

【Workshop 2】 Crop Production under Heat Stress
Effects of High Night Temperature and Plant Growth Regulators on
U.S. Rice (*Oryza sativa* subsp. *japonica*) Productivity

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For crop scientists, the biggest challenge is to increase crop production in the future. The increase in global temperature will decrease crop productivity per acreage, thereby increasing demand for global food production. Moreover, as a result of global warming, the nighttime temperatures are predicted to increase more than the daytime temperatures and have been implicated in lowering yields throughout the world. The presence of seasonally high nighttime temperatures (HNT) in the rice growing areas, occurring during the critical stages of development, could reduce rice yield and quality. The objective of this study was to determine the effects of HNT and plant growth regulators (vitamin E, glycine betaine [GB], salicylic acid [SA]) on growth, development and physiology of rice plants.

Plants were grown under ambient nighttime temperature (ANT) (27 °C) and HNT (32 °C) in the greenhouse. They were subjected to a HNT through use of continuously controlled infrared heaters. Nighttime temperatures were imposed from 2000h until 0600h. Net photosynthesis (P_n) of the penultimate leaves from three plants in each treatment was measured between 1000 h and 1200 h using a LI-6400 portable photosynthetic system (LI-COR Inc., Lincoln, Nebraska, USA) at pre-boot, boot, early grain-fill and mid-dough stages. Respiration rates were measured on the penultimate leaves between 2400 h and 0200 h using a LI-6400 at boot, early grain-fill and mid-dough stages. Membrane stability was determined at boot stage, and total antioxidant capacity was determined using DPPH (2,2-diphenyl-1-picrylhydrazyl) assay at boot and mid-dough stages. Spikelet fertility was defined as the ratio of filled grains to total number of grains in the panicle. Grain length and width of brown (dehulled) rice were determined using a Winseedle, which uses image analysis of scanned color images of the grain to calculate these parameters. Grain nitrogen concentration was measured using a FP-528 Nitrogen/Protein analyzer.

The results indicated no effects of HNT on photosynthesis; however, HNT increased respiration rates and grain nitrogen concentration, and decreased membrane stability, pollen germination, spikelet fertility, grain length, width, and weight. In addition, HNT hastened the crop development rate, as indicated by the dates of panicle emergence. All the above parameters contributed towards decreased rice yields under HNT. Rice plants treated with GB or SA showed an increase in total antioxidant capacity and yield compared to untreated plants, when grown under ANT and HNT. In conclusion, HNT decreased rice yields and exogenous application of glycine betaine and salicylic acid partially negated the negative effects of HNT possibly acting through increased antioxidant levels, which might have protected the membranes and enzymes against heat-induced ROS-mediated degradation.