Adapting the Rice Crop to Hotter Environments: Current and Future Activities at IRRI

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Future climate scenarios are claiming for an increase in global temperature of 2 to 4°C by 2100 in the rice production areas in Asia. One of the mandates of the International Rice Research Institute is to predict to what extent the different rice growing areas will be affected, to analyze consequences on rice production and to provide adaptive strategies. A regional assessment of vulnerability to heat has been conducted by IRRI scientists on rice cropping areas by linking ORYZA2000 with Geographic Information System (GIS). The establishment of a spatio-temporal geo-statistical framework will soon allow identifying regions of risks of heat induced sterility, for which the threshold panicle temperature commonly ranges from 35 to 38°C with respect to the variety. To face this major issue, IRRI scientists are conducting multi-location testing of promising varieties and developing new genetic materials by screening donors from gene bank accessions. Some heat tolerance breeding populations have been developed and dispatched for hotspot screening, and 4 QTL mapping populations have been developed for polymorphism characterization. In addition, anthers of 3 lines contrasted for heat induced sterility were extracted, and some candidate genes are currently being sequenced and will be targeted for transformation. Donors for earlier time of the day of anthesis are investigated for heat induced sterility avoidance: 42 lines among 4000 from the IRRI gene bank accessions appeared to have peaked by 9am and were sent for testing in 5 Asian countries. An integrated phenotyping study for earlier time of the day of anthesis, heat tolerance to sterility and heat tolerance to chalkiness during grain filling, is actually conducted on a set of 212 contrasted accessions in the phytotron. Indeed, IRRI scientists demonstrated under plant temperatures higher than 30°C that genotypes that did not adapt to high temperature produced chalky grains whereas those that sacrificed part of their sink size maintained high quality grains. Similarly, such temperature regimes affect plant growth processes also at earlier stages like for leaf elongation rate. In the case of addressing confounding effects of climatic factors, the correlation observed during the last 15 years in the IRRI farm between the increase in night time temperature from 22 to 24°C and the reduction in grain yield is now confronted with additional data collected in a contrasted night temperature setup in the field. In collaboration with IRRI, scientists from Cirad and NIAES are collecting data in various field environments to quantify panicle temperature and predict its variation with regard to weather conditions, crop architecture and plant cooling ability. At the same time, IRRI scientists are developing the energy balance and exchange routines of ORYZA2000 and adding routines for canopy temperature and spikelet sterility. Considering rice is often grown in humid environments and soon under doubling air [CO_2], additional routines addressing interactions between temperature, humidity and [CO_2] will be developed by IRRI collaborators and included into crop models. Such cumulated efforts from rice scientists are necessary to face the challenges of future climate scenarios and make the rice production systems more resilient.