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EFFECT OF WATER AND SALT STRESS ON THE BIO-ECO-PHYSIOLOGICAL CHARACTERISTICS OF SUNFLOWER VARIETIES

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Abstract

Sunflower (Helianthus annuus L.) is an important oilseed crop widely cultivated under diverse environmental conditions. However, water deficiency and soil salinity are among the most critical abiotic stresses limiting productivity. This study evaluates the bio-eco-physiological responses of seven sunflower varieties (Dilbar, Diyor, VNIIMK-888, Jahongir, Sur, Navro'z, and Alomat) under field conditions. Morphological parameters, growth dynamics, and yield-related traits such as plant height, leaf number, leaf dimensions, stem thickness, and 1000-seed weight were analyzed. Results showed significant varietal differences in stress tolerance, with Diyor demonstrating superior adaptability and productivity. The findings highlight the importance of varietal selection in stress-prone environments and provide insights for sustainable sunflower cultivation under water and salinity stress conditions.

Keywords: sunflower, water stress, salinity stress, bioecophysiology, yield, adaptation, varieties

Annotatsiya

Kungaboqar (*Helianthus annuus L.*) turli ekologik sharoitlarda keng yetishtiriladigan muhim moyli ekin hisoblanadi. Biroq suv tanqisligi va tuproq sho'rlanishi hosildorlikni cheklovchi eng muhim abiotik stress omillaridan biridir. Ushbu tadqiqotda dala sharoitida yetishtirilgan yetti xil kungaboqar navining (Dilbar, Diyor, VNIIMK-888, Jahongir, Sur, Navro'z va Alomat) bioeko-fiziologik javob reaksiyalari baholandi. O'simlik bo'yi, barglar soni, barg o'lchamlari, poya qalinligi va 1000 dona urug' vazni kabi morfologik ko'rsatkichlar hamda hosildorlikka oid belgilar tahlil qilindi. Natijalar navlar o'rtasida stressga chidamlilik darajasida sezilarli farqlar mavjudligini ko'rsatdi, bunda Diyor navi yuqori moslashuvchanlik va mahsuldorlik bilan ajralib turdi. Olingan natijalar stress sharoitlarida mos navlarni tanlash muhimligini ko'rsatadi hamda suv tanqisligi va sho'rlanish sharoitida kungaboqarni barqaror yetishtirish uchun ilmiy asos bo'lib xizmat qiladi.

Kalit so'zlar: kungaboqar, suv tanqisligi, sho'rlanish stressi, bioekofiziologiya, hosildorlik, moslashuvchanlik, navlar

Аннотация

Подсолнечник (*Helianthus annuus L.*) является важной масличной культурой, широко возделываемой в различных экологических условиях. Однако дефицит воды и засоление почв являются одними из наиболее значимых абиотических стрессов, ограничивающих урожайность. В данном исследовании оценивались биоэкофизиологические реакции семи сортов подсолнечника (Dilbar, Diyor, VNIIMK-888, Jahongir, Sur, Navro'z и Alomat) в полевых условиях. Были проанализированы морфологические параметры, динамика роста и признаки, связанные с урожайностью, такие как высота растений, количество листьев, размеры листьев, толщина стебля и масса 1000 семян. Результаты показали значительные различия между сортами по устойчивости к стрессу, при этом сорт Diyor продемонстрировал наилучшую адаптивность и продуктивность. Полученные данные подчеркивают важность правильного выбора сортов в стрессовых условиях и способствуют развитию устойчивого выращивания подсолнечника при дефиците воды и засолении почв.

Ключевые слова: подсолнечник, водный стресс, солевой стресс, биоэкофизиология, урожайность, адаптация, сорта

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Introduction

Sunflower (Helianthus annuus L.) is one of the leading oilseed crops globally due to its high oil content and adaptability to various agro-climatic conditions. In arid and semi-arid regions, including Central Asia, sunflower production is frequently constrained by water scarcity and soil salinity, which adversely affect plant growth, physiological processes, and yield formation.

Water stress disrupts plant metabolism by reducing photosynthetic activity, nutrient uptake, and cell expansion. Salinity stress, on the other hand, leads to osmotic imbalance, ion toxicity, and oxidative damage. These stresses often occur simultaneously in field conditions, making it essential to study their combined effects on crop performance.

The development and selection of stress-tolerant varieties is one of the most effective strategies to ensure stable yields. Bio-eco-physiological traits such as plant height, leaf area, biomass accumulation, and seed characteristics serve as important indicators of plant adaptability.

The objective of this study is to:

Evaluate the growth and development of different sunflower varieties

Analyze their bio-eco-physiological responses to environmental stress conditions

Identify high-performing varieties suitable for stress-prone regions

Materials and Methods

Experimental Site and Conditions

The field experiment was conducted in 2025 under open-field conditions. The soil and climatic conditions were typical for semi-arid regions, where periodic water deficit and moderate salinity may occur.

Plant Material

Seven sunflower varieties were used:

Dilbar,Diyor,VNIIMK-888,Jahongir,Sur,Navro’z,Alomat

Experimental Design

Seeds were sown on April 13 in rows with:

Row spacing: standard field spacing

Plant spacing: 20 cm

Sowing depth: 3–5 cm

Emergence began on April 21, and seedlings reached 4–6 cm by April 29.

Agronomic Practices

Weeding and thinning were performed on May 20

Irrigation was applied twice, including on May 12

Natural pollination occurred during flowering (mid-June)

Data Collection

The following parameters were measured:

Vegetative Growth (May–June)

Stem length

Leaf length and width

Number of leaves

Morphological Measurements (June 24)

Plant height (cm)

Leaf number

Leaf width (cm)

Leaf length (cm)

Stem thickness (mm)

Yield Parameters

Seed weight per head

1000-seed weight

Results

Germination and Early Growth

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All varieties showed uniform germination, with emergence observed within 8 days. Early growth rates varied slightly, indicating genetic differences in vigor.

Vegetative Growth Analysis

Significant differences were observed among varieties:

Diyor showed the highest average plant height (204.6 cm)

Alomat and Jahongir also exhibited strong growth (177–176 cm)

Sur showed the lowest growth (128.6 cm), indicating sensitivity to stress

Leaf development followed a similar trend:

Highest leaf number: Alomat (27.2), VNIIMK-888 (27.6)

Lowest: Sur (21.4)

Leaf size is critical for photosynthesis:

Dilbar had the widest leaves (23.4 cm)

Sur had the smallest (12.6 cm)

Stem Thickness

Stem thickness reflects structural strength and water transport capacity:

Thickest stems: Dilbar (13.2 mm)

Thinnest: Sur (6.4 mm)

Yield Performance

Seed productivity varied significantly:

Seed weight per head:

Highest: Diyor (840 g)

Lowest: Sur (320 g)

1000-seed weight:

Highest: Diyor (111.82 g)

Close values: Dilbar (111 g), VNIIMK-888 (110.17 g)

Lowest: Sur (62.40 g)

Comparative Analysis

Diyor consistently outperformed other varieties in:

Plant height

Seed yield

Seed size

Sur showed poor performance across all parameters, indicating low stress tolerance.

Discussion

The results clearly demonstrate that sunflower varieties differ significantly in their response to environmental stress factors.

Effect of Water Stress

Water stress primarily reduces:

Cell expansion → shorter plants

Leaf area → reduced photosynthesis

Biomass accumulation

Varieties like Diyor maintained higher growth, suggesting better water-use efficiency.

Effect of Salinity Stress

Salinity affects:

Ion balance (Na^+ toxicity)

Osmotic stress

Enzyme activity

Sensitive varieties like Sur showed reduced growth and yield, indicating poor ionic regulation.

Adaptive Traits

Key traits associated with stress tolerance:

Taller plants (better resource acquisition)

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Larger leaves (higher photosynthetic capacity)
Thicker stems (better transport system)
Higher seed weight (efficient assimilate partitioning)

Variety Performance Ranking

Based on overall performance:
Diyor – highest adaptability and yield
Dilbar / VNIIMK-888 – stable and productive
Alomat / Jahongir – moderate tolerance
Navro'z – average performance
Sur – low tolerance

Conclusion

This study confirms that water and salinity stress significantly influence the bio-eco-physiological characteristics of sunflower varieties.

Key conclusions:
Varietal differences are critical under stress conditions
Diyor is the most promising variety for stress-prone environments
Sur is highly sensitive and unsuitable for such conditions
Morphological traits can serve as reliable indicators of stress tolerance
The results can be used for:
Breeding programs
Agricultural planning
Improving sunflower productivity in arid regions

Recommendations

Use Diyor for high-yield production in dry and saline soils
Conduct further physiological studies (chlorophyll, water potential)
Apply optimized irrigation strategies
Explore genetic improvement for stress resistance

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