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A REVIEW

Physiological mechanisms of respiration in millets: A comprehensive review

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Abstract : Millets, renowned for their resilience in marginal environments, exhibit unique physiological adaptations that underpin their ability to thrive under abiotic stresses such as drought, heat, and nutrient deficiency. This comprehensive review synthesizes current knowledge on the respiratory mechanisms in millets, focusing on their biochemical, genetic, and environmental regulation. We elucidate the core respiratory pathways-glycolysis, the tricarboxylic acid (TCA) cycle, and mitochondrial electron transport-and their plasticity under stress. Key findings highlight the role of alternative oxidase (AOX) in mitigating oxidative damage, the integration of C,, photosynthesis with respiration, and developmental-stage-specific adjustments in energy metabolism. Comparative analyses reveal that millets outperform conventional cereals like rice and wheat in respiratory efficiency, particularly under stress, due to traits such as lower CO, loss and optimized biomass partitioning. Furthermore, we explore the genetic control of respiration-linked traits (e.g., stay-green) and their potential for breeding climate-resilient cultivars. The review identifies critical knowledge gaps, including root respiration dynamics and multi-stress interactions, and proposes future directions for research and biotechnology applications. By leveraging millets' natural respiratory adaptations, this work provides a framework for enhancing crop resilience and sustainable agriculture in a changing climate.

Key Words : Millets, Respiration, Abiotic stress, Alternative oxidase (AOX), C_4 photosynthesis

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INTRODUCTION

Millets, a group of small-seeded grasses that includes species like pearl millet (*Pennisetum glaucum*), finger millet (*Eleusine coracana*), proso millet (*Panicum miliaceum*), and foxtail millet (*Setaria italica*), have gained renewed attention due to their exceptional adaptability, nutritional richness, and resilience to environmental stressors. These climate-resilient crops have long supported marginalized farming systems in arid and semi-arid regions of Asia and Africa and are now being reappraised as important components of sustainable agriculture and food security strategies under climate change scenarios (Wilson and VanBuren, 2022). Millets exhibit strong root systems, efficient water use, and early

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