Optimizing Planting Density for Hybrid Winter Wheat: A Pathway to Sustainable Yield Improvement

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Commentary

Received: 30-Dec-2024, Manuscript No. JBS-25-157156; **Editor assigned:** 02-Jan-2025, PreQC No. JBS-25-157156 (PQ); **Reviewed:** 16-Jan-2025, QC No. JBS-25-157156; **Revised:** 20-Feb-2026, Manuscript No. JBS-25-157156 (R); **Published:** 27-Feb-2026, DOI: 10.4172/2320-0189.15.1.001

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Citation: Zhao C. Optimizing Planting Density for Hybrid Winter Wheat: A Pathway to Sustainable Yield Improvement. RRJ Botanical Sci. 2026;15:001.

DESCRIPTION

Wheat (*Triticum aestivum* L.) is a cornerstone of global food security, with the eastern Huang-Huai-Hai region of China contributing approximately 50% of the country's total wheat yield. Meeting the dual demands of high productivity and sustainable resource use requires innovative approaches, particularly in this pivotal agricultural zone. Hybrid wheat varieties, such as Jingmai 17, offer a promising solution, combining superior agronomic traits with enhanced Nitrogen Use Efficiency (NUE) and yield potential. Our recent study, published in the International Journal of Plant Production, sheds light on the optimal planting density for hybrid winter wheat and its broader implications.

Key insights from the study

Optimal planting density: A Critical Factor: Our research evaluated three planting densities 150, 300, and 450 plants•m^{-2} over two growing seasons (2021–2023). Results identified 300 plants•m^{-2} as the ideal density for both hybrid ('Jingmai 17') and conventional ('Jimai 22') varieties. This density strikes a balance by ensuring sufficient canopy structure for maximum light interception while avoiding the drawbacks of excessive competition seen at higher densities or the inefficiency of lower densities.

Superior agronomic traits of Jingmai 17: Jingmai 17 outperformed Jimai 22 across all planting densities, demonstrating the advantages of hybrid vigor. The hybrid variety maintained a larger green leaf area and higher SPAD (chlorophyll) values post-anthesis, reducing the rate of leaf senescence and enhancing photosynthetic activity during grain filling. These traits translated into greater biomass accumulation, a higher thousand-grain weight, and increased grain numbers per spike, ultimately yielding 10% more than Jimai 22.

Enhanced nitrogen use efficiency: Efficient nitrogen management is crucial for sustainable wheat production. Our findings revealed that Jingmai 17 not only accumulated more nitrogen during growth but also displayed higher Pre-Anthesis Nitrogen Remobilization (PANR) and NUE. At a planting density of 300 plants•m^{-2}, Jingmai 17 achieved the highest Nitrogen Harvest Index (NHI), underscoring its potential for reducing environmental impacts while maintaining high productivity.

Implications for agricultural practice

The identification of 300 plants•m^{-2} as the optimal planting density has far-reaching implications for wheat cultivation in the Huang-Huai-Hai region and beyond. By adopting this density, farmers can maximize yields, enhance NUE, and promote sustainable use of resources. Furthermore, hybrid varieties like Jingmai 17 provide a pathway for leveraging heterosis to address the challenges of rising food demand and environmental pressures.

Future directions

While our study provides a robust foundation for optimizing hybrid wheat cultivation, further research is needed to: Investigate the interactions between planting density, nitrogen application rates, and irrigation practices under diverse environmental conditions. Integrate precision agriculture technologies to fine-tune management practices for hybrid wheat. Explore the genetic and physiological mechanisms underlying the superior performance of hybrids like Jingmai 17.

CONCLUSION

The hybrid wheat variety Jingmai 17 exemplifies the potential of genetic innovation to meet the dual goals of productivity and sustainability. By adopting the optimal planting density of 300 plants•m^{-2}, farmers can achieve significant yield improvements while enhancing NUE. These findings not only advance our understanding of wheat agronomy but also provide actionable strategies for improving food security in key production regions.