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Studying the Azerbaijani barley accessions to drought Stress Induced by Polyethylene glycol (PEG)

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Abstract

Population growth and climate change necessitate the expansion of agricultural products. Drought stress has a significant impact on crop growth as a result of global warming. Drought stress can occur at any stage of plants growth and reduce production. One of the most important crops with high resistance to environmental abiotic stresses is barley (Hordeum vulgare). In order to choose the best barley accessions resistance to drought stress, 8 barley genotypes with different levels of (PEG) 0, -3, -6 and -9 bar were tested in a randomized complete block design with three replications at Khazar University's Center for Cell Pathology Research laboratory in November 2022. Traits such as root length, coleoptile length, plumule length, weight dry matter, percentage and rate of germination were measured. Selected drought tolerance genotypes can be used in barley breeding programs.

Keywords: Barley, Drought stress, Polyethylene glycol (PEG), Germination

Introduction

Drought stress (Ds) is one of the most serious and widespread environmental stresses on the planet. Ds, the most prevalent abiotic cause, has impacted agricultural production and growth (Kour D, et al., , 2019). Drought stress can be caused by any human or natural environmental actions (Shahid S, *et al*., 2018). Due to climate change, global warming, and water shortages, drought stress is inevitable (Sallam, Alqudah, Dawood, Baenziger, & Börner, 2019). Azerbaijan is located in the south Caucasus and has a variety of climates, including particularly hot summers with temperatures raising up to 40 to 45 degrees Celsius. Drought-tolerant cultivar selection is vital for sustainable agricultural production. Barley (*Hordeum vulgare)* belongs to the cereal grass family, one of the primary crops that has been domesticated and used as human food and livestock feed as well as the beverage industry (Stein and Muehlbauer 2018). Due to high resistance to environmental changes and its diploid genome, barley has been implemented in breeding programs, wheat studies as a model and genetic resource (Ullrich, 2010). Plant physiological condition and changes play a significant part in drought stress tolerance; for example, proline regulates plant osmosis and prevents leaf chlorophyll degradation under stress conditions (Miller G, *et al*., 2005). Ds can occur at any point of plant growth and has the highest effect on yield loss (Kadam, 2014). Ds influences germination and the early development stage of barley.

This study was conducted to investigate genetic diversity among barley accessions under drought stress, comparing genotypes' responses to different levels of drought, and selecting drought tolerance barley accessions for use in breeding programs.

Material and method

This research has been conducted at Center for Cell Pathology Research laboratory, Khazar University, in November 2022. Seeds were obtained from the National Gene bank of Azerbaijan, ANAS (Azerbaijan National Academy of Sciences' Genetic Resources Institute). To estimate drought stress on seedling growth of barley cultivars, a completely randomized design (CRD) with 3 replicates was used (N=24). In this research 8 barley genotypes (table 1) with different levels of PEG (0, -3, -6 and -9 bar) were tested. Seeds were sterilized in sodium hypochlorite solution 2.5% for 10 minutes and after 3 times washed with distilled water. Seeds of each genotype as per treatment are placed on filter paper in petri dish with a diameter of 9 cm. Ten milliliters of concentration in varying levels of drought were given to each treatment. Petri dishes were kept for 8 days at room temperature of 20–22 °C with 16 hours of light and 8 hours of darkness for seven days. Polyethylene glycol (PEG) at pressures of 0, -3, -6 and -9 bar was used for the initial irrigation, and distilled water was utilized for the subsequent irrigation. Lids were used to avoid evaporation.

Barley morphological treats such as root length, coleoptile length, plumule length, weight dry matter, percentage and rate of germination were measured. The mean squares for the traits under study were calculated using the SPSS software and the Tukey test and Excel's bar-drawing software.

Table 1. Barley genotypes and gene bank code

No.	Code	Cultivar
1	2540	*Hordeum vulgare* var. nigropallidum
2	8830	*Hordeum vulgare* var. pallidum
3	8834	*Hordeum vulgare* var. nutans
4	8837	*Hordeum vulgare* var. nutans
5	8842	*Hordeum vulgare* var. nutans
6	8845	*Hordeum vulgare* var. erectum
7	8846	*Hordeum vulgare* var. pallidum
8	8853	*Hordeum vulgare* var. pallidum

Results and discussion

Based on the result of ANOVA data analysis, drought stress had significant effect on all treats such as root length, coleoptile length, plumule length, weight dry matter and rate of germination. Also, analysis shows high genetic variation among barley accessions based on the drought stress traits (table 2).

Barley genotype 5 and 8 have the highest coleoptile length by 5.1 cm and 4.12 cm among all seeds and 3.28 cm & 1.35 cm (in order) growth in -0.9 level of PEG, but first barley accession with 3.82 cm coleoptile growth as third longest length at control level had no growth at -0.9 level of PEG (table 3). The same highest numbers were studied for root and plumule length in both genotype no 5 and no 8. Root length increased in all genotypes at level -0.3 bar in comparison with control level, except genotype no 2, 6 & 7. First and second genotypes showed high germination rate as 1.7and germination rate decreased in almost all genotypes by increasing PEG levels (figure 1). Hellal reported that PEG% had a negative effect on the germinated seeds in the early stage (Hellal *et al*., 2018)

Table 2. main squares for studied traits of barley accessions evaluated under PEG treatment

TRAITS	REP.	LE.	GENO.	G×LE	ERROR
DF	1	3	7	21	31
COL.	0.005 $^{n.s}$	7.48**	5.66**	0.24**	0.06
ROOT	1.23 $^{n.s}$	26.73**	25.47**	7.14**	0.46
PLUM	0.74 $^{n.s}$	208.73**	14.16**	1.48 $^{n.s}$	3.32
WEIGH	0.32 $^{n.s}$	1.9*	1.39*	1.27 $^{n.s}$	0.54
PER	6.89 $^{n.s}$	11264.3**	462.85**	207.62**	15.66
RATE	0.05 $^{N.S}$	2.19**	1.2*	0.08 $^{N.S}$	0.088

Table 3. effect of different levels of PEG on barley growth.

	COLEOPTILE LENGTH				ROOT LENGTH				PLUMULE LENGTH			
	0	**-0.3**	**-0.6**	**-0.9**	**0**	**-0.3**	**-0.6**	**-0.9**	**0**	**-0.3**	**-0.6**	**-0.9**
1	3.82	3.42	2.92	0	5.77	7.15	5.64	0	14.51	16.02	7.325	0
2	3.15	2.35	2.52	1.31	6.78	5.6	4.39	0	9.8	7.51	7.19	0
3	1.95	1.51	1.33	0.99	4.81	9.5	6.16	4.12	11.6	10.35	8.51	2.6
4	2.26	1.95	1.67	1.38	2.7	4.01	1.97	1.81	10.25	11.82	7.65	6.55
5	5.1	3.98	3.61	3.28	6.12	9.79	5.55	11.24	14.44	12.54	6.21	4.5
6	2.32	1.85	1.79	0.65	7.87	3.73	2.99	0	10.27	7.37	6.78	0
7	3.51	3.04	1.73	0	5.14	3.99	2.7	0	10.24	9.53	6.02	0
8	4.12	3.12	2.74	1.35	10.63	7.49	4.44	3.92	13.24	10.16	5.14	3.15

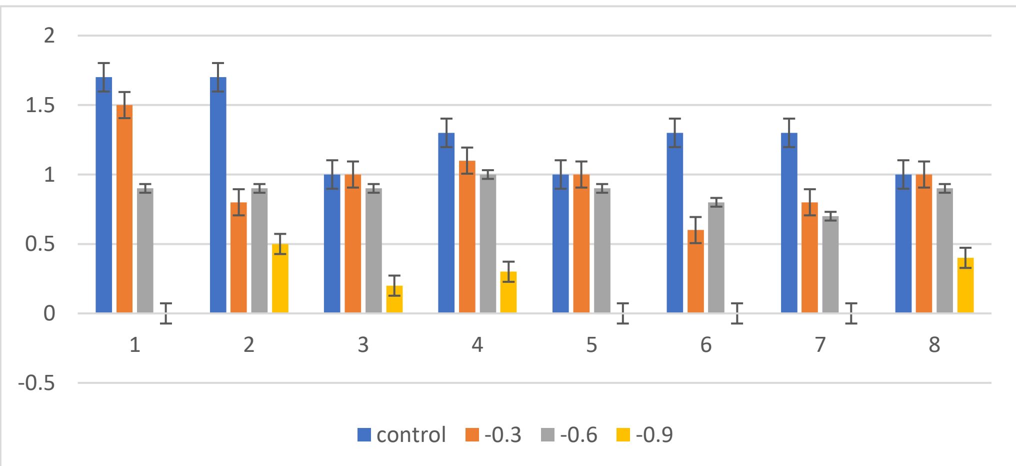

Figure 2. germination rate of barley cultivars affected by PEG levels

References

Hellal, F. A., El-Shabrawi, H. M., Abd El-Hady, M., Khatab, I. A., El-Sayed, S. A. A., & Abdelly, C. (2018). Influence of PEG induced drought stress on molecular and biochemical constituents and seedling growth of Egyptian barley cultivars. *J Genet Eng Biotechnol, 16*(1), 203-212. doi:10.1016/j.jgeb.2017.10.009

Kadam, N. N. (2014). Agronomic and physiological responses to high temperature, drought, and elevated CO2 interactions in cereals. . In Advances in agronomy , Vol. 127, pp. 111-156. Academic Press.

Kour D, et al., . (2019). Drought-Tolerant Phosphorus-Solubilizing Microbes: Biodiversity and Biotechnological Applications for Alleviation of Drought Stress in Plants. In: Sayyed R., Arora N., Reddy M. (eds) Plant Growth Promoting Rhizobacteria for Sustainab Microorganisms for Su. Springer, Singapore., vol 12. https://doi.org/10.1007/978-981-13-6536-2_13.

Miller, G., H. Stein, A. Honig, Y. Kapulnik and A. Zilberstein. (2005). Responsive modes of Medicago sativa proline dehydrogenase genes during salt stress and recovery dictate free proline accumulation. Planta 222: 70-79

Sallam, A., Alqudah, A., Dawood, M., Baenziger, P., & Börner, A. (2019). Drought Stress Tolerance in Wheat and Barley: Advances in Physiology. Breeding and Genetics Research. International Journal of Molecular Sciences., 20(13):3137. doi:https://doi.org/10.3390/ijms20133137

Ullrich, S. E. (2010). Barley: Production, improvement, and uses . (Vol. 12). John Wiley & Sons.