MIRZO ULUG‘BEK NOMIDAGI
O‘ZBEKISTON MILLIY UNIVERSITETI
JIZZAX FILIALI



"BIOTEXNOLOGIYANING RIVOJLANISH ISTIQBOLLARI VA MUAMMOLARI"

MAVZUSIDAGI RESPUBLIKA MIQYOSIDAGI ILMIY-TEXNIK ANJUMAN TO‘PLAMI





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МИНИСТЕРСТВО ВЫСШЕГО ОБРАЗОВАНИЯ, НАУКИ И ИННОВАЦИЙ РЕСПУБЛИКИ УЗБЕКИСТАН

ДЖИЗАКСКИЙ ФИЛИАЛ НАЦИОНАЛЬНОГО УНИВЕРСИТЕТА УЗБЕКИСТАНА ИМЕНИ МИРЗО УЛУГБЕКА

СБОРНИК ТЕЗИСОВ РЕСПУБЛИКАНСКОЙ НАУЧНОЙ КОНФЕРЕНЦИИ

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Foydalanilgan adabiyotlar ro'yxati

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MORPHOPHYSIOLOGICAL AND GENETIC ADAPTATIONS OF PLANTS TO DROUGHT STRESS

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Annotation: This article discusses abiotic stress factors affecting plants, particularly morphophysiological adaptation strategies to drought and their genetic basis. Under drought conditions, plants exhibit flexibility by reducing water loss, deepening root systems, and altering leaf structures. The article also explores genetic mechanisms of drought resistance and their expression, analyzing how plants combat biotic and abiotic stresses, including osmotic pressure regulation and optimization of photosynthesis.

Keywords: Abiotic stress, drought, adaptation, gene, osmotic pressure, transpiration, photosynthesis, stomata, drought tolerance.

Introduction

Anthropogenic factors have significantly influenced the environment, leading to global warming, which directly contributes to drought stress affecting both plants and animals. Plants are particularly susceptible to drought stress, resulting in reduced growth and productivity. Understanding plant adaptation

mechanisms is crucial to mitigating drought-induced effects. Drought stress induces changes at morphophysiological, biochemical, cytological, and molecular levels.

According to the Global Meteorological Organization, by 2050, approximately 5 billion people will face water scarcity. Currently, 2 billion people lack access to clean drinking water. Research from the World Institute for Natural Resources suggests that by 2040, 33 countries, including Uzbekistan and Central Asia, will experience severe water shortages. In Uzbekistan, about 70% of the land (31.4 million hectares) consists of arid and semi-arid regions affected by natural salinization, sand drifts, and dust storms. The Aral Sea disaster has further exacerbated these challenges, with over 5.5 million hectares of desertified land now forming the Aralkum Desert [1].

Plants adapt to drought stress through four main mechanisms:

1. **Drought avoidance** – Regulating cellular osmotic capacity.
2. **Drought survival** – Adjusting life cycles, e.g., transitioning to shorter growth cycles.
3. **Drought tolerance** – Controlling stomatal conductivity and root volume.
4. **Recovery** – Maintaining viability after drought periods [10].

Morphophysiological Adaptations

1. Root Volume Control: Roots are the first organs to detect drought stress, playing a crucial role in water acquisition. Longer roots enhance drought tolerance by accessing deeper soil moisture. Studies on *Helichrysum petiolare* reveal significant changes in root structures under drought stress [7]. Maize (*Zea mays*) has an extensive primary root system, which aids in water absorption. The *ZMDRO1* gene promotes deeper root growth, improving drought resistance, as observed in *Oryza sativa* and *Arabidopsis* [3].

2. Leaf Modifications: Plants alter leaf morphology to cope with drought. Water-deficient leaves dry out, their edges yellow, and leaf development slows, reducing plant productivity [9]. Some species minimize transpiration by forming a waxy cuticle, regulated by zmfdl1/zmmyb94 genes [2]. Xerophytic plants exhibit reduced stomata, increased leaf hairs, and smaller leaf sizes to conserve water [12]. In maize, the Zmravl1 gene regulates leaf architecture, optimizing photosynthesis under high-density planting conditions [8]. The Zmnl4 gene controls leaf cell division, and its knockout reduces leaf area, promoting higher planting density [5]. However, excessive reduction in leaf area can negatively impact photosynthetic efficiency.

3. Stomatal Regulation: Stomata play a critical role in controlling water loss. During drought, stomatal closure reduces transpiration, enhancing drought resistance [10]. The Zmabp9 gene regulates stomatal movement, promoting

photosynthesis, detoxifying reactive oxygen species, and managing responses to drought, salinity, and oxidative stress [11].

Conclusion: Due to population growth and climate change, developing high-yielding and stress-resistant plant varieties is essential for global food security and sustainable agriculture. Understanding abiotic stress resistance mechanisms in plants can help develop resilient crops. Biotechnological approaches, including CRISPR-Cas9 gene editing, offer efficient solutions for improving drought tolerance. Our study aims to enhance drought resilience in maize by knocking out genes such as *Zmnl4, Osabi5, ABI5,* and *Open Stomata2 (OST2),* which negatively regulate drought tolerance.

By leveraging advanced genetic technologies, we can accelerate the development of climate-resilient crops, ensuring agricultural sustainability in the face of increasing environmental challenges.

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