【Workshop 2】Crop Production under Heat Stress

High Nocturnal Temperature Effects on Growth and Gas Exchange Rates during the Vegetative Stage of Rice

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Global climate change will have profound effects on rice production and the livelihood of rice farmers. Rising air temperature or more frequent occurrence of extreme heat or drought brought about by shifts in weather patterns may increase crop yield losses. The 4th Inter-governmental Panel for Climate Change Assessment Report showed that minimum temperature increased about twice as maximum temperature over global land areas since 1950 (0.204 vs. 0.141 per decade). Earlier findings at IRRI showed that high night temperature (HNT) accounted for the year-to-year variation in rice grain yield. Lesser vegetative growth is one of the major reasons for the limited grain yield under HNT. However, the mechanism of HNT effect during the vegetative stage has not been fully understood. Using controlled-environment growth chambers, we conducted pot experiments to determine the responses of three genotypes to the HNT treatment imposed during the vegetative stage. We used three rice cultivars: Nipponbare (japonica), and IR36 and IR72 (indica), which were grown in 5-L pots at 30/21 ^{o}C (LNT) and 30/25^{o}C (HNT) day/night temperatures. We measured photosynthesis, night respiration rates, and plant growth parameters at the end of the vegetative growth period. The HNT treatment increased leaf area by 3-16% and total biomass of genotypes, except for IR36, where a 9% reduction in total biomass was observed. Plants grown at HNT had thinner leaves as shown by higher specific leaf area, which increased by 3-6%. SPAD values, which are estimates of the leaf chlorophyll content decreased by 2-4% at HNT. Across genotypes, whole plant dark respiration increased with HNT by an average of 20 %, but there were noted differences among varieties. The increase in respiration was higher in both IR36 and IR72 and not remarkable in Nipponbare. The specific dark respiration (dark respiration divided by dry weight) showed a modest response to HNT (by an average of 14%), compared to the whole plant respiration, suggesting that the increase in biomass in part accounts for the HNT effect on dark respiration. Photosynthetic rate measured under photosynthetically active radiation of 1800 μmol m^{-2} s^{-1} was not significantly affected by the HNT treatment in all the genotypes tested, despite the generally lower SPAD readings under HNT. These preliminary results showed that HNT enhanced vegetative growth of rice plants mainly by promoting leaf development, which was quite different from previous field observations. Experiments are still on-going to determine the after-effects of HNT and its effects on spikelet formation and degeneration during the reproductive growth period.