Challenges of Life Support - Medical Support for Manned Space Exploration (9)
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# APPLICATION OF IRON NANOPARTICLES AS A POTENTIAL IRON FERTILIZER IN CELSS

**Abstract**

During the last decade, a new application of nanobiological technology was put forward to boost crop production and quality in Controlled Ecological Life Support System (CELSS) to provide the life support requirements for the astronaut. And the nanotechnology has been applied successfully in space botany research in Russia recently. However, the mechanisms of nanomaterials on plant are poorly understood. In this study, we performed systematic analysis of the effect of nanozero valent iron (nZVI) on leaves, stems and roots with the crop plant *Capsicum annuum* using the light and electron microscope analyses. Experiments were designed with three concentrations treatment of iron element: 0.1mM/L Fe2+ ions, 0.05mM/L nZVI nanoparticles and the MS medium without any iron content as control. After 20 days growth period, the 0.05mM/L nZVI-treated seedlings showed the greatest increase in plant height (10.60±0.56 cm), which almost twice of the control. Compared to the control and Fe2+ ions-treatment, the number of chloroplast per cell was also significantly increased under 0.05mM/L nZVI-treatment. Transmission electron microscopy (TEM) images showed that the mesophyll chloroplasts envelope and grana was severely disrupted in Fe-deficiency plants, while the ultrastructure of chloroplasts was found in the typical form, well organized grana, lamellar network and well developed outer membrane under Fe iron treatment, especially the grana were found to contain relatively more lamellae under the nZVI-treatment than that of Fe2+ ions-treated group. The changes in chloroplasts numbers and structure indicate that the nZVI-treated seedlings possess higher photosynthesis efficiency than control and Fe2+ ions-treated group. Meanwhile, the cell wall thickness measurements of the control and nZVI-treated seedlings were 0.16±0.01$\mu$m and 0.08±0.01$\mu$m, respectively ($P<0.05$), and the mesophyll cells and cortical cells in stem of *C. annuum* were found to be loosely arranged. These results are consistent with the previous study that nZVI induced plant cell rapidly elongation by the formation of a thin and loosening cell wall compared to the slow-growing cells. Moreover, more vascular bundles were observed in the stem and root tissues of nZVI-treated seedlings compared to the seedlings in control and Fe2+ ions-treated group, indicating the high-efficiency absorption of nutrients under the nZVI-treatment. These findings emphasized that low concentration of nZVI nanoparticles do have a significant beneficial impact on the plant growth, and the nZVI nanoparticles have future potential application in CELSS.