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Analysis of Photosynthesis Depression under Low Leaf Water Potential by Comparison of CO_2 Exchange and O_2 Evolution Rates

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Abstract:
Reductions in CO_2 supply through stomata and photosynthetic capacity in mesophyll are the two major processes for depression of photosynthesis under water stress conditions. The objective was to clarify which process limits photosynthesis of rice and sunflower plants most dominantly by comparing rates of CO_2 exchange by an infrared CO_2 analyzer method as well as O_2 evolution by an oxygen evolution method on leaves in the decreasing process of water potential. Since diffusive conductance of leaves under water stress is low, photosynthetic capacity needs to be measured at the highest CO_2 concentration where there is no CO_2 inhibition effect on photosynthesis. One hundred and twenty mLL^{-1} was the highest CO_2 concentration at which photosynthetic capacity could be measured without the damage to leaves of both plants. It was also clear that diffusive conductance did not affect O_2 evolution rate at 120 mLL^{-1} of CO_2 concentration unless diffusive conductance decreased to lower than 0.09 mol $m^{-2}s^{-1}$. Leaf water potential, at which CO_2 exchange rate at 350 μLL^{-1} of CO_2 concentration started to decrease, was higher than the O_2 evolution rate in both plants. These results suggested that the initial depression of photosynthesis due to water stress might be caused by stomatal closure only. As leaf water potential decreased further, the reduction of the photosynthetic capacity might also contribute to the depression of photosynthesis.

Keywords:
Air phase oxygen electrode, Infrared CO_2 analyzer, Photosynthesis, Photosynthetic capacity, Rice plant, Stomata, Sunflower plant, Water stress

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