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DETERMINING THE DROUGHT TOLERANCE OF WINE GRAPE VARIETIES USING PEG-6000-INDUCED OSMOTIC STRESS

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Abstract
In the article, the drought tolerance of the grape varieties Plechistik and Muscat Yursky is evaluated under in vivo conditions using different concentrations (0%, 2%, 4%, 6%) of PEG-6000 (polyethylene glycol). The cuttings were studied based on shoot and root development indicators, biomass parameters, chlorophyll content, leaf turgor weight, and tolerance indices. The results showed that as the PEG concentration increased, all vegetative and physiological parameters of the plants significantly decreased, with the 4% and 6% PEG concentrations causing the strongest stress responses. The findings of the study provide an important basis for selecting and breeding drought-tolerant grapevine varieties.

Keywords: PEG-6000, grape, varity,stress of drought, shoot growth, rooting rate, physiological parameters, drought tolerance, in vivo, breeding.

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Introduction

The impact of abiotic stress caused by global warming is becoming increasingly evident worldwide. The negative consequences of global climate change may affect not only plants but also all living organisms and their ecological balance." [1].

Stress is defined in the literature as any factor that slows down plant growth and development or disrupts its metabolism. A plant's ability to withstand such conditions is referred to as stress tolerance 222. Throughout their life cycle, plants are exposed to various stress conditions, which often occur simultaneously 333. Drought stress occurs when water uptake through the roots becomes difficult or when transpiration rates increase excessively. Among the effects of drought on plant growth, limited nutrient availability and impaired water absorption are considered the primary causes [4].

The drought conditions, plants lose water, which negatively affects their growth and development. The severity of this situation depends on the duration and the plant's adaptability to changing conditions 555. Water stress adversely impacts parameters such as plant height, number of branches, internode length, leaf area, and overall plant biomass. This effect clearly manifests as restricted growth to balance the demand for water and nutrients [6].

Material and methods

In the study, plant material consisted of hardwood cuttings collected during the dormancy period from the grapevine varieties Plechistik and Muscat Yursky.

Conditions for planting and growing cuttings: One- to two-bud cuttings were taken and then planted into pre-weighed 12-liter containers. The containers were filled with a mixture of peat and perlite. The cuttings were irrigated based on their growth capacity in the field until they reached the 4–5 leaf stage. After reaching the 4–5 leaf stage, artificial drought stress was induced by applying four different concentrations of PEG-6000 (0, 2, 4, and 6%) to the environment. To prevent evaporation, the substrate surface was covered with white polyethylene films.

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The plants were maintained under the following climatic conditions: temperature 20±2°C, humidity 50–55%, and a photoperiod of 9 hours daily under sun lamps.
Assessment of the Efficacy of PEG Treatment
Plant survival rate (%): The number of living plants is divided by the total number of planted plants and multiplied by 100.
Assessment of shoot and root growth: Shoot and root lengths (cm) were measured using a measuring tape. The number of nodes and leaves on the shoots were counted.
Biomass measurements**:** The fresh and dry weights of the plant shoots, roots, and leaves were measured using an electronic balance with an accuracy of ±0.001 g.
Dry Weight Measurements: Plant residues were dried at 65°C for 72 hours, and the final dry mass was measured.
Rooting Rate (%):The number of plants that developed roots was divided by the total number of planted cuttings and multiplied by 100.
To determine tolerance indices, the shoot and root tolerance coefficients were calculated separately for each PEG concentration:

$$T = \frac{T_x}{T_0}$$

T_x *– Dry weight of shoot and root (g) of plants grown at a specific PEG concentration*
T_0 *– Dry weight of shoot and root (g) of control plants without PEG treatment*

Assessment of Plant Damage Level:The degree of plant damage was evaluated based on the scale developed by Sivritepe et al.:

- Level 1 – No visible damage symptoms,
- Level 2 – Signs of drying and scorching on leaf edges and shoot tips,
- Level 3 – Complete damage to leaves and necrosis in some parts of the plant body,
- Level 4 – The plant is completely dried out and dead.

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Determination of Chlorophyll Content and Leaf Nitrogen: Chlorophyll content and nitrogen levels in the leaves were measured using a SPAD-502 chlorophyll meter.

Experimental Design:
The study was conducted using a randomized block design with three replications. Each replication included three plants.

Research Results
Shoot: A shoot is the young, newly grown stem or branch of a plant. It is a vegetative organ from which leaves, nodes, buds, and fruits can develop.
The following types of shoots are distinguished:
1. Vegetative shoot – consists only of leaves and stem and does not bear fruit.
2. Generative (fruit-bearing) shoot – a shoot that produces flowers and fruits.
3. Root shoot – in some plants, new shoots grow from the roots (e.g., in raspberry and cherry trees).
4. Lateral shoots – shoots that grow sideways from the main stem.
In viticulture, shoot length, number of leaves, and number of nodes are important agrobiological indicators, as they directly affect the plant's growth rate and productivity [2].
Results of branch development table 1 presents the results related to shoot development parameters of cuttings from the grapevine cultivars *Plechistik* and *Muscat Yurskiy* subjected to drought stress under various PEG (polyethylene glycol) concentrations. As shown in the table, all characteristics of shoot development were significantly affected by the applied PEG levels.
As the PEG concentration increased, the survival rate of the plants decreased. The lowest plant survival rates were recorded at the 6% PEG concentration: *Plechistik* – 56%, and *Muscat Yurskiy* – 59%. Statistically significant differences in plant survival were observed under 0%, 2%, and 4% PEG concentrations.
According to the research results on shoot length, the longest shoots were observed in the control group (0% PEG): *Plechistik* – 4.07 cm, *Muscat Yurskiy* –

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6.33 cm. The shortest shoots were recorded under the 6% PEG treatment: *Plechistik* – 2.20 cm, *Muscat Yurskiy* – 4.60 cm. Under the 4% PEG concentration, the shoot lengths were *Plechistik* – 2.93 cm and *Muscat Yurskiy* – 4.67 cm.

In terms of shoot fresh weight (g), the highest values were observed in the control group (0% PEG): *Plechistik* – 0.32 g, *Muscat Yurskiy* – 0.39 g. The lowest shoot fresh weights were recorded under the 6% PEG concentration: *Plechistik* – 0.19 g, *Muscat Yurskiy* – 0.23 g.

Shoot dry weight (g): The results for shoot dry weight were similar to those of shoot fresh weight, with the highest dry weight (0.04 g) recorded in the control group. The lowest shoot dry weight (0.03 g) was observed in the 2%, 4%, and 6% PEG treatment groups.

Number of nodes (pcs): The control group produced the highest number of nodes, with *Plechistik* – 5.33 and *Muscat Yurskiy* – 6.33. All PEG-treated groups showed statistically similar results in terms of node number.

Number of leaves (pcs): The number of leaves decreased as the PEG concentration increased, indicating a negative effect of drought stress on leaf development.

Table 1 Effect of Different PEG Concentrations on Shoot growth Parameters of Plechistik and Muscat Yurskiy Grapevine Cultivars Grown under In Vivo Conditions

Name of variety	PEG concentrations, %	Survival rate, (%)	Shoot length, sm	Shoot fresh weight (g)	Shoot dry weight, g	Nodes number	Number of leaves
Plechistik	0%	90%	4,07±0,42	0,32	0,04	5,33±0,18	5,67±0,37
	2%	82%	3,93±0,32	0,29	0,03	4,33±0,18	5,33±0,18
	4%	67%	2,93±0,29	0,21±0,01	0,03	3,67±0,18	3,67±0,18
	6%	56%	2,20±0,17	0,19±0,03	0,03	3,33±0,18	3,67±0,18
Muscat yurskiy	0%	92%	6,33±0,62	0,39±0,01	0,05	6,33±0,18	7,33±0,48
	2%	80%	5,07±0,60	0,36±0,05	0,05±0,01	4,00±0,55	4,00±0,84
	4%	73%	4,67±0,66	0,28±0,01	0,04	1,33±0,37	2,33±0,66
	6%	59%	4,60±0,14	0,23±0,01	0,03	1,33± 0,18	1,67±0,18

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Root growth results table 2 shows the root growth parameters of cuttings from *Plechistik* and *Muscat Yurskiy* grapevine cultivars subjected to drought stress under different PEG concentrations.

PEG concentrations had a significant effect on root development, with noticeable differences in rooting percentage. The highest rooting percentage (90%) was observed in the control group (0% PEG). Almost no rooting occurred at the 6% PEG concentration. Although no statistically significant differences were found in root length, fresh weight, and dry weight across PEG treatments, these values tended to decrease as PEG concentration increased.

2-table **Effect of Different PEG Concentrations on Root growth parameters of *Plechistik* and *Muscat Yurskiy* Grapevine Cultivars Grown under *In Vivo* Conditions**

Navlar nomi	PEG concentrations, %	The root's moisture weight, g	The root's dryness weight, g	Root length, sm	Number of roots, piece	Route level, %
Plechistik	0%	0,53±0,01	0,03	4,10	4,67±0,37	90%
	2%	0,29	0,02	2,07	3,00±0,32	73%
	4%	0,15	0,01	1,12	1,33±0,37	56%
	6%	0,03	0,0019	0,88	1,33±0,18	25%
Muscat yurskiy	0%	0,12	0,01	2,94	4,33±0,18	87%
	2%	0,11	0,01	2,18	4,00	76%
	4%	0,01	0,0032	1,25	3,33±0,97	22,67%
	6%	0,0020	0,0019	0,73	2,67±0,80	12%

Results of Physiological Parameters:

The effects of different PEG concentrations on the physiological parameters of *Plechistik* and *Muscat Yurskiy* grapevine cultivars subjected to drought stress are presented in Table 3. According to the results, PEG treatments had a statistically significant effect on most physiological parameters. No significant changes were observed in the relative water content of the leaves under PEG treatment. However, significant differences were noted in chlorophyll content, leaf turgor weight, and the drought tolerance of shoots and roots.

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Chlorophyll Content: The highest chlorophyll content was recorded in the control group for *Plechistik* (11.90 SPAD) and *Muscat Yurskiy* (5.63 SPAD). The lowest chlorophyll content was observed in *Plechistik* under 6% PEG treatment (4.73 SPAD) and in *Muscat Yurskiy* under 4% PEG treatment (3.00 SPAD).

Leaf Turgor Weight: The highest leaf turgor weight was noted in the control group for *Plechistik* (0.32 g) and *Muscat Yurskiy* (0.24 g). This parameter decreased in plants treated with PEG; however, all PEG-treated groups belonged to statistically similar categories.

Tolerance of shoot : The highest shoot tolerance was observed in the control group for *Plechistik* (1.00) and *Muscat Yurskiy* (1.00). The lowest shoot tolerance values were recorded at 6% PEG concentration: *Muscat Yurskiy* (0.66) and *Plechistik* (0.79).

Tolerance of root: The highest root tolerance (1.00) was recorded in the control group. The lowest root tolerance was observed at 6% PEG concentration: *Plechistik* (0.07) and *Muscat Yurskiy* (0.18).

Damage Level: The damage level increased with rising PEG concentration. While the damage level was rated as 1 in the control group, it increased to 2.67 at 6% PEG treatment.

3-table **Effect of Different PEG Concentrations on Physiological Parameters of *Plechistik* and *Muscat Yurskiy* Grapevine Cultivars Grown under *In Vivo* Conditions**

Navlar nomi	PEG concentrations, %	The quantity of chlorophyl (SPAD)	Leaf turgor weight,g	The quantity of nitrogen in leaf	The shoot stability rate	The root stability rate	Level of damage (rating)
Plechistik	0%	11,90±0,86	0,32±0,06	6,87±0,25	1,00	1,00±0,60	1,00
	2%	11,40±0,41	0,29±0,02	6,73± 0,79	0,86±0,06	0,66±0,12	1,33±0,18
	4%	9,83±0,74	0,15±0,05	5,77±0,24	0,84±0,10	0,40±0,03	2,33±0,48
	6%	4,73±0,19	0,05±0,01	5,53±0,43	0,79±0,04	0,07	2,67±0,48
Muskat yurskiy	0%	5,63±0,10	0,24±0,04	4,23±0,05	1,00±0,00	1,00±0,73	1,00
	2%	5,30±0,35	0,22±0,04	4,10±0,05	0,95±0,09	0,90±0,03	1,33±0,18
	4%	3,00±0,83	0,14±0,01	2,70±0,74	0,69±0,07	0,30±0,08	2,67±0,37
	6%	3,13±0,32	0,09±0,01	2,67±0,14	0,66±0,01	0,18±0,05	3,0±0,32

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According to the experimental results, increasing PEG concentrations led to a significant decrease in physiological parameters. Chlorophyll content, leaf turgor weight, and shoot tolerance all declined, with the 4% and 6% PEG treatments producing the poorest outcomes. At 6% PEG concentration, root development was severely limited. The highest damage level was also observed under the 6% PEG treatment.

Conclusion

The results of this study demonstrated that applying different PEG concentrations can effectively induce artificial drought stress in grapevine plants. As the PEG concentration increased, the growth parameters of the plants declined. Significant changes were observed in survival rate, biomass measurements, physiological parameters, and leaf number at 6% PEG concentration. The difference between 4% and 6% PEG treatments was relatively small, with notable effects on plants starting from 4% PEG. It was confirmed that PEG concentrations of 4% and above impose considerable drought stress on the plants. These findings provide valuable information for identifying and selecting drought-tolerant grapevine cultivars.

References

1. Appenzerler, Tim., Dimick, R.Dennis. (2004). “Dünya Alarm Veriyor.” National Geographic. Eylül 2004.
2. Bilir Ekbiç, H., İlhan M. (2022). Kokulu üzümün (Vitis labrusca L.) kuraklık stresine toleransının PEG uygulamasıyla in vivo koşullarda belirlenmesi. Academic Journal of Agriculture/Akademik Ziraat Dergisi, 11(2).
3. Uzumning sharobbop Plechistik va Muskat yurskiy navlarini qurg‘oqchilik stressini fiziologik parametrlariga ta’sirini sun’iy qurg‘oqchilik (PEG-6000) qo‘llash orqali aniqlash. J.N.Fayziev, D.M.Abdullaev, O.A.Xasanova “Meva-sabzavotchilik va uzumchilik sohalarida ilmiy innovatsion texnologiyalar” Xalqaro ilmiy-amaliy konferenцiya.

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Website: usajournals.org

4. Manivannan, P., Jaleel, C. A., Somasundaram, R., Panneerselvam, R. (2008). Osmoregulation and antioxidant metabolism in drought-stressed Helianthus annuus under triadimefon drenching. Comptes Rendus. Biologies, 331(6).
5. Jongdee, B., Fukai, S., & Cooper, M. (2002). Leaf water potential and osmotic adjustment as physiological traits to improve drought tolerance in rice. Field Crops Research, 76(2-3), 153-163.
6. Yadav, R. K., Sangwan, R. S., Sabir, F., Srivastava, A. K., Sangwan, N. S. (2014). Effect of prolonged water stress on specialized secondary metabolites, peltate glandular trichomes, and pathway gene expression in Artemisia annua L. Plant Physiology and Biochemistry, 74, 70-83.