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# Effect of drought on the growth of tomatoes genotypes

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**Abstract**

Drought stress reduces the yield and production of tomato ( *Lycopersicon esculentum* L). To assess the effect of drought stress on the growth and yield of tomato a pot experiment was conducted in green house condition Garris Dopatta, Azad Kashmir, Pakistan. Twenty six genotypes of tomato were evaluated for morphological characters. They were subjected to drought stress during vegetative growth by using Poly ethylene glycol (PEG-6000) at different concentrations ranging from, 0% (control), 5%, 7.5%, 10% and 12.5%. The Morphological parameters compared were number of branches, number of leaves, Plant height, internodal distance, number of flowers, number of trusses, number of fruits, root length, root diameter. Polyethylene glycol showed significant effect on the production of number of branches. The maximum number of branches were recorded at control leading to minimum were at highest level of the drought. Maximum number of branches (10.667) at control and 2 at 12.5% PEG were found in genotype G 31-19289. Plant height data also indicated show that drought stress adversely affects the plant height. The maximum plant height 184 cm was recorded in genotype G 31-19289 at control and 70cm at 12.5% PEG. Similar trends in number of leaves and number of flowers were recorded. The number of fruits were also recorded and showed the similar pattern. The internodal distance decreased with the decreasing plant height. The number of trusses, the root length and root diameter also indicated the similar trend. However root length was better in genotype G8-19219 and its diameter was higher in genotype G 7-88572. Genotype 31-19289 proved to be the best performing under drought stress compared with other genotypes.

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## Introduction

Tomatoes (*Lycopersicon esculentum* Mill) are one of the important vegetable crops which occupies the at least 4.8 ha. The increasing the trend for area and yield of tomato is the interest which is approximately now is 33.5 t/ha. (Takac *et al.*, 2007; Zdravkovic *et al.*, 2011). Tomatoes are having high contents of vitamins A and C and also contains the minerals like Ca, P and Fe (Dhaliwal *et al.*, 2003). The elevated temperature and lack of water are the major factors which govern the biotic stresses (Pena and Hughes, 2007). The germination and seedling growth are adversely effected by the dry weather conditions and cells are damaged by the stress conditions (Delachiave and Pinho, 2003, Hamayun *et al.*, 2010a). Plants adapt to stress situations with biochemical and physiological interventions (Lisar *et al.*, 2012). Water stress is principally caused by drought or high soil salinity which leads to water deficit and then it reduces plant growth by affecting various physiological and biochemical processes (Farooq *et al.,* 2008).

The drought severely affect the water balance of the plant body which cause changes in the water uptake mechanism of the plants. (Kmet *et al.*, 2009; Waraich *et al.*, 2011). Many crops such as tomato (Ragab *et al.*, 2007), soybean (Sakthivelu *et al.,* 2008; Hamayun *et al.*, 2010b), corn (Khoda-rahmpour, 2011) and citrus (Ben-Hayyim, 1987) are severely affected by the water stress. Tomato the major crop of the world (Aazami *et al.*, 2010) and Pakistan. In Pakistan it is cultivated over an area of 52300 hectares with 529600 tones annual production and 10.1 tonnes/hec is the average yield (Anon., 2011). The present study aimed to evaluate drought tolerant potential and compared the twenty six genotypes of tomatoes at different concentrations of PEG 6000.

## Materials and methods

*Plant Material*

The seeds of 26 genotypes of tomato were provided by the National Agriculture Research Centre (NARC) Islamabad. The chemicals were provided by the Department of Botany University of Azad Jammu and Kashmir Muzaffarabad.

*PEG Treatment*

The experiment was arranged in complete randomized block design with three replicates. Five treatments of Polyethylene glycol (PEG) Control, 5%, 7.5%, 10% and 12.5% were applied. The composite soil was used for the experiment. Morphological data for plant height, internodal length, root length and root diameter was recorded with the help of meter rod in centimeters. Number of leaves, number of branches, number of flowers, number of trusses and number of fruits were counted.

## Results and discussion

Polyethylene glycol showed significant effect on number of branches during growth of tomato when compared with control (without PEG-6000). The highest numbers of branches were found in control (10. 67) by genotype G 31-19289 (Fig 1-2). While lowest numbers of branches were when with maximum PEG 12.5% was applied in all genotypes. The longest shoot length was recorded in G 31- 19289 (184cm) at control (Fig 3) whilst the shortest was exhibited by G 19212 (20cm) at control (Fig 4). With increasing the PEG concentration the Tomato genotypes showed significant reduction in the plant height. The genotype G 31-19289 although showed a reduction in plant height but better growth pattern in comparison to all other genotypes. The highest number of leaves (97) were observed in genotype G 31- 19212 at control (Fig 5) and lowest number of leaves (12.33) were produced by G 8-19212 (Fig 6). The dose of PEG was inversely proportional to the number of leaves. All the genotypes were sensitive to drought from moderate to high. The highest number of flowers (138) are produced by the genotype G 31-19289 at control (Fig 7) followed by G 28- 17903 producing 84 (Fig 8). All the genotypes except G 31-19289 produced no flower at the highest concentration of PEG (12.5%). Most of the genotypes showed a continuous decrease in the number of flowers with increasing the concentration of PEG. Regarding the genotypes tested for drought tolerance, the maximum number of fruits (59) are produced by the genotype G 31-19289 followed by G 28- 17903 at control (Fig 9).

By increasing PEG concentration the numbers of fruits are also decreased in all genotypes. The data regarding number of trusses revealed that maximum number (56.34) were produced by the genotype G 31-19289 (Fig 10-11) and minimum (4) produced by the G Lo4360 (Fig 12-13). It was found that internodal distance was maximum at control and decreased to minimum at higher concentration of PEG. The maximum internodal distance (5.67) was shown in genotype G 7 -88527 (Fig 14) and minimum (1.84) by G 7-10593 (Fig 15-18). All the genotypes produced internodal distance ranged between 5.67 and 1.83. The mean root length ranged between 32cm to 13 cm, Root diameter is also important characteristic regarding the growth of the plant. The root diameter is also affected by the drought stress induced by the use of PEG.

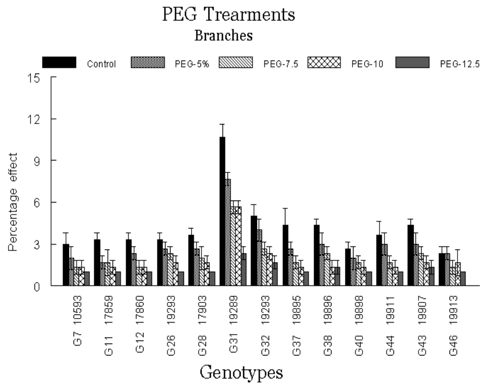


**Fig. 1.** Number of branches of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

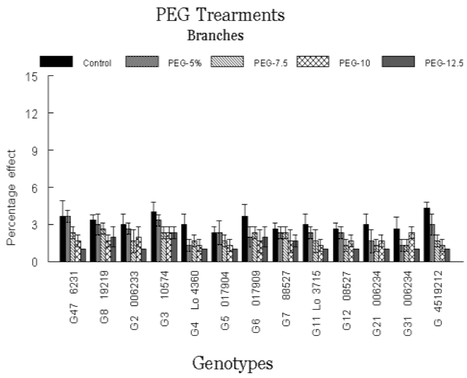


**Fig. 2.** Number of branches of tomato genotypes under different Polyethylene glycol concentrations. The values are means ± SD (n=3).

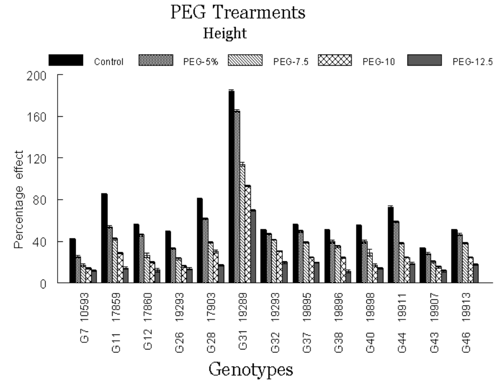


**Fig. 3.** Height (cm) of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

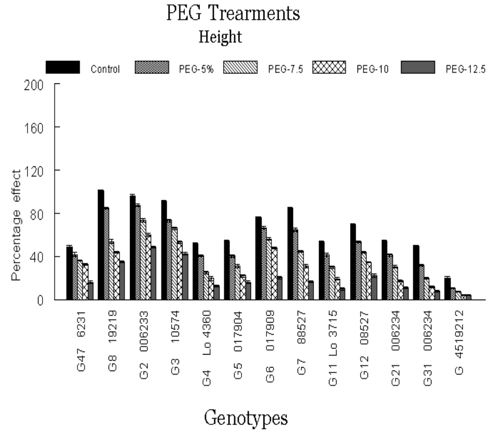


**Fig. 4.** Height (cm) of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

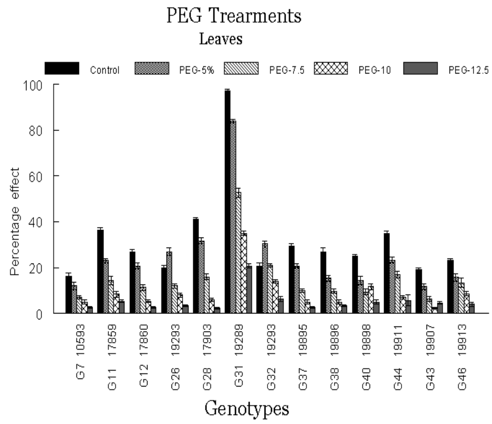


**Fig. 5.** Number of leaves of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

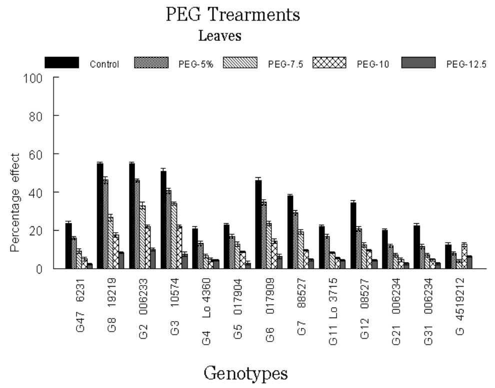


**Fig. 6.** Number of leaves of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

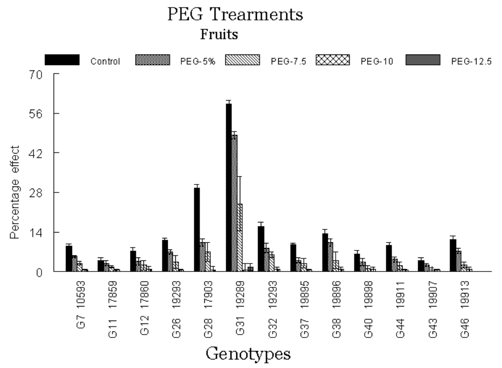


**Fig. 9.** Number of fruits of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

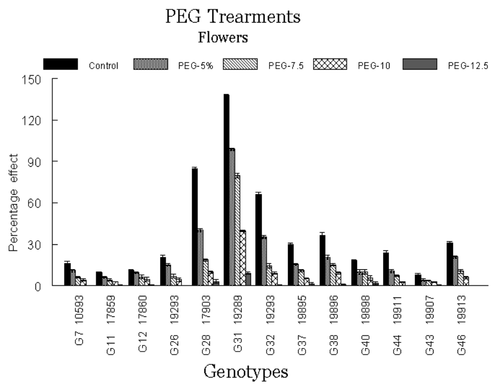


**Fig. 7.** Number of flowers of tomato genotypes under different PEG concentrations. The values are means ± SD (n=3).

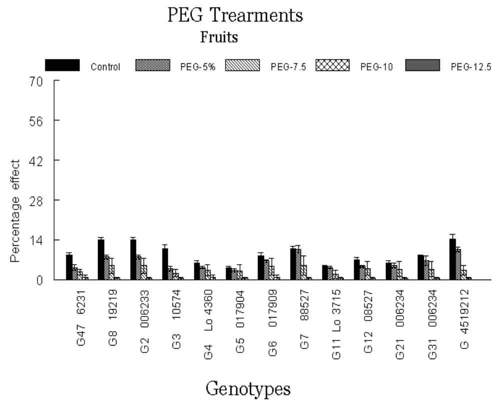


**Fig. 10.** Number of fruits of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

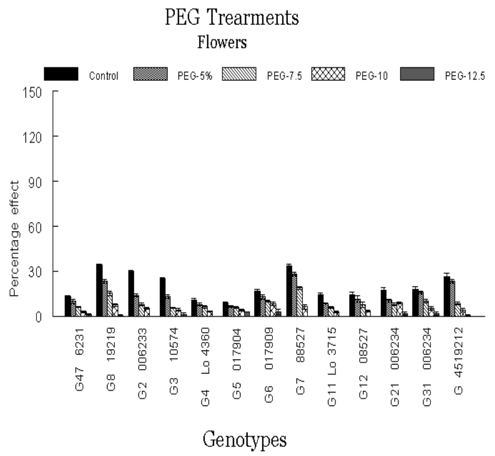


**Fig. 8.** Number of flowers of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

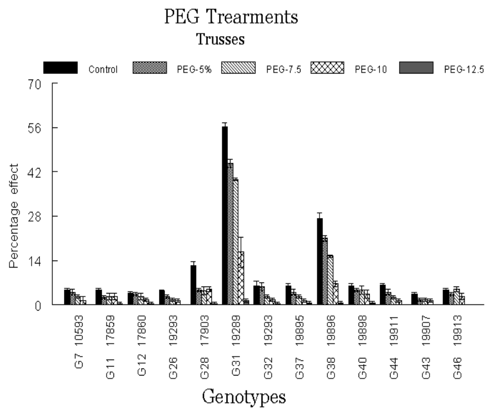


**Fig. 11.** Number of Trusses of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD(n=3).

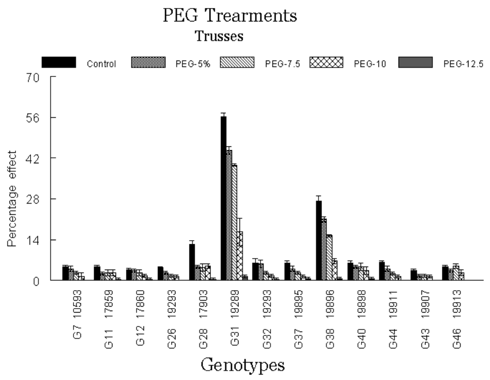


**Fig. 12.** Number of trusses of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

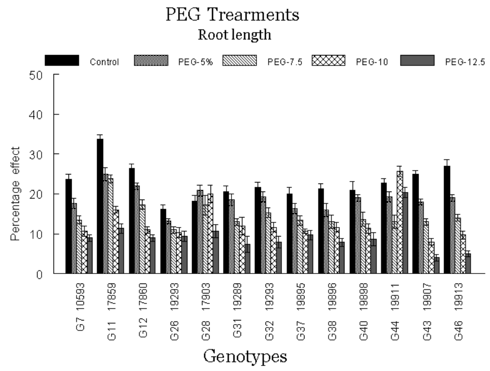


**Fig. 15.** Root length of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

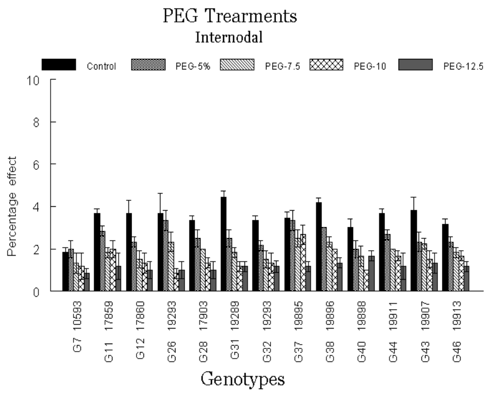


**Fig. 13.** Internodal distance of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

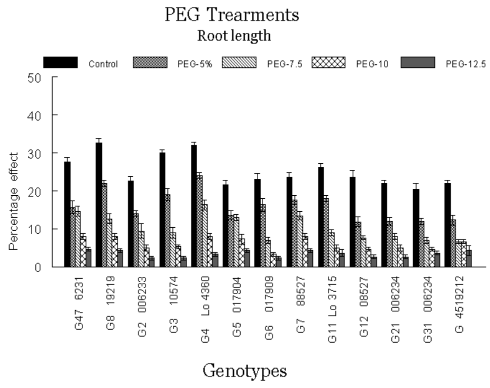


**Fig. 16.** Root Length of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

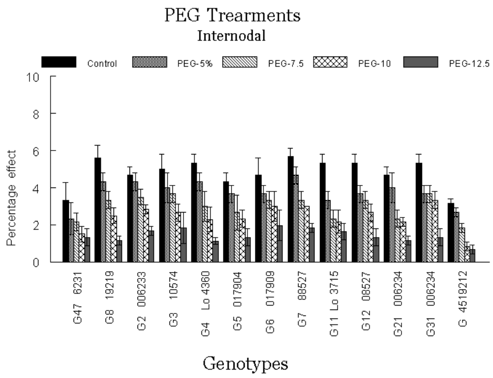


**Fig. 14.** Internodal distance of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

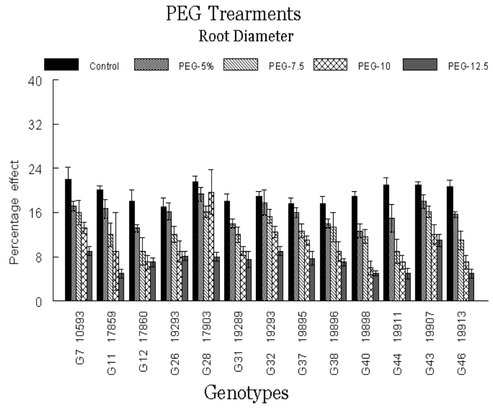


**Fig. 17.** Root diameter of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

The present study was conducted to produce the artificially drought stress by using the PEG6000 at different concentrations ranging between 5% to 12.5% on 26 different tomato genotypes at seedling stage. The results recorded during the experiment showed the different drought tolerance levels of the tomato genotypes and a significant effect of drought stress on the growth of the tomato genotypes was observed.

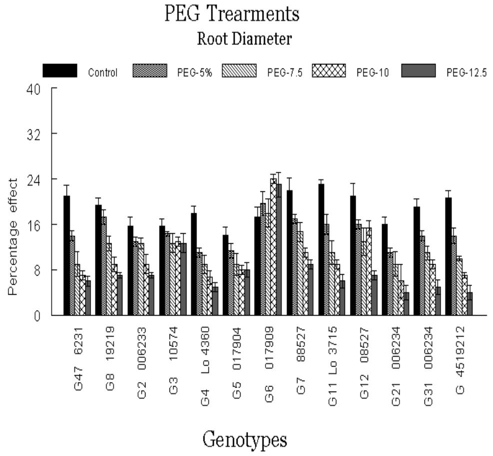


**Fig. 18.** Root diameter of tomato genotypes under different Poly ethylene glycol concentrations. The values are means ± SD (n=3).

A common observed phenomenon due to stress is the decline in the different characters of the plants which ultimately shows the tolerance level of the plants. The reduced growth under the drought stress is not a unusual phenomenon and is reported in many plant crops (Waseem *et al.*, 2006; Kulkarni & Deshpande, 2007; Jajarmi, 2009; Hamayun *et al.*, 2010b; Sultan, *et al.,* 2012; Shinwari, *et al.,* 2013 ).

A reduction in the growth rate in tomato genotypes under drought stress produced by PEG was also studied by Aazami *et al.*, (2010). Abdel-Raheem *et al.*, (2007) reported a decline in the shoot growth in tomato under osmotic stress conditions induced by PEG. Kulkarni & Deshpande, (2007) also reported a significant reduction in the shoot length of tomato grown under drought stress induced by using different concentrations of PEG. Seedling biomass affected by PEG solution in tomato has also been recorded by Nahar & Gretzmacher (2002).

The Reduction in root lengths under osmotic stress conditions has also been reported in sunflower (Jajarmi, 2009) and pea (Whalley *et al.*, 1998).

The tomato genotypes used in the present study have shown low growth level when compared to normal growth conditions. This character is because plants have the capacity to tolerate the water deficit conditions (Oliveira *et al.*, 2011) and those genotypes which perform better growth are considered to be the drought tolerant. The foliar application of minerals can be used to enhance the growth and yield of tomato (Azeem & Ahmad, 2011).

A tolerant mechanism may be present in those genotypes which show positive behavior under stressed conditions when compared to those under controlled conditions, which makes plants to retain the good turgor pressure and high level of water contents under stressed conditions (Saxena & O' Toole, 2002).

Hence genotypes which have ability to elongate the root length under stress conditions and root length is retained by extracting water under stress conditions are considered to be stress tolerant (Kulkarni & Deshpande, 2007).

Though the genotype G 31-19289 had the highest value of root length and biomass, it seems that the genotypes have advanced the root growth and biomass at the cost of shoot development. However, the internal physiological investigation is needed for assessing their variable response.

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