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Life and Microgravity Sciences on board ISS and beyond (Part II) (7)

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EFFECTS OF SPACE ENVIRONMENT ON PLANT CELL GROWTH AND PROLIFERATION. ROLE OF RED LIGHT IN COUNTERACTING GRAVITATIONAL STRESS AND PROMOTING ADAPTATION.

Abstract

Human space exploration must be accompanied by plants, as essential components of Bioregenerative Life Support Systems. Plant growth and development are driven by the gravity vector by means of gravitropism. Successful plant growth in space requires full knowledge of the mechanisms of sensing and response to the microgravity environment. In the root, gravity signals are transduced to meristems through the hormone auxin and they regulate the coordination between cell proliferation (cell cycle progression) and cell growth (protein synthesis, ribosome biogenesis) in the root meristem, the tissue that provides the mother cells for differentiation. This coordination is called "meristematic competence". Young plants (seedlings) grown in real or simulated microgravity show alterations in the root meristematic cells, consisting of an increased proliferation rate (cell cycle acceleration) and a decreased growth rate (reduced ribosome biogenesis). This means the disruption of meristematic competence. We also observed accumulation of auxin in root meristems of plants exposed to microgravity conditions, suggesting that auxin transport was disturbed as seen in DII-Venus reporter line. Furthermore, there is an important reorganization of the general pattern of gene expression. These alterations could seriously compromise the developmental patterns of the plant. However, it has been recently shown that apparently normal adult plants and flowers can be produced in the ISS, revealing that plants eventually adapt to survive in space. The study of the adaptation mechanisms is one of our major challenges for the near future. The results of

the ESA-NASA experiment "Seedling Growth", carried out in the International Space Station, have shown that light may act as a replacing tropistic stimulus of gravity, driving plant growth in microgravity. Novel phototropisms have been identified in space, which do not exist on ground. Illumination, particularly with red light, is capable of reverting (totally or partially) the alterations caused by microgravity and of re-establishing meristematic competence, auxin transport and the gene expression patterns to standard values of control environmental conditions.