Effects of light intensity, light quality and air velocity on temperature in reproductive organs of plants

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Excess temperature increase in plant reproductive organs such as anthers and stigmata could cause fertility impediments and thus produce sterile seeds under artificial lighting conditions in closed plant growth facilities. There is a possibility that the aberration was caused by an excess increase in temperatures of reproductive organs in Bioregenerative Life Support Systems under microgravity conditions in space. The fundamental study was conducted to know the thermal situation of the plant reproductive organs as affected by light intensity, light quality and air velocity on the earth and to estimate the excess temperature increase in the reproductive organs in closed plant growth facilities in space. Thermal images of reproductive organs of rice and strawberry were captured using infrared thermography at an air temperature of 10˚C. The temperatures in flowers at 300 μmol m^{-2} s^{-1} PPFD under the lights from red LEDs, white LEDs, blue LEDs, fluorescent lamps and incandescent lamps increased by 1.4, 1.7, 1.9, 6.0 and 25.3˚C, respectively, for rice, and by 2.8, 3.4, 4.1, 7.8 and 43.4˚C, respectively, for strawberry. The flower temperatures increased with increasing PPFD levels. The temperatures in petals, anthers and stigmas of strawberry at 300 μmol m^{-2} s^{-1} PPFD under incandescent lamps increased by 32.7, 29.0 and 26.6˚C, respectively, at 0.1 m s^{-1} air velocity, and by 20.6, 18.5 and 15.9˚C, respectively, at 0.8 m s^{-1} air velocity. The temperatures of reproductive organs decreased with increasing air velocities. It was confirmed that the LED was an appropriate light source for providing high PPFD with less heat load on plant reproductive organs than other light sources. Flower temperatures were higher than the air temperature even under LEDs and air movement was essential to reduce the temperatures of plant reproductive organs in closed plant growth facilities.