

GRAVI-2 space experiment: The effects of statolith location on early stages of gravity sensing pathways in lentil roots

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Abstract:

The plant ability to orient their growth with respect to environmental stimuli such as gravity, is a key factor for survival and acclimation to their environment. In heterogeneous soils, plant roots modulate their growth towards gravity, allowing soil exploration and uptake of water and nutrients. Gravity sensing in roots occurs in specialized cells called statocytes, located in the central root cap, and which contain starch-filled plastids called statoliths. Being denser than the cytoplasm, statolith position depends on the inclination of roots. Root growth reorientation, triggered by statoliths displacement, is based on auxin redistribution in the root apex, inducing differential growth between the root upward and downward sides. At the cell scale, signaling events starting from statoliths displacement and leading to auxin redistribution remain poorly documented. Some signaling molecules such as calcium, reactive oxygen species, nitric oxide and inositol 1,4,5-triphosphate are serious candidates previously shown to be involved within minutes before modification of the expression of auxin-related genes. In order to investigate the effects of statoliths location on the triggering of signaling pathways, a space experiment called GRAVI-2 was set up aboard the ISS in 2014. During the experiment, lentil roots were grown in microgravity conditions in the European modular cultivation system (EMCS) and were then submitted to a period of gravity (9h at 0.01 g or 15 min at 2 g). The analysis of statolith location showed that statoliths are clustered in microgravity. This clusterization is not affected by 0.01g. On the contrary, a period of 5 min at 2g induces a change in statolith location. Thanks to these changes in statolith positioning, cytological analysis were coupled with RNA sequencing of root apex. Transcriptomic analyses clearly show a regulation in gene expression. Our data are among the first involving global transcriptomic analyses of root material grown in microgravity and of root submitted to a gravity-short period after a growth in microgravity. The effects of the statolith location on signaling mechanisms will be discussed.

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