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Optimized nitrogen management enhances lodging resistance of rice and its morpho-anatomical, mechanical, and molecular mechanisms

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Abstract

Increasing evidence shows that improved nitrogen management can enhance lodging resistance and lower internodes play a key role in the lodging resistance of rice. However, little is known about the cellular and molecular mechanisms underlying the enhanced lodging resistance under improved nitrogen management. In the present study, two rice varieties, with contrasting lodging resistance, were grown under optimized N management (OPT) and farmers' fertilizer practices. Under OPT, the lower internodes of both cultivars were shorter but the upper internodes were longer, while both culm diameter and wall thickness of lower internodes were dramatically increased. Microscopic examination showed that the culm wall of lower internodes under OPT contained more sclerenchyma cells beneath epidermis and vascular bundle sheath. The genome-wide gene expression profiling revealed that transcription of genes encoding cell wall loosening factors was down-regulated while transcription of genes participating in lignin and starch synthesis was up-regulated under OPT, resulting in inhibition of longitudinal growth, promotion in transverse growth of lower internodes and enhancement of lodging resistance. This is the first comprehensive report on the morpho-anatomical, mechanical, and molecular mechanisms of lodging resistance of rice under optimized N management.

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