Capturing the Spatiotemporal Dynamics of Heat Stress Response Using a 3D-Reconstrution Approach

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Abstract

Plant response to environmental stresses varies with time and is not uniformly manifested across the entire plant or specific organs. However, in most cases the phenotypic responses are measured at a single time point and lack spatial resolution. In this study, we aimed to develop and test a non-destructive approach to capture the dynamic plant stress responses over a time course and with spatial resolution. We used the rice panicle as the organ with known spatial heterogeneity and heat stress as the environmental perturbation. We used a series of 2D RGB images to reconstruction the rice panicle at high resolution. This analysis was applied to the rice diversity panel and enabled us to identify multiple loci regulating heat stress response by combining the 3D-reconstruction derived-approach digital traits with genome-wide association analysis. We further validated this approach with gene edits to confirm the role of the identified targets genes in heat stress response. In summary, our results present a high spatiotemporal resolution approach to identify digitals traits and underlying genetic variation that is unlikely to have emerged from conventional image-based phenotyping.

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