Biological effects due to weak magnetic field on plants

N.A. Belyavskaya ,

Institute of Botany, 2 Tereschenkivska Str., Kyiv 01601, Ukraine

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Abstract

Throughout the evolution process, Earthôs magnetic field (MF, about 50 εT) was a natural component of the environment for living organisms. Biological objects, flying on planned long-term interplanetary missions, would experience much weaker magnetic fields, since galactic MF is known to be 0.1ï 1 nT. However, the role of weak magnetic fields and their influence on functioning of biological organisms are still insufficiently understood, and is actively studied. Numerous experiments with seedlings of different plant species placed in weak magnetic field have shown that the growth of their primary roots is inhibited during early germination stages in comparison with control. The proliferative activity and cell reproduction in meristem of plant roots are reduced in weak magnetic field. Cell reproductive cycle slows down due to the expansion of G1 phase in many plant species (and of G2 phase in flax and lentil roots), while other phases of cell cycle remain relatively stabile. In plant cells exposed to weak magnetic field, the functional activity of genome at early pre-replicate period is shown to decrease. Weak magnetic field causes intensification of protein synthesis and disintegration in plant roots. At ultrastructural level, changes in distribution of condensed chromatin and nucleolus compactization in nuclei, noticeable accumulation of lipid bodies, development of a lytic compartment (vacuoles, cytosegresomes and paramural bodies), and reduction of phytoferritin in plastids in meristem cells were observed in pea roots exposed to weak magnetic field. Mitochondria were found to be very sensitive to weak magnetic field: their size and relative volume in cells increase, matrix becomes electron-transparent, and cristae reduce. Cytochemical studies indicate that cells of plant roots exposed to weak magnetic field show Ca2+ over-saturation in all organelles and in cytoplasm unlike the control ones. The data presented suggest that prolonged exposures of plants to weak magnetic field may cause different biological effects at the cellular, tissue and organ levels. They may be functionally related to systems that regulate plant metabolism including the intracellular Ca2+ homeostasis. However, our understanding of very complex fundamental mechanisms and sites of interactions between weak magnetic fields and biological systems is still incomplete and still deserve strong research efforts.

Keywords: Space life science; Weak magnetic field; Botany; Plant cells