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A REVIEW

Optimizing high density maize cultivation: A review of key physiological traits for enhanced productivity

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SUMMARY

The rapid global rise in maize (*Zea mays* L.) demand necessitates innovative strategies to sustainably intensify production on limited land. High-density planting has emerged as a key approach to increase yield per unit area, yet it imposes substantial physiological stress on maize plants due to intensified competition for light, water, and nutrients. This review synthesizes the critical plant physiological traits that underpin successful adaptation to high-density cultivation, including optimized canopy architecture, efficient root systems, enhanced photosynthetic performance, reproductive resilience, and source–sink coordination. Traits such as upright leaf angles, high leaf area duration (LAD), stay-green expression, and deeper, vertically oriented roots enable maize to maintain photosynthetic efficiency and resource uptake under crowding stress. Furthermore, hormonal regulation, particularly the balance of cytokinins and abscisic acid, plays a vital role in delaying senescence and sustaining grain filling. The review also underscores the importance of integrating agronomic practices such as precise planting patterns, strategic nitrogen management, and irrigation scheduling with physiological insights to amplify yield gains. Field studies have shown that combining genotype selection with tailored management improves light interception, nitrogen use efficiency, and reproductive stability in high-density systems. Despite these advances, challenges remain in understanding trait plasticity under variable environments, quantifying root phenotypes in situ, and managing trade-offs between photosynthesis and nutrient remobilization. Overall, the convergence of plant physiology, agronomy, and breeding offers a promising path forward for improving maize productivity under intensified cropping systems.

Key Words : High-density planting, Maize physiology, Canopy architecture, Root system traits, Photosynthetic efficiency Stay-green trait

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The global demand for maize (*Zea mays* L.) has grown rapidly over the past few decades, driven by population growth, changing dietary patterns, increased livestock feed requirements, and the rise of biofuel industries. Maize is one of the most widely grown cereals globally, providing not just food but also raw material for industries, feed for animals, and income for millions of farmers. From 1960 to 2011, global maize production rose from approximately 200 million tons to over 800 million tons, largely due to genetic improvement,

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