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Radiation Fields, Effects and Risks in Human Space Missions (4)

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RESPONSE OF PHASEOLUS VULGARIS L. PLANTS TO LOW-LET IONIZING RADIATION: GROWTH AND OXIDATIVE STRESS

Abstract

The possibility to grow plants in Space represents an important challenge of plant space biology in the sight of future long-duration manned missions. All scenarios for the long-term habitation of space platforms and planetary stations involve plants as fundamental part of Bioregenerative Life Support Systems (BLSS) to support the crew needs. Several constraints may limit plant growth in space: among them ionizing radiation is recognised to severely affect plant cell at morphological, physiological and biochemical level. The exposure of plants to ionizing radiation may also induce radioresistance. The acquisition of radioresistance may be ascribed to both biochemical and molecular mechanisms and is related to plant capability to perform protection mechanisms and to activate repair strategies. In order to explore the mechanisms involved in plant resistance against ionizing radiation, plants of Phaseolus vulgaris L. have been irradiated with different doses of X-rays ranging from 0.3 to 100 Gy. In particular, the effects of X-rays on plant growth have been assessed by measuring stem elongation, number of internodes and leaf area measurements. Moreover, in order to evaluate if the leaf sensitivity to X-rays depends on leaf growth stage at the moment of irradiation, leaves irradiated at complete development, and leaves irradiated while developing have been analysed. The integrity of photosynthetic apparatus in both leaf stages was evaluated by photosynthetic pigment composition and Rubisco expression, whereas changes in total antioxidant pool and glutathione S transferase activity (GST) have been utilized as markers of oxidative stress. At 50 and 100 Gy, in both leaf populations, a reduction of plant growth, a decrease of photosynthetic pigment concentration as well as an increase of total antioxidant content and GST activity compared to control were found. More specifically, leaves developing at the time of irradiation showed an lower resistance to radiation. In this population a partial Rubisco fragmentation at 100 Gy was also observed. These data were discussed also considering the distribution of phenolic compounds throughout tissues assessed by means of cytological analyses through epi-fluorescence microscopy. The overall results were pondered to estimate the potential for radioresistance in P. vulgaris in the sight of its suitability for cultivation in BLSSs.