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Evaluation of Rice Hybrids Under Artificial Drought Stress by Using Polyethylene Glycol (PEG)

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Abstract

The current climate change is arising as a serious risk to the global food security because it disturbs the crop productivity by creating drought conditions. Integrated approaches are needed to enable the crop plants to combat this alarming issue. The act of identification and development of resistive genotypes through various techniques, served as an interesting solution to this alarming issue. Current study was conducted in order to scrutinize the drought tolerance among various rice hybrids i.e., G-50, G-403, LP-18, WDR-73 by using polyethylene glycol (PEG). All hybrids were grown hydroponically in petri plates by using four different PEG levels (0%, 10%, 20% and 30% PEG). After two weeks' different phenotypic parameters i.e., germination percentage, mortality rate, number of roots, shoot length, root length, fresh weight and dry weight were studied in order to observe the resistance of the hybrids towards drought. After comprehensive examination we observed that among all five hybrids, G-50 and G-403 showed better results for the above-mentioned phenotypic traits which indicates its high resistance towards drought as compared to control and other hybrids. The hybrid G-50 and G-403 shows 15-10 % and 5-10 % enhancement in all parameters respectively. The results suggested that the two rice hybrids i.e., G-50 and G-403 are suitable for drought affected areas in order to ensure the food security.

Keywords: Climate change; Drought; Rice crop; PEG

Introduction

The changing climate of the world has been arising as the most problematic issue for the society today [1,2]. Climate change, also known as global warming, refers to an increase in average surface temperature on earth which may be exposed through some compelling evidence [3]. Climate change is now an increasingly significant concern because of its large socio-economic consequences. The climate of earth is changing continuously because of various natural and anthropogenic agents [4]. It has been observed from different experiments that large explosive volcanic eruptions are the main culprits of natural climate change over the past centuries by releasing a huge amounts of particulate matter (ash) and gases into the stratosphere [5]. On the other hand, the anthropogenic climatic variability arises due to various human activities such as industrialization, deforestation and release of different greenhouse gases. It is predicted that extreme climate change will increase the intensity of the extreme events. i.e., floods, droughts, hurricanes etc. [6]. Among various disasters arising due to changing climatic conditions the most detrimental one to the whole world is drought. Drought is a global problem, significantly limiting worldwide crop production and ongoing global climate change have actually made things more serious [7-10]. Drought is considered as one of the most important environmental stress that influences all forms of life. Soil microbes are considered as fertility enhancers [11], thus

drought have dramatically adverse effects especially on plants, its growth, development and microbes etc. Hence, it is viewed as an important challenge to agricultural researchers. In the current scenario, drought is arising as a major threat to the global food security as it has made interference in the performance of rice crop which provides nutrition to more than three billion people and comprising 50-80% of their daily calorie intake [12]. Many poor countries are facing the problem of food items and nutrients deficiency problems [13]. Rice (*Oryza sativa* L.) is important crop [14] and locally known as Chawal. It is served as staple food which aims for ensuring food security sustainable livelihoods for millions of people of more than half the world's population. Rice requires ample amount of water for its production but the whole world especially Pakistan is facing water crisis day by day due to climate change effects and per capita water consumption due to increase of population. Under these scenario rice varieties/ hybrids development is need of the day that can withstand with limited water resources. Different approaches have already been used from period to period to classify drought tolerant gene variants for this purpose and measures have been taken in the old days to monitor tomato varieties that vary in drought resistance [15].

Numerous studies demonstrated that one of the reliable approaches to the selection of suitable genotypes for thorough analysis of water shortage on plant germination indices is the *in vitro* screening strategy using PEG [16]. Polyethylene glycol (PEG) derivatives have been used to cause osmotic pressure in the petri plates (*in vitro*) during the experimental phase for plants to keep a consistent water capacity. In several studies, polyethylene glycol (PEG) has also been used to screen drought-tolerant germplasm as an abiotic stress enhancer [17]. PEG is a polymer and considered as better chemical than others to induce water stress artificially [18]. PEG induced osmotic stress is inductee to decrease cell water potential [19]. In some crop plants, the rise in PEG concentration triggered a decline in the percentage of germination and seedling vigour [20]. Keeping in mind about conditions, current study was planned to explore such type of rice genotypes that have higher tolerance to drought.

Material and Methods

Experimental site

Present experiment was conducted in the crop physiology laboratory of Crop Sciences Institute (CSI) at National Agriculture Research Center Islamabad (NARC) during 2019.

Experimental design and treatments

To conduct this CRD factorial experiment, five rice hybrids named as pearl super, G-50, G-403, LP-18, WDR-73 were taken from Rice Research Program, CSI, NARC. These hybrids were tested against artificial drought created through different concentration (0%, 10%, 20% and 30%) of polyethylene glycol (PEG) in test tubes with three number of replications.

Methodology

Forty test tubes were taken and washed properly by using detergents. The PEG solution (w/v) of different concentrations were prepared as 0% (PEG solution mean only distilled water), 10% (PEG solution; 5 gram of polyethylene glycol in 50ml distilled water), 20% (PEG solution 10 gram of polyethylene was dissolved in 50ml distilled water) and 30% (PEG solution 15gram of polyethylene glycol was dissolved in 50ml distilled water).

After preparation, one large filter paper was divided into 40 small equal pieces according to tube size and kept it in water for soaking. After complete soaking of filter paper, took the one small piece of filter paper and spread it in petri dish and placed 10 seeds of one hybrid in it and folded it and placed it inside the test tube having labeled with the name of concern hybrid. Similarly repeated the same process for all rice hybrids. After filling all tubes with filter paper having rice seeds, 5ml of specific solution (0%, 10%, 20% and 30%) was added to each tube according to its label i.e., T1, T2, T3 and T4. After the completion of the whole process the stands were taken into darker side in the laboratory and kept it there to germinate.

Data collection

The data regarding germination percentage, mortality rate, number of roots, shoot length, root length, fresh weight and dry weight were collected after seven days of the experiment initiation.

Statistical analysis

The data were analyzed statistically by using Fisher analysis of variance technique and treatments means were compared by using the least significant difference test (LSD) at 0.05 probability [21].

Results and Discussion

Germination percentage

Germination Percentage of rice was significantly influenced due to the treatment (Figure 1). Data indicated that hybrid G-50 showed highest germination at 20% PEG which shows it was highly resistant to drought stress. Similarly, the remaining four hybrids named pearl super, G-403, LP-18 and WDR-73 showed highest germination at 20% PEG, 30% PEG, 10% PEG and 20% PEG respectively. These results are confirmed by the findings of [22].

Mortality rate

Mortality rate of rice was significantly influenced due to the treatments (Figure 2). Data indicated that hybrid G-50 had lowest mortality rate, 0% at 30% PEG which shows its resistance to drought stress. Similarly, the remaining four hybrids named pearl super, G-403, LP-18 and WDR-73 showed lowest mortality rate at 30% PEG, (30% & 20% PEG), 10% PEG and 30% PEG respectively. These results are confirmed by the findings of [20].

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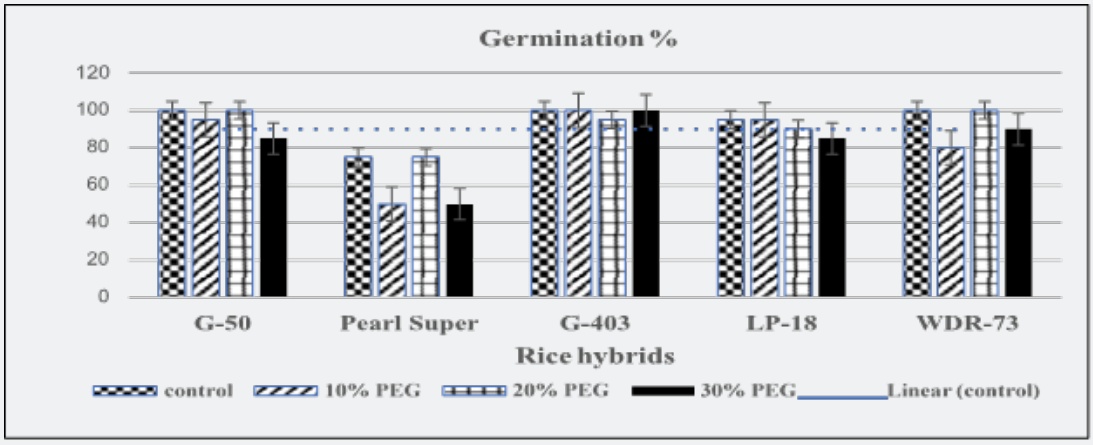

Figure 1: Germination % of rice hybrids seedlings at different PEG levels.

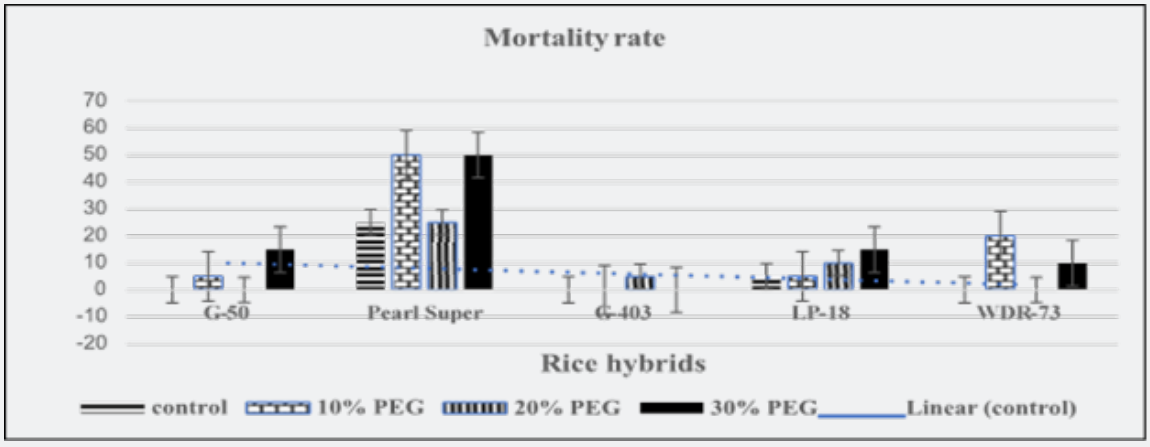

Figure 2: Mortality rate of rice hybrids seedlings at different PEG levels.

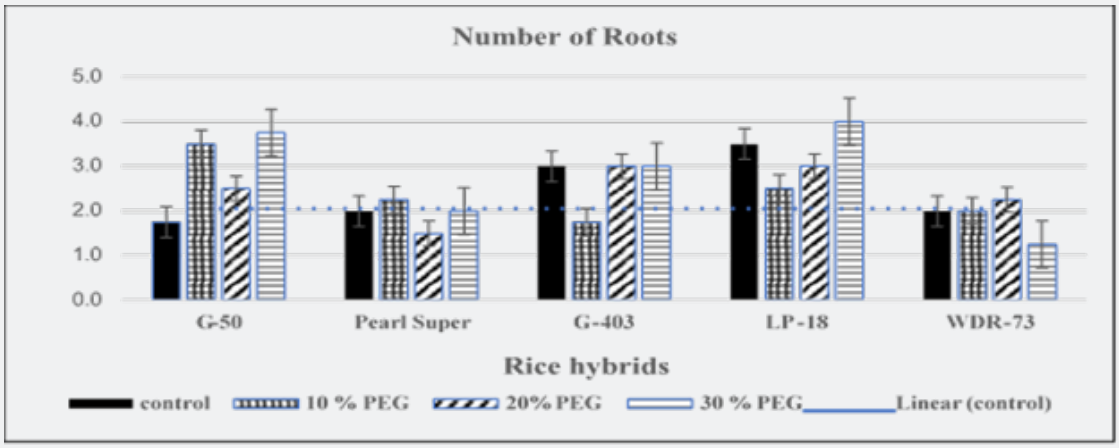

Figure 3: Number of roots of rice hybrids seedlings at different PEG levels.

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Number of roots

Number of roots of rice was significantly influenced due to the treatment (Figure 3). Data indicated that hybrid G-50 showed maximum number of roots, 3.8 at 30% PEG which shows that it was highly resistant to drought stress. Similarly, the remaining four hybrids, pearl super, G-403, LP-18 and WDR-73 showed maximum number of roots, 2.3, 3, 4, 2.3 at 10% PEG, 30% PEG, 30% PEG and 20% PEG respectively. These results are confirmed by the findings of [23].

Shoot length

Shoot length of rice was significantly influenced due to the treatments (Figure 4). Data indicated that hybrid G-50 showed maximum shoot length, 9.91cm at 30% PEG which shows that it was highly resistant to drought stress. The remaining three hybrids named pearl super, G-403 and LP-18 showed reduction in shoot length under different PEG levels as compared to controls while the hybrid WDR-73 showed greater shoot length at 10% PEG. These results are confirmed by the findings of [24].

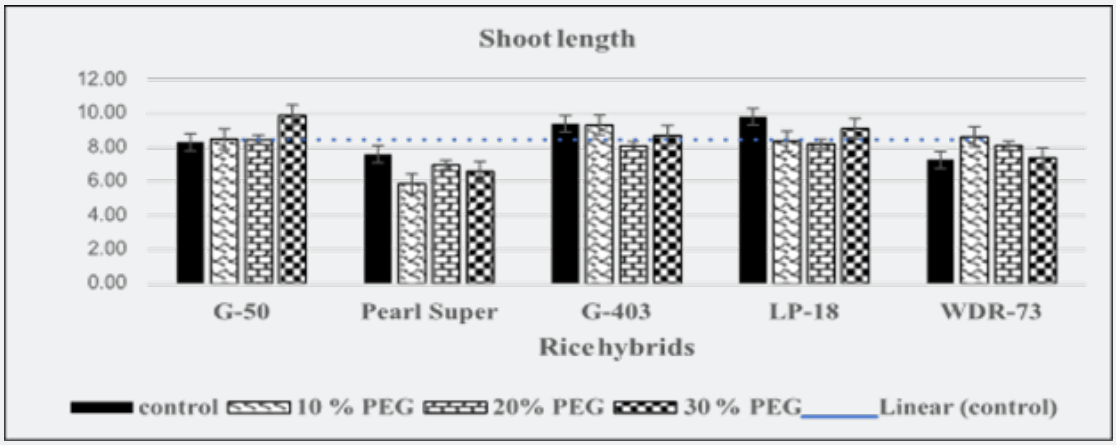

Figure 4: Shoot length of rice hybrids seedlings at different PEG levels.

Root length

Root length of rice was significantly influenced due to the treatments (Figure 5). Data indicated that hybrid G-50 showed maximum root length, 16.31cm at 10% PEG which shows that it was highly resistant to drought stress. In the given figure hybrids named pearl super and LP-18 showed reduction in root length under different PEG levels as compared to controls while the hybrids G-403 and WDR-73 showed greater shoot length 14.01cm and12.66 at 10% PEG and 20% PEG respectively. The figure shows that among the five hybrids the hybrid G-50 showed maximum shoot length, 16.31 cm at 10% PEG, [25] hence showing greater resistance under drought condition compared to remaining four hybrids.

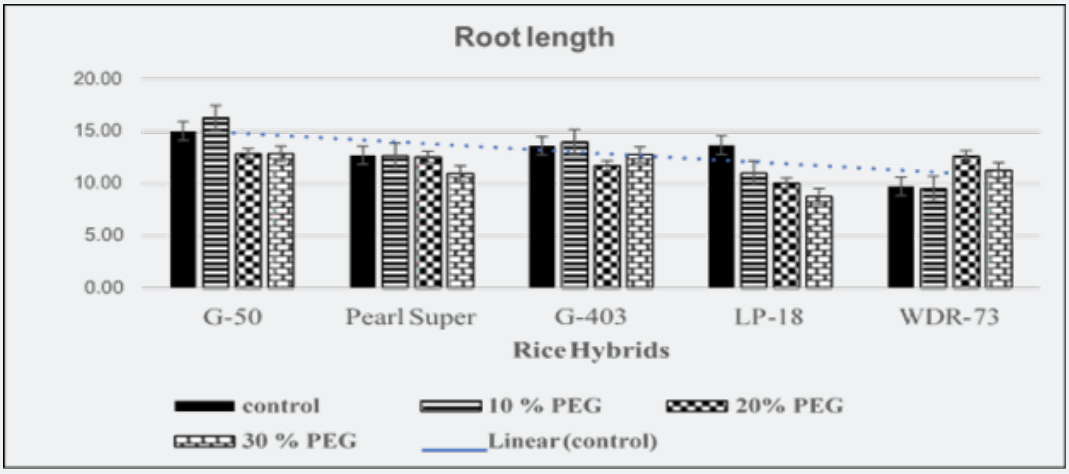

Figure 5: Root length of rice hybrids seedlings at different PEG levels.

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Fresh weight

Fresh weight of rice was significantly influenced due to the treatments (Figure 6). Data indicated that hybrid G-50 showed maximum fresh weight 225 mg at 30% PEG which shows that it is highly resistant to drought stress. Similarly, the remaining four hybrids named pearl super, G-403, LP-18 and WDR-73 showed maximum fresh weight 160, 165, 205 and 250mg at 30% PEG, 30% PEG, 20% PEG and 10% PEG respectively. The figure shows that among the five hybrids the hybrid WDR-73 showed maximum fresh weight 250mg at 10% PEG, hence showing greater resistance under drought condition compared to remaining four hybrids. These results are confirmed by the findings of [23].

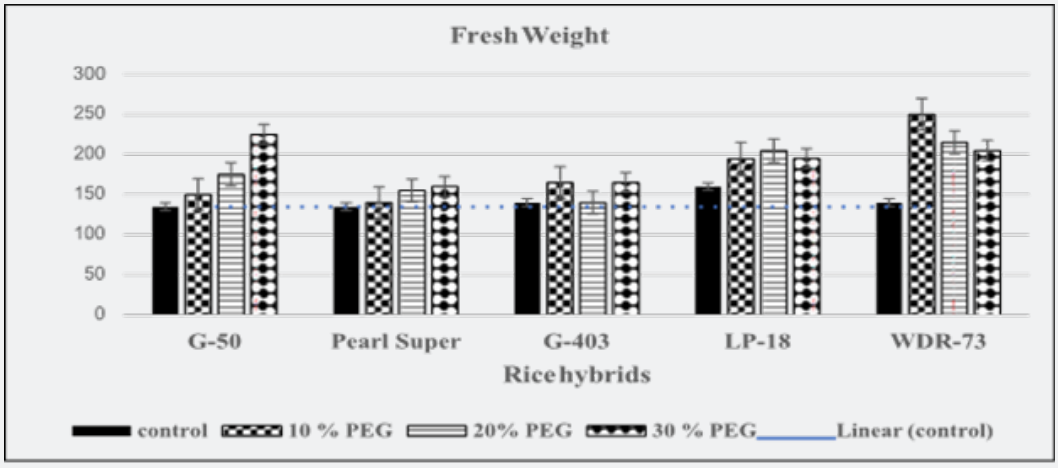

Figure 6: Fresh Weight of rice hybrids seedlings at different PEG levels.

Dry weight

Dry weight of rice was significantly influenced due to the treatments (Figure 7). Data indicated that hybrid WDR-73 showed maximum dry weight 60mg at 30% PEG which shows that it is highly resistant to drought stress. Similarly, the two hybrids named G-403 and LP-18 showed maximum dry weights 45 and 50mg at 20% PEG, and 30%PEG respectively. While the hybrid G-50 showed reduction in dry weights under different PEG levels as compared to control and hybrid, Pearl Super do not show any response to various PEG stress levels. The figure shows that among the five hybrids the hybrid WDR-73 showed maximum dry weight 60mg at 30% PEG, [26] hence showing greater resistance under drought condition compared to remaining four hybrids.

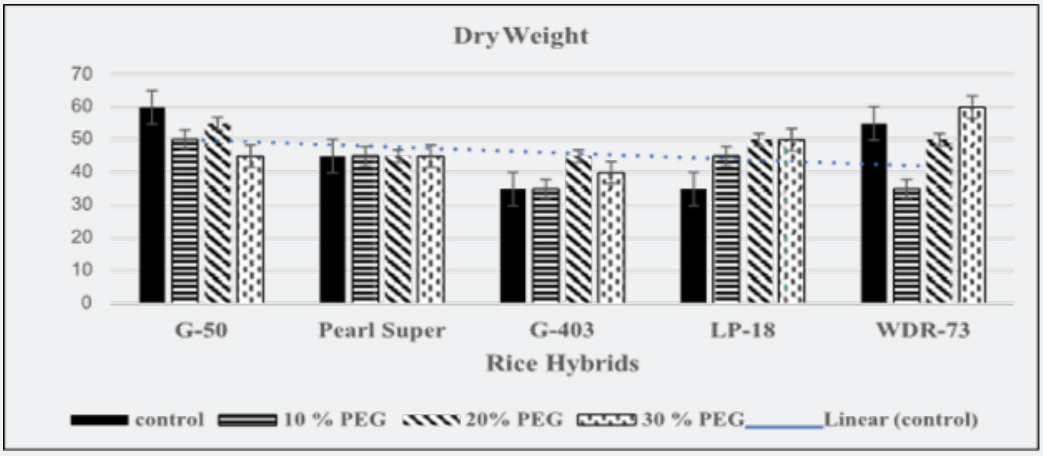

Figure 7: Dry Weight of rice hybrids seedlings at different PEG levels.

Conclusion

On the basis of above result and discussion it is concluded that among all the five hybrids, two hybrids named as; G-50 and G-403 are the most drought resistant hybrids. Both of the hybrids showed its better performance from the enhancement of its shoot and root length as compared to control one. On the basis of its

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improved shoot and root growth in the drought condition we recommend it as suitable for dry areas in order to ensure food security. It is further recommended that the performance of the resistive two hybrids can be enhanced more by working on its genotypic aspects in the future.

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References

1. Toor MD, Rehman FU, Adnan M, Kalsoom M, Shahzadi L (2020a) Relationship between Environment and Agriculture. A Review. Sun Text Review of Biotechnology 1: 1-5.

2. Hadi A, Naz N, Rehman FU, Kalsoom M, Tahir R, et al. (2020) Impact of Climate Change Drivers on C4 Plants: A Review. Current Research in Agriculture and Farming 1(4): 13-18.

3. Dabi T, Khanna VK (2018) Effect of climate change on rice. Agrotechnology 7: 2-7.

4. Wahid F, Sharif M, Ali A, Fahad S, Adnan M, et al. (2020) Plant-Microbes Interactions and Functions in Changing Climate. In: Fahad S. et al. (Eds.), Environment, Climate, Plant and Vegetation Growth. Springer, Cham, pp. 397-419.

5. Jungclaus JH, Lorenz SJ, Tamarack C, Reick CH, Brovkin V (2010) Climate and carbon-cycle variability over the last millennium. CP 6: 723-737.

6. Seneviratne SI, Donat MG, Mueller B, Alexander LV (2014) No pause in the increase of hot temperature extremes. Nature Climate Change 4: 161-163.

7. Ali A, Adnan M, Abbas A, Javed MA, Safdar ME, et al. (2020) Comparative performance of various maize (*Zea mays* L.) cultivars for yield and related attributes under semi-arid environment. An International Journal Agricultural and Biological Research 36(4): 63-66.

8. Bayoumi TY, Manal H, Eid EM Metwali (2008) Application of physiological and biochemical indices as a screening technique for drought tolerance in wheat genotypes. African Journal of Biotechnology 7(14): 2341-2352.

9. Toor MD, Adnan M, Javed MS, Habibah U, Arshad A, et al.(2020b) Foliar application of Zn: Best way to mitigate drought stress in plants; A review. International Journal of Applied Research 6(8): 16-20.

10. Adnan M (2020) Application of Selenium; A Useful Way to Mitigate Drought Stress; A Review. Open Access Journal of Biogeneric Science and Research 3(1): 1-4.

11. Ilahi H, Wahid F, Ullah R, Adnan M, Ahmad J, et al. (2020) Evaluation of Bacterial and Fertility Status of Rawalpindi Cultivated Soil with Special Emphasis on Fluoride Content. International Journal of Agricultural and Environmental Research-IJAAER 6(3): 177-184.

12. Al-Ashkar IM, Zaazaa EI, Barutçular C (2016) physio-biochemical and molecular characterization for drought tolerance in rice genotypes at early seedling stage. Journal of Experimental Biology and Agricultural Sciences 4(6): 675-687.

13. Saeed MS, Saeed A, Adnan M (2020) Production and Utilization of Single Cell Proteins-An Overview. Current Research in Agriculture and Farming 1(4): 9-12.

14. Chadhar AR, Nadeem MA, Ali HH, Safdar ME, Raza A, et al. (2020) Quantifying the Impact of Plant Spacing and Critical Weed Competition Period on Fine Rice Production under the System of Rice Intensification. International Journal of Agriculture and Biology 24(5): 1142-1148.

15. George S, Jatoi SA, Siddiqui SU (2013) Genotypic differences against PEG simulated Drought Stress in Tomato. Pakistan Journal of Botany 45(5): 1551-1556.

16. Sakthivelu G, Devi MKA, Giridhar P, Rajasekaran T, Ravishankar GA, et al. (2008) Drought- induced alterations in growth, osmotic potential and in vitro regeneration of soybean cultivars. General and Applied Plant Physiology 34(1-2): 103-112.

17. Jatoi SA, Latif MM, Arif M, Ahson M, Khan A, et al. (2014) Comparative Assessment of Wheat Landraces against Polyethylene Glycol Simulated Drought Stress. Science, Technology and Development 33(1): 1-6.

18. Kaur S, Gupta AK, Kaur N (1998) Gibberellic acid and kinetin partially reverse the effect of water stress on germination and seedling growth in chickpea. Plant Growth Regulation 25: 29-33.

19. Govindaraj M, Shanmuga SP, Sumathi P, Muthiah AR (2010) Simple, rapid and cost-effective screening method for drought resistant breeding in pearl millet. Electronic Journal of Plant Breeding 1(4): 590-599.

20. Khodarahmpour Z (2011) Effect of drought stress induced by polyethylene glycol (PEG) on germination indices in corn (*Zea mays* L.) hybrids. African Journal of Biotechnology 10(79): 18222-18227.

21. Steel RG, Torrie JH, Dickey DA (1997) Principal and procedure of statistics: A biometrical approach. (3rd edn), McGraw Hill Book Co., New York, USSA.

22. Muscolo A, Sidari M, Anastasi U, Santonoceto C, Maggio A (2014) Effect of PEG-induced drought stress on seed germination of four lentil genotypes. Journal of Plant Interactions 9(1): 354-363.

23. Ming DF, Pei ZF, Naeem MS, Gong HJ, Zhou WJ (2012) Silicon alleviates PEG-induced water-deficit stress in upland rice seedlings by enhancing osmotic adjustment. Journal of Agronomy and Crop Science 198(1): 14-26.

24. Whalley WR, Bengough AG, Dexter AR (1998) Water stress induced by PEG decreases the maximum growth pressure of the roots of pea seedlings. Journal of Experimental Botany 49(327): 1689-1694.

25. Danish S, Zafar UH, Hussain M, Shaaban M, Núñez DA, et al. (2019) Rhizobacteria with ACC-deaminase activity improve nutrient uptake, chlorophyll contents and early seedling growth of wheat under PEG-induced osmotic stress. International Journal of Agriculture and Biology 21: 1212-1220.

26. Ragab AR, Abdel Raheem AT, Kasem ZA, Omar FD, Samera AM (2007) Evaluation of R1 tomato somaclone plants selected under poly ethylene glycol (PEG) treatments. African Crop Science Society 8: 201-202.

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