Heat and gas exchanges under microgravity conditions in space

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Plant growth and reproduction in space have recently been a matter of the utmost concern as the possibility of realizing manned space flight over a long term increases. The feasibility of achieving long term manned space missions is strongly dependent on plant production systems in the Bioregenerative Life Support Systems (BLSS). Plants cultured in the BLSS will play important roles in food production, CO2/O2 conversion and water purification. Life support of crews in space is greatly dependent on the amounts of food, atmospheric O2 and clean water produced by plants. Therefore, the BLSS with scheduling of crop production, obtaining high yields with a rapid turnover rate, converting atmospheric CO2 to O2 and purifying water should be established with precisely controlling environmental variables around plants grown at a high density in a limited space. In this study, effects of gravity on heat and gas exchanges between plants and the ambient air were investigated in parabolic airplane flight experiments. Suppressions of photosynthesis and transpiration and temperature increases in plant leaves and reproductive organs such as anthers and stigmas were confirmed. Suppressions of photosynthesis and transpiration could cause retardation of vegetative growth and excess temperature increases in reproductive organs could cause fertility impediments and thus produce sterile seeds. There is a possibility such a situation could occur in BLSS under microgravity conditions in space because there will be little natural convective or thermal mixing. Proper environmental control is essential to promote the plant growth not only in the vegetative growth stages but also in the reproductive growth stages in space.