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EFFECTS OF HYPOMAGNETIC FIELD AND PEMF ON PLANTS FOR LIFE SUPPORT ON PLANETARY BODIES

Abstract

Hypomagnetic field research suggests a lack of electromagnetic fields beyond Earth is considered a hazard to the health of terrestrial organisms, bacteria, plants, and humans. Pulsed electromagnetic fields (PEMF) can be used to simulate Earth's geomagnetic field to help improve the quality of life in orbit, in space, on planetary bodies such as the Moon, Mars and beyond.

PEMF of optimal cycles, durations, and intensities hold the potential to sustain the health, cellular communication and processes of photosynthetic organisms in near null field space environments. This study outlines the results and effects from a 6-month experiment of the near null magnetic Field (NNMF) and PEMF on (i) photosynthetic organisms such as cilantro, kale, butterhead lettuce, basel, arugula, and spirulina using commercial off-the-shelf (COTS) equipment, Helmholtz coil, T340 EM wave generator (4-channel, +12 V, 700 mA max), and magnetic shielded box. A larger helmholtz coil 1m3 apparatus was designed to test the effect of NNMF, PEMF, and Mars Crustal Field (MCF; 300 nT to 5 T) on plants and cyanobacteria algae in vitro.

Experiment goals are (i) to evaluate genes that are upregulated/downregulated after hypomagnetic field (HMF) exposure or pulsed fields, and (ii) to identify top three phenotypes most impacted in HMF and potentially impactable from PEMF, and (iii) to determine the effect and relationship of HMF or Crustal Field on ion accumulation and biochemical reactions. After plant exposure to control groups and HMF, spectrophotometer and atomic absorption spectroscopy will be used to monitor effects of HMF on plant mineral ion accumulation after mineralisation, considering the altered ion transport of K, N, Ca ion transport across plant cell membrane has been observed in microgravity.

A spectroradiometer will monitor the microorganisms and soil parameters such as organics, erosion, hydraulic properties, degradation, and soil analysis. RNA-sequencing is performed to identify differentially expressed genes in tissues before and after exposure to EM conditions. Metagenomics and metatranscriptomics will be used to identify all species present and their differentially expressed genes in soil samples before and after exposure to EM conditions. All omics approaches are conducted using the handheld Oxford Nanopore MinION (to simulate remote fieldwork) and/or with traditional sequencing technologies. RNA sequencing will derive statistically significant magnetic field responses and evaluate gene expression associated with hypomagnetic field.

As most biological experiments are conducted within Earth's natural 20-70uT geomagnetic field (GMF), this study is one of the first to simulate the effects of a PEMF and hypo magnetic field or the Mars Crustal field on plants and organisms. The experiment results hold the potential to explain

up and down regulation of genes, proteins, cells, in plants and humans adapting in microgravity and alternative gravity environments.