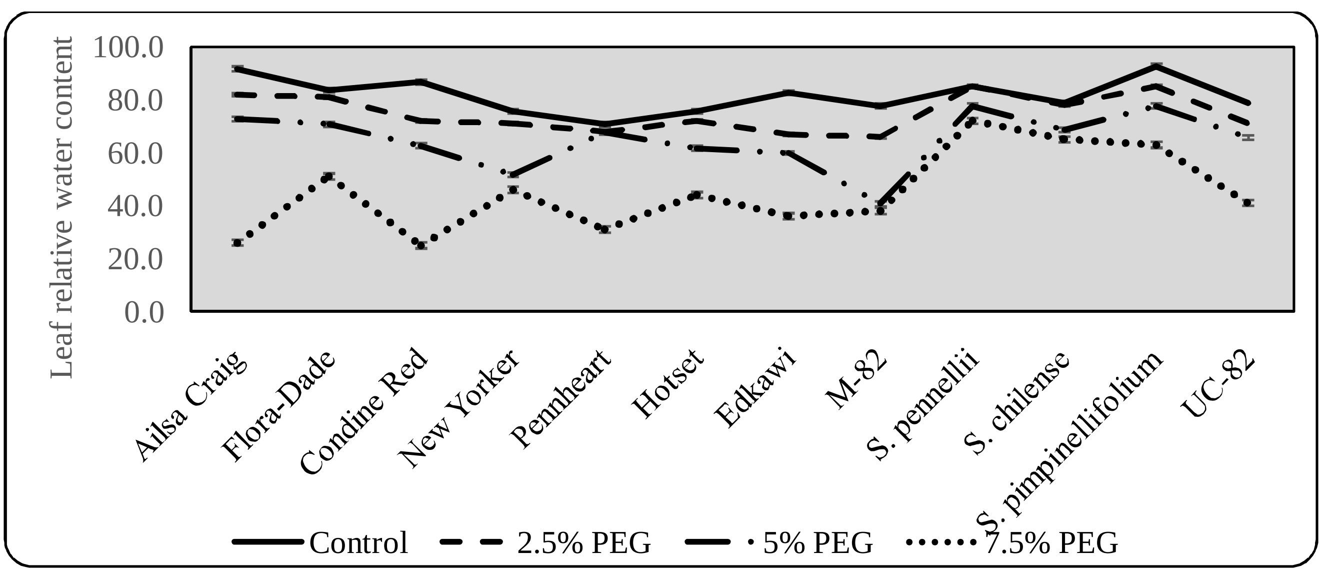


Figure 2. Effect of PEG_{8000} (2.5%, 5.0% and 7.5%) induced water stress with control on leaf relative water content of 12 exotic tomato accessions. A notable decrease in water content can be computed under maximum concentration of PEG_{8000}.

Table 1. Effect of different levels (2.5%, 5.0% and 7.5%) of PEG_{8000} induced water stress on seed germination (%) and rate of seed germination & shoot and root length on 12 exotic tomato accessions after employing the formula of stress index.

Accessions	Germination %					Rate of germination				
Levels of water stress (PEG_{8000} in grams)										
	2.5%	5.0%	7.5%	Means	Ranking	2.5%	5.0%	7.5%	Means	Ranking
Ailsa Craig	91.11	64.44	57.78	71.11 f	12	94.3 b	50.0	35.9	60.0 g	12
Flora-Dade	97.78	77.78	71.11	82.22 bc	6	96.6 a	60.3	51.7	69.5 c	4
Condine Red	96.99	85.71	69.92	84.20 b	4	95.0	66.0	43.1	68.0 d	5
New Yorker	96.99	78.94	65.40	80.44 cd	7	95.0	60.8	40.3	65.4 e	8
Pennheart	85.71	78.94	72.17	78.94 d	8	91.1	60.8	44.5	65.5 e	7
Hotset	92.47	85.71	58.64	78.94 d	9	93.4	66.0	36.1	65.2 e	9
Edkawi	93.90	80.16	73.28	82.45 bc	5	92.6	61.3	47.9	67.3 d	6
M-82	85.71	72.17	58.64	72.17 ef	11	91.1	55.6	36.1	61.0 fg	11
S. pennellii	97.78	97.78	97.78	97.78 a	1	85.0	73.3	70.8	76.4 a	2
S. chilense	97.78	97.78	97.78	97.78 a	2	85.0	73.3	71.7	76.7 a	1
S. pimpine	97.78	97.78	97.78	97.78 a	3	82.1	71.8	70.1	74.6 b	3
UC-82	92.47	72.17	58.64	74.43 e	10	93.4	55.6	36.1	61.7 f	10
Accessions	**Shoot length (cm)**			**Means**	**Ranking**	**Root length (cm)**			**Means**	**Ranking**
Ailsa Craig	90.5	61.5	44.7	65.6 h	8	98.0	90.9	48.0	79.0 h	12
Flora-Dade	94.1	68.0	61.5	74.5 d	4	96.1	93.3	62.7	84.0 de	6
Condine Red	93.7	60.6	48.3	67.5 g	7	97.6	91.9	49.4	79.6 h	10
New Yorker	86.5	55.8	42.2	61.5 k	11	113.3	92.3	58.7	88.1 b	2
Pennheart	87.5	57.3	44.4	63.1 i	9	95.5	85.8	57.3	79.5 h	11
Hotset	92.0	52.6	43.4	62.7 j	10	98.4	93.6	65.4	85.8 c	4
Edkawi	89.3	49.8	34.2	57.8 l	12	97.3	95.3	49.5	80.7 g	9
M-82	93.4	63.5	53.3	70.1 e	5	95.9	85.3	69.9	83.7 e	7
S. pennellii	98.9	91.2	86.1	92.1 a	1	102.4	101.8	65.8	90.0 a	1
S. chilense	97.9	87.0	83.8	89.6 b	2	95.9	94.3	64.4	84.9 d	5
S. pimpine	97.2	68.0	65.4	76.9 c	3	96.9	91.5	75.0	87.8 b	3
UC-82	89.6	63.2	55.4	69.4 f	6	93.9	91.7	59.4	81.6 f	8

Means in column with similar letters (a-l) did not differ significantly at $P < 0.05$ level (*S. Pimpine = S. pimpinellifolium*)

Table 2. Effect of different levels (2.5%, 5.0% and 7.5%) of PEG_{8000} induced water stress on fresh shoot and root biomass & dry shoot and root biomass on 12 exotic tomato accessions after employing the formula of stress index.

Accessions	Shoot fresh weight (mg)					Root fresh weight (mg)				
Levels of water stress (PEG_{8000} in grams)										
	2.5%	5.0%	7.5%	Means	Ranking	2.5%	5.0%	7.5%	Means	Ranking
Ailsa Craig	51.3	5.0	4.5	20.3 c	12	93.8	18.0	9.0	40.3 bc	6
Flora-Dade	99.0	11.2	9.5	39.8 bc	7	51.5	25.9	12.9	30.1 cde	9
Condine Red	98.5	13.9	8.2	40.2 bc	5	49.4	25.6	12.8	29.3 cde	10
New Yorker	98.4	10.9	9.3	39.5 bc	8	50.4	40.1	20.0	36.9 c	7
Pennheart	98.6	13.4	10.9	40.9 bc	4	66.4	61.1	30.6	52.7 a	4
Hotset	98.7	12.9	8.2	39.9 bc	6	72.9	69.6	36.5	59.7 a	1
Edkawi	98.0	11.2	8.0	39.1 bc	9	38.1	16.8	8.4	21.1 e	12
M-82	98.5	7.6	6.2	37.4 bc	10	35.0	24.7	12.3	24.0 de	11
S. pennellii	98.0	49.9	43.5	63.8 a	2	90.2	40.4	20.2	50.3	5
S. chilense	98.9	40.6	35.9	58.5 ab	3	78.8	63.5	19.2	53.8	3
S. pimpine	99.5	58.1	36.5	64.7 a	1	113.3	43.1	21.6	59.3	2
UC-82	98.6	7.3	6.2	37.4 bc	11	42.7	38.4	19.2	33.4	8
Accessions	**Shoot dry weight (mg)**			**Means**	**Ranking**	**Root dry weight (mg)**			**Means**	**Ranking**
Ailsa Craig	45.4	1.5	0.8	15.9 fg	10	25.54	13.21	7.14	15.30 e	12
Flora-Dade	58.5	13.5	6.9	26.3 de	6	43.98	18.05	11.59	24.54 d	9
Condine Red	65.6	4.2	2.4	24.1 de	7	36.27	8.97	5.79	17.01 e	11
New Yorker	67.9	13.7	7.0	29.6 cd	5	67.62	29.95	15.42	37.00 c	6
Pennheart	89.0	13.4	4.8	35.7 bc	4	57.09	16.81	3.96	25.95 d	8
Hotset	53.4	6.2	3.4	21.0 ef	9	57.09	17.14	8.99	27.74 d	7
Edkawi	25.6	1.1	0.8	9.1 g	12	91.91	37.16	37.16	55.41 b	3
M-82	95.1	11.4	5.9	37.5 b	3	43.70	22.04	5.14	23.63 d	10
S. pennellii	91.2	80.2	13.5	61.6 a	1	96.05	56.07	25.96	59.36 b	2
S. chilense	96.6	72.7	8.7	59.3 a	2	102.63	78.10	72.64	84.46 a	1
S. pimpine	46.7	13.0	6.8	22.2 def	8	43.70	38.89	28.46	37.02 c	5
UC-82	31.2	9.2	4.7	15.0 fg	11	65.88	33.43	21.47	40.26 c	4

Means in column with similar letters (a-g) did not differ significantly at $P < 0.05$ level (*S. Pimpine = S. pimpinelli folium*)

Table 3. Effect of different levels (2.5%, 5.0% and 7.5%) of PEG_{8000} induced water stress on leaf relative water content on 12 exotic tomato accessions after employing the formula of stress index.

Accessions	Leaf relative water content (%)				
	2.5	5.0	7.5		
	PEG_{8000} %			Means	Ranking
Ailsa Craig	89.5	79.3	28.4	65.7 h	10
Flora-Dade	96.8	84.5	61.0	80.7 c	4
Condine Red	90.3	83.5	52.1	75.3 e	7
New Yorker	93.8	68.3	60.8	74.3 f	8
Pennheart	96.2	95.8	43.9	78.6 d	5
Hotset	95.2	81.5	58.1	78.3 d	6
Edkawi	81.0	81.9	43.5	68.8 g	9
M-82	85.0	52.4	48.9	62.1 i	11
S. pennellii	93.8	85.7	79.4	86.3 b	2
S. chilense	99.2	87.3	82.6	89.7 a	1
S. pimpinelli folium	91.7	83.8	68.0	81.2 c	3
UC-82	83.1	72.3	28.8	61.4 i	12

Means in column with similar letters (a-g) did not differ significantly at $P < 0.05$ level

Table4.Correlation matrix for different screening parameters for 12 exotic tomato accessions under water stress imposed by various concentration of PEG_{8000}.

	GERM	RATE	SL	RL	SFW	RFW	SDW	RDW
GERM								
RATE	0.886**							
SL	0.836**	0.822**						
RL	0.696*	0.716*	0.761*					
SFW	0.805**	0.856**	0.890**	0.716*				
RFW	0.636*	0.687*	0.757*	0.676*	0.766*			
SDW	0.673*	0.776*	0.738*	0.668*	0.812**	0.841**		
RDW	0.664*	0.669*	0.687*	0.472NS	0.724*	0.591NS	0.657*	
RWC	0.805**	0.798*	0.835**	0.870**	0.796*	0.712*	0.708*	0.620*

* = Significant at the 0.05; probability level** = Significant at the 0.01 probability level

GERM = Germination percentage; RATE = Rate of seed germination(% day^{-1});

SL = Shoot length (cm); RL = Root length (cm);

SFW = Shoot fresh weight (mg); RFW = Root fresh weight (mg);

SDW = Shoot dry weight (mg); RDW = Root dry weight (mg);

RWC = Leaf relative water content (%)

DISCUSSION

Under water stress, existence of variation is a pre-requisite for the improvement of any desirable character. Screening of available germaplasm local or exotic of crop is essential because this data is useful to study the extent of variation for the desirable trait. Moreover, both seed germination and later stages are sensitive to water stress for many crops including many accessions/cultivars of *S.lycopersicum* but wild accessions of *S.lycopersicum* has been ranked as better genetic material because wild genotypes are more tolerant to stress as compared to cultivated genotypes of *S. lycopersicum* (Bai and Lindhout, 2008; Nuez *et al*., 2008; Knapp*et al*., 2009; Bedinger *et al*., 2011; Mittova*et al*., 2014). It is evident from the results that water stress induced by employing negatively affected both seed of germination and rate of germination which depicts that available germplasm contained great genetic variation. Our results are in line with finding of previously reports (Shamim*et al*., 2014; Basha*et al*., 2015). It might be due to osmotic stress which was imposed by induction of PEG_{8000} which creates (i) osmotic barrier (ii) hinder water uptake leading to reduction in cell division and cell enlargement (iii) lowers osmotic potential of the medium (iv) ultimately, hamper protein synthesis along with mobilization of reserved stored resources (Farooq *et al*., 2009; Osorio *et al*., 2014) and (v) due to activation of stress inducible genes which express themselves under specific stress conditions (Foolad, 1996;Foolad *et al*., 2003; Foolad, 2007). Hence both seed germination and rate of germination decreased in all tomato accessions due to upsurge concentrations of PEG_{8000} in the nutrient solution which decreased water potential gradient (Dodd and Donovan, 1999; Basha *et al*., 2015). Moreover, a desirable trait for drought tolerant programs is longer root system because fast and better root structure promotes the water intake from deeper soils. Accordingly under water stress those tomato accessions with better root and shoot length depicted better fresh and biomass. Our results are in accordance with many research reports on tomato that under drought stress shoot growth is more sensitive to water stress in contrast to root growth (Agong*et al*., 2000; Prodriguez *et al*., 1997; Soltani*et al*., 2002; Kulkarni and Deshpande 2007; Nahar and Gretzmacher, 2011; Jokanovic and Zdravkovic, 2015). Similarly another study on tomato by Jokanovical*et al*. (2014) depict that under water stress condition dry weight of roots respond differently hence tomato accessions differ in their root metabolic adjustment. In contrast our data disagree with the results of Dasgan*et al*. (2002) that dry weight of shoot and root were independent of stress condition. Leaf relative water content, one of the inherited traits in crop also showed deleterious effect upon upsurge concentration of osmoticum and has been reported as index of water stress tolerance to calculate the water status of crop. While working on tomato many researchers reported decline in this attribute due to water stress while, pronounced reduction was noted in less tolerant accessions (Shtereva *et al*., 2008; George *et al*., 2013). Our results also in line with the findings of Sanchez-Rodriguez *et al*. (2010) that drought stress caused significant decrease in leaf water content of tomato due to decrease water potential. It hasbeen reported by Steel and Torrie (1980) that correlation is a measure of the degree to which variables vary together or it may be a measure of intensity of association therefore, in the current study highly significant and positive correlation was computed among all the growth attributes. Leaf water content has been reported to have a strong correlation with plant water status hence significant decrease in leaf relative water content may be due to decrease in water potential of the medium imposed by employing different concentrations of PEG_{8000} (Chaudhry *et al*., 1999; Lawlor and Cornic, 2002). Hence drought reduced the growth of all tomato genotypes hence confirmed our results that with increase in stress different genotypes respond differently so, drought tolerant genotypes of tomato produced greater biomass than susceptible ones.Moreover, the production of higher dry biomass in both absolute and relative terms by *wild* accessions followed by Pennheart and their higher shoot water content also proved the water stress resilience of these accessions as compared to rest of accessions.

CONCLUSION

Taken together, in this study considerable amount of genetic variability has been noted in available exotic tomato accessions and the upsurge concentrations (2.5%, 5.0% and 7.5% *w/v*) of PEG_{8000} substantially decreased the biometric traits of all the tomato accessions. The 7.5% PEG_{8000} treatment is recommended as informative for comparison among large and diverse population of *S.lycopersicum* in order to evaluate their drought tolerance potential to early vegetative stage. Moreover accessions 'Ailsa Craig', 'M-82' and 'UC-82' were ranked as susceptible to drought whilst, wild accessions were ranked as tolerant. Remaining accessions showed intermediate performance. Hence, for screening the drought tolerance potential of the accessions, the traits like germination of seeds and leaf relative water content could be potential selection criteria at vegetative stage of tomato plant however, it is essential for plant breeders to decide on the method for differentiating the level of the tolerance among the accessions.

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