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Water-carbon exchange at the leaf scale of rice in response to elevated temperature

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Global warming with climate change may affect the process of water consumption and carbon uptake of rice. However, the specific impact of elevated air temperature on the water-carbon exchange at the leaf scale of rice remains unclear currently. In this study, a three-year warming experiment was conducted in Jiangnan Plain, China, and three treatments were set within natural supplemental light climate chambers in the field, mimicking ambient air temperature (ET_0), an increase of 2°C (ET_2), and an increase of 5°C (ET_5), respectively. The objective was to investigate the direct effects of increasing air temperature on transpiration, photosynthesis, stomatal behavior, and leaf growth status of rice plants throughout the whole growth stage, while clarifying the indirect effects of variations in leaf growth status on carbon uptake and water consumption of rice. In this experimental area, the results indicated that treatments ET_2 and ET_5 during the vegetative growth phase led to an increase in transpiration rate (T_r) but a decrease in the net photosynthetic rate (A_n) compared to ET_0 , consequently lowering water use efficiency (WUE). Stomatal conductance (G_s) decreased initially and then increased with air temperature, showing a critical point at 35°C , while leaf area index (LAI) and leaf weight (LW) decreased due to increasing air temperature. However, during the reproductive growth phase, chlorophyll content (CCI), LAI and LW in treatments ET_2 and ET_5 were higher compared to ET_0 due to a deceleration in the decline rate, enhancing leaf photosynthetic capacity and resulting in increased A_n . Consequently, the WUE also increased. The results showed that both elevated temperature and the leaf growth status differences caused by long-term high temperature had significant effects on leaf water-carbon exchange processes of rice.

Key words: elevated temperature, transpiration, photosynthesis, stomatal conductance, water use efficiency