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



"BIOTEXNOLOGIYANING RIVOJLANISH ISTIQBOLLARI VA MUAMMOLARI"

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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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ENHANCING THE YIELD OF BARLEY (HORDEUM VULGARE L.) USING CRISPR/CAS TECHNOLOGY

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This paper provides a review of current and ongoing research focused on increasing barley (*Hordeum vulgare L.*) yield using CRISPR/Cas technology. Barley is a crucial cereal crop with significant economic and agricultural importance, and improving its yield is essential for addressing food security challenges. Recent studies highlight the potential of CRISPR/Cas gene-editing technology to modify key genes involved in yield improvement, such as HvDEP1, HvGA20ox2, and HvCKX2, which regulate plant architecture, gibberellin biosynthesis, and cytokinin metabolism, respectively. This review discusses the effectiveness of CRISPR/Cas-mediated gene editing in barley, emphasizing different transformation methods, including Agrobacterium-mediated transformation and direct gene editing techniques. The successful applications of genome editing in barley, along with potential future directions, are explored to provide insights into the role of CRISPR-based breeding in improving crop productivity [4].

Keywords: Barley, CRISPR/Cas, gene editing, yield improvement, transformation methods, HvDEP1, HvGA20ox2, HvCKX2.

Introduction: Barley (*Hordeum vulgare L.*) ranks among the top cereal crops worldwide and plays a fundamental role in food, feed, and brewing industries. Given the increasing global demand for agricultural productivity, improving barley yield is critical [2]. Traditional breeding approaches have made significant contributions to barley improvement; however, these methods are often time-consuming, labor-intensive, and limited by genetic variability. The advent of

genome-editing technologies, particularly CRISPR/Cas, has revolutionized plant breeding by enabling precise modifications in crop genomes, facilitating rapid trait improvement with high specificity and efficiency [1].

This review aims to summarize recent progress in CRISPR/Cas-mediated barley yield enhancement, focusing on key genes targeted for modification. It also discusses gene-editing strategies, transformation techniques, and the challenges associated with CRISPR/Cas applications in barley breeding [3]. Understanding these aspects is essential for harnessing the full potential of genome editing to achieve sustainable agricultural productivity.

Main part: CRISPR/Cas technology enables site-specific modifications in plant genomes, offering a precise and efficient approach for improving agronomic traits [2]. In barley, researchers have identified several key genes that influence yield potential, and targeted editing of these genes has shown promising results.

Key Target Genes for Yield Enhancement: HvDEP1 (DENSE AND ERECT PANICLE 1) HvDEP1 plays a critical role in regulating panicle architecture and grain number in barley. Studies indicate that mutations in HvDEP1 can lead to increased grain yield by modifying plant architecture, resulting in more compact and erect panicles [5]. The deletion or suppression of HvDEP1 via CRISPR/Cas has been demonstrated to enhance grain productivity by improving grain number per spike. HvGA20ox2 (GIBBERELLIN 20-OXIDASE 2) Gibberellins (GAs) are key regulators of plant growth, affecting plant height and lodging resistance. HvGA20ox2 encodes an enzyme involved in GA biosynthesis, and its targeted mutation can reduce excessive stem elongation, leading to semi-dwarf phenotypes with improved lodging resistance and yield stability [4]. CRISPR/Cas-mediated knockout of HvGA20ox2 has shown promising results in producing barley varieties with optimized plant height and improved grain production.

HvCKX2 (Cytokinin oxidase/dehydrogenase 2) Cytokinins regulate cell division, grain filling, and overall plant development. HvCKX2 encodes an enzyme responsible for cytokinin degradation. Knocking out HvCKX2 using CRISPR/Cas technology leads to increased cytokinin accumulation, which enhances grain filling and promotes larger grain size and higher grain numbers [2].

CRISPR/Cas Transformation Approaches in Barley: CRISPR/Cas-mediated gene editing in barley has been successfully performed using various transformation methods, including: Agrobacterium-mediated transformation: A widely used technique that facilitates the stable integration of CRISPR/Cas components into the barley genome [1].

Particle bombardment (biolistic transformation): A direct method that delivers gene-editing components into barley cells [3]. Protoplast-based transformation: A transient gene-editing approach that enables targeted

mutagenesis without stable genomic integration [4]. Each transformation approach has unique advantages and limitations, influencing gene-editing efficiency, regeneration rates, and heritability of mutations. Challenges and future directions while CRISPR/Cas technology presents immense potential for barley yield improvement, several challenges must be addressed: Efficiency of transformation and regeneration: Achieving high transformation efficiency and plant regeneration rates remains a bottleneck in barley genome editing [2]. Off-target effects: Despite its precision, CRISPR/Cas can occasionally introduce unintended genetic modifications, necessitating rigorous validation and screening [1]. Regulatory considerations: The legal and ethical frameworks surrounding genome-edited crops vary globally, affecting commercialization prospects [4]. Future research should focus on optimizing gene-editing strategies, improving transformation techniques, and conducting field trials to validate CRISPR-edited barley lines under real agricultural conditions. Advances in base editing and prime editing may further enhance the specificity and efficiency of genome modifications, opening new avenues for targeted trait improvement [5].

Conclusion: CRISPR/Cas technology has emerged as a powerful tool for improving barley yield through precise genome editing. Targeting key genes such as HvDEP1, HvGA20ox2, and HvCKX2 has demonstrated significant potential for enhancing plant architecture, gibberellin biosynthesis, and cytokinin metabolism, ultimately leading to increased productivity. While challenges such as transformation efficiency and regulatory hurdles persist, continued advancements in genome-editing technologies are expected to accelerate the development of high-yielding barley cultivars. Future research should prioritize field-based validation of edited lines and explore novel genome-editing techniques to further refine CRISPR-based breeding strategies for sustainable crop improvement.

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