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New Heat Resilient Rice Varieties Addressing Climate Change in South and South-East Asia (IRRI)

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Abstract

Changing climates with rising temperatures pose a major threat to sustaining rice production in Asia and Africa, and to global food security. High night temperatures (HNT) cause rice grain yields in Asia to decline by 10 % for every 1°C (>23 °C) rise in minimum temperature in rice-growing seasons, and these losses are currently widespread. Under HNT, increases in rates of dark respiration create an imbalance in source-sink relationship with reduced carbohydrate supply to developing seeds, thereby reducing grain yield and quality. Through our extensive screening of MAGICheat population, promising lines have been identified from multiple locations and seasons experiments and they are valuable materials for beneficiary, like NARES breeders with at least 1.5 to 2 $^{\text{tonnes}}/_{\text{hectare}}$. The identified QTLs are good sources for breeding heat-tolerant lines for HNT hotspot regions. Within a subset of lines, increased Rn was related to lowering spikelet number per panicle and thus reduced yield. HNT enhanced the night-time consumption of non-structural carbohydrates (NSC) in stem tissue, but not in leaves, and stem night-time NSC consumption was negatively correlated with yield. Between heading and harvest, the main form of stem NSC remobilisation was starch, not soluble sugar. HNT weakened the relationship between NSC remobilisation and harvest index at both the phenotypic and genetic level. Through genome wide association studies (GWAS), an invertase inhibitor, MADS box transcription factors and a UDP-glycosyltransferase that were identified as candidate genes orchestrating stem NSC remobilisation prominent under control were lost under HNT. Through identification of physiological and genetic components related to rice HNT response, this study can help specify breeding targets to sustain yield stability under climate change. These outputs will be beneficial to breeders, and farmers in the regions of rice productivity suffering with heat stress. The tolerant lines with clear yield advantage under HNT were characterised for grain quality preferences and identified lines matching local preferences of Myanmar. Based on conservative estimates, the potential production loss avoided with the adoption of HNT tolerant rice varieties in Bangladesh and Myanmar is 1.2M and 1.7 M tons of paddy, respectively (total of 2.9 M tons for the two countries). This is equivalent to 296M USD for Bangladesh and 348M USD for Myanmar.

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