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Leaf-colour modification affects canopy photosynthesis, dry-matter accumulation and yield traits in rice

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Abstract

Recent research has proposed to modify leaf-colour traits to improve canopy photosynthesis (A_c) by allowing light penetration to lower layers of a dense canopy. However, whether and how enhanced light penetration can really increase A_c and whether leaf-colour modification influences other growth-related traits remain unclear. Canopy light and nitrogen profile parameters (i.e., the extinction coefficient for light, K_L ; and for nitrogen, K_N ; and their ratio, K_N/K_L), A_c , and agronomic yield traits were examined in nine rice genotypes comprising different genetic backgrounds and their leaf-colour variants. Compared with stay-green (G) variants, yellow-leaf (Y) variants caused larger effects on crop growth and development: altered growth duration (increased in one genetic background while decreased in the other), lower tiller number, and reduced leaf area. As with G traits, a delayed senescence at the post-flowering stage was observed in Y variants, which was associated with nitrogen dynamics in plants. Although Y variants expectedly allowed more light penetration into lower layers of the canopy (i.e., lower K_L), the local leaf-nitrogen, and thus, local leaf photosynthetic capacity (i.e., A_{max}) profiles did not necessarily follow more closely the light profile. Improved A_c was observed in the Y variant of one genetic background but not of the other, and the higher A_c was due to improved leaf photosynthetic nitrogen use efficiency and higher canopy K_N values. This contributed to its higher daily crop growth rate (CGR) and thus greater yield productivity. Multiple regression analysis of the data of all nine genotypes indicated that the $K_N:K_L$ ratio was the most important factor determining A_c and CGR. Our results suggest that phenotypic variations of multiple traits caused by leaf-colour modification can be exploited by breeding or crop management for improving rice biomass and yield.

Keywords: agronomic trait, canopy photosynthesis, light and nitrogen profile, *Oryza sativa*, stay-green and yellow-leaf variants