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研究论文

转玉米C 4光合酶基因水稻株系中的光合C4微循环

季本华,朱素琴,焦德茂

南通师范学院生命科学与技术系，江苏南通 226007

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摘要 用转PEPC、PPDK、NADP-ME、PEPC+PPDK等酶基因的水稻株系及原种野生型(WT)为材料，研究了不同基因型水稻叶片中的C4光合微循环及其功能。用外源OAA或MA饲喂叶切片或离体叶绿体后，光合放氧速率在野生型水稻中增加了50%、在NADP-ME-和PPDK-转基因水稻中增加了50%～54%、在PEPC- 和PEPC+PPDK-转基因水稻中增加了100%～150%，证明原种水稻Kitaake叶片中具有一个原初的和有限的C4光合微循环，除PPDK基因、NADP-ME基因外，外源PEPC基因或PEPC+PPDK双基因导入原种水稻Kitaake后，可大幅度提高C4光合微循环的运行。水稻中C4光合微循环的增强有降低光呼吸速率(Pr)、增加净光合速率(Pn)的作用，在光能利用上，可增加PS Ⅱ光化学效率(Fv/Fm)、光化学猝灭(qp)、降低非光化学猝灭(qN)的作用;这些结果为转C4光合酶基因水稻中建立C4微循环系统来提高光合作用效率的可能性提供了依据。

关键词 转基因水稻 C4微循环 叶绿素荧光 C4-光合酶 草酰乙酸 苹果酸

分类号

Photosynthetic C4-Microcycle in Transgenic Rice Plant Lines Expressing the Maize C4-Photosynthetic Enzymes

JI Ben-Hua,ZHU Su-Qin1,JIAO De-Mao

Department of Life Sciences and Technology, Nantong Normal University, Nantong, 226007, Jiangsu

Abstract Photosynthetic C4-microcycle and its function in photosynthetic apparatus were explored by comparing the transgenic rice lines expressing the maize C4-specific PEPC gene, PPDK gene, NADP-ME gene and PEPC+PPDK double genes with their wild type rice Kitaake. The activities of photosynthetic C4-pathway related key enzymes, PEPC, NADP-ME, PPDK were detected in both wild type rice Kitaake and transgenic rice. Photosynthetic oxygen-evolution rates of leaf segments or intact chloroplasts in vitro fed with oxaloacetate (OAA) or malate (MA) increased by 50% in wild type rice Kitaake, by 50%—54% in NADP-ME- and PPDK-transgenic rices (no significant difference with wild type rice Kitaake), by 100%—150% in PEPC- and PEPC+PPDK- transgenic rices, which indicated that there was a primitive and limited photosynthetic C4-microcycle in wild type C3-rice Kitaake, and heterogenous PEPC gene and/or PEPC+PPDK double genes, with the exception of PPDK gene and NADP-ME gene, from C4-plant could enhance the operation of existed C4-microcycle in C3-transgenic rice Kitaake. As the photosynthetic C4-microcycle enhanced, the rates of photorespiration (Pr) were lowered and the net photosynthetic rates increased by determining the CO2 exchanging rates, and as a consequence, PS Ⅱ photochemical efficiency (Fv/Fm) and photochemical quenching (qp) increased accompanied with a decrease in the non-photochemical quenching (qN) by determining the chlorophyll fluorescence characteristics. Above results might offer the experimental evidences for photosynthetic efficiency-raising gene engineering of rice.

Key words Transgenic rice Photosynthetic C4-microcycle Chlorophyll fluorescence Photosynthetic C4-enzyme Oxaloacetate Malate

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通讯作者 焦德茂 photosyn@public1.ptt.js.cn