512

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Global Rice Field laboratory to understand rice response to climate variability

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Adapting rice cropping systems to climate change requires new tolerant varieties. Harnessing genetic diversity is crucial to adapt to contrasting environments. We present results from a global rice array (GRA) network built to evaluate 50 varieties nominated by breeders in 52 trials carried out by CG centers, CIRAD, IRD and NARES institutions, in 21 sites across Asia, Africa, and Latin America, from 2018 to 2020. Grain yield varied greatly among varieties, sites, and seasons. Seven Mega-environments (ME) were determined depending on whether abiotic and/or biotic constraints prevailed. ME1 and ME2 showed the highest grain yield, along with high cumulative radiation, while differing in relative humidity and maximum temperatures. In these ME, varieties like Kinandang Pathong, Tequing, and TN1, selected for deep root systems, high yield, and disease sensitivity respectively, showed their potential. Abiotic stresses led to significant yield losses: 10% in ME3, 40% in ME4, and 52% in ME6 compared to ME1 and ME2, due to high frequencies of maximum temperatures above 33°C and night temperatures surpassing 24°C during the reproductive and grain filling stages. Elevated night temperatures led to reduced grain yields for majority of varieties except Nanhi, an Aus Landrace variety. In ME5 and ME7 biotic stresses reduced grain yield. Bacterial blight and blast had the highest damage scores, together with high relative humidity during reproductive and grain filling stages and yield losses of 40% and 52%. However, Chomrong Dhan, one of the tested disease-tolerant variety, consistently demonstrated stable grain yields in both ME5 and ME7. Overall, disease-tolerant varieties performed better than others in MEs with biotic stress. However, Abiotic stress-tolerant varieties did not exhibit a consistent pattern of superiority in ME's with abiotic stress conditions. The GRA network enabled the definition of ME with stress profiles that are likely to occur in the mid to long-term future and identify genotypes that are either adapted or susceptible to these stress conditions. Additionally, the sequencing of all GRA varieties gives the possibility to explore potential candidate genes for stress tolerance, thereby supporting the development of climate-resilient genotypes.