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Effects of Atmospheric Partial Pressure of Carbon Dioxide and Phosphorus Nutrition on the Ultrastructure of Rice (Oryza sativa L.) Chloroplasts

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Abstract:

Rice plants were grown in artificially illuminated growth cabinets under combinations of atmospheric partial pressure of CO_2 (35 vs. 70 Pa) and phosphorus (P) nutrition (3 vs. 300 µM) to examine their effects on the ultrastructure of rice chloroplasts. The 9th and flag (terminal) leaves were harvested 3 days after full expansion and ultrathin sections were prepared for transmission electron microscopy. In general, starch accumulation was observed in both the mesophyll and the vascular bundle sheath cell chloroplasts with more accumulation in the former. In the 9th leaf, chloroplasts developed under ambient CO_2 (35 Pa) accumulated starch grains at deficient P (3 µM) but these grains decreased at sufficient P (300 µM). On the other hand, chloroplasts under high CO_2 (70 Pa) accumulated few starch grains at deficient P but the grains increased at sufficient P. In the flag leaf, starch accumulation increased with increasing CO_2 and P levels. Under high CO_2 and sufficient P, several huge, spherical starch grains accumulated and the thylakoids and grana were deformed. These observations suggested that in the 9th leaf, the high CO_2 promoted photosynthesis and produced too much carbohydrate to translocate irrespective of sufficient P, and in the flag leaf starch accumulation decreased the capacity of electron transport in addition to the feedback inhibition of carbon reduction.

Keywords:

Carbon dioxide, Chloroplast, Mesophyll cell, Rice, Phosphorus, Starch accumulation, Vascular bundle sheath cell

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