Plant magnetoreception:
ionomics and lipidomics of plant responses to reduced magnetic fields

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The Earth magnetic field (or geomagnetic field, GMF) is a natural component of our planet and variations of the GMF are perceived by plants by a still uncharacterized magnetoreceptor. In particular, (near null magnetic field, NNMF) caused an early downregulation of clock genes, photoperiod, gibberellin, and vernalization pathways resulting in a delay in the transition to flowering (1). The overall goal of this project is to provide new findings about magnetoreception mechanism of plants. Therefore, the impact of MF intensity variation on i) plant growth and development; ii) plant metabolism (lipid metabolism) and iii) on nutrients homeostasis were carried out to reach our aim. Arabidopsis plants were grown under normal (GMF) and near null magnetic field (NNMF), which was generated by using a triaxial Helmholtz coil system (Fig.1). Morphological, biomolecular, metabolome and ionome analyses were performed on both root and shoot tissues. NNMF-grown plant showed i) a decrease in plant growth, leaf area index and in the number of rosette leaves and ii) a delay of flowering time in reproductive stage. Such impairment of plant growth parameters could be reflected also at the metabolic level. Particularly, plants exposed to NNMF conditions showed a general increase of plant surface alkanes and the increase of unsaturated fatty acids and associated gene expression. Lipids are one of the major components of biological membranes and act as a signaling molecules for abiotic stress, indicating that MF intensity variation is perceived by plants as a stress condition. Moreover, metal homeostasis of plant exposed to NNMF was affected: in particular, a strong induction of genes involved in the Fe uptake was observed. Under Fe deficiency, the Fe uptake genes were activated at lower extent, while Cu and Zn strongly accumulates in NNMF compared to GMF plants. These results indicate that lowering MF intensity impairs metals homeostasis, particularly at the root level. Furthermore, we provide evidence that by transferring plant from GMF to NNMF root Fe reductase activity (which is responsible for the Fe mobilization in the rhizosphere) is affected in vivo. These results indicate that NNMF affects Fe uptake process directly at the root level. Since, it is known that Fe is involved in the maintenance of the Circadian period (2) the effect of NNMF on Circadian clock might be linked to the observed impact of NNMF on Fe homeostasis in plant (3). The obtained results highlight the influence of MF on plant growth. Understanding the nature and function of the plant magnetoreceptor will be important for future space programs involving plant growth in environments with a reduced MF.

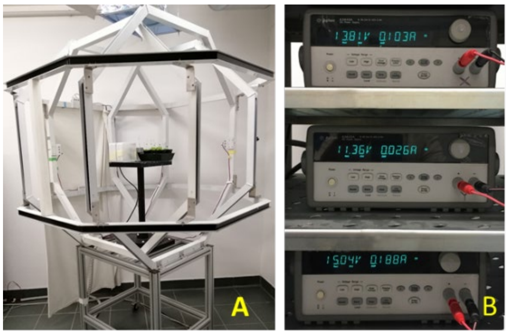

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Fig.1. Geomagnetic field compensation system. (**A**) Triaxial coils (comprised of a Helmholtzpair of octagonal coils for each of three perpendicular axes) for cancelling the geomagnetic field. (**B**) 3 DC power supply.