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Development of gravitropic response: unusual behavior of flax phloem G-fibres

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Gravitropic response of flax (*Linum usitatissimum* L.) plants is well expressed: several days after the forced inclination for 90° relative to gravity vector direction, plants correct their position in space and return into vertical position. The major input into the restoration of stem position is made by the curvature formed in the stem part that has stopped elongation long before gravistimulation. We applied various approaches of microscopy to analyze the stem curvature region and found the previously uncharacterized significant modifications in primary phloem fibres that have constitutively developed G-layer. In fibres on the pulling stem side, cell portions were widened with formation of "bottlenecks" between them, leading to the "sausage-like" shape of a cell. Lumen diameter in fibre widening increased, while cell wall thickness decreased. Callose was deposited in proximity to "bottlenecks" and sometimes totally occluded their lumen. Structure of fibre cell wall changed considerably, with formation of breaks between G- and S-layers. Thick fibrillar structures that were revealed in fibre cell wall by light microscopy got oblique orientation instead of parallel to the fibre axis one in control plants. Thus, phloem fibres with constitutively formed gelatinous cell wall, located in non-elongating parts of herbal plant, are involved in gravitropism and may become an important element in general understanding of the gravity effects on plants.
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Effect of gamma radiation on root growth in *Arabidopsis thaliana* plants from Chernobyl zone and plants lacking key ion transport and signaling systems

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Introduction. Approximately 80% of radionuclide fallout caused by Chernobyl was received by Belarus. Therefore the effect of radiation on living systems including plants has a special significance for this European country. Plant systems are generally more resistant to gamma irradiation than animals. Moreover, low doses of gamma radiation can stimulate plant growth causing 'radiation hormesis'. However, mechanisms of radiation effects on plant growth at cellular and molecular levels, are largely unknown.
The aim of this study was to characterize growth of different Chernobyl lines and KO mutants of *Arabidopsis thaliana* L. Heynh treated by different doses of exogenous γ-radiation (0.5-30 Gy).
Materials and methods. The growth rate of main root was measured in sterile vertically-grown culture. A number of genotypes were tested including the following: Chernobyl zone plants (collected at effective doses of 0.7 and 5 μSv), knockout mutants of K^+ efflux channel (*gork1-1*), DNA damage response genes (*atm1-1*, *atr1-1* kinases) and histone acetylation systems (*yaf9-a1, yaf9-b2*). Irradiation was carried out during 60 min and then measurement of root length was undertaken during 7 days.
Results. We have found that low doses of γ-radiation (0,5-3 Gy) stimulate WS-0 and Col-0 root growth while high doses inhibit this process. Plants collected in the Chernobyl zone on territories with background radiation of 0,7 μSv have demonstrated extreme sensitivity to low doses. However plants collected in Chernobyl at 5 μSv were similar to control WS. The effect of growth stimulation by low doses was much lower in KO lines of ATM kinases comparing to WS. The knockout of ATR kinases reacted to radiation similar to control WS. Surprisingly, growth stimulation by radiation decreased in KO line of YAF9-B2 histone acetylation control system while the closely related homologue YAF9-A1 demonstrated response closed to WT. Intriguingly, plants lacking outwardly-rectifying potassium channel GORK, demonstrated insensitivity to low doses and did not show a stimulation effect. The inhibition of growth by higher doses of gamma radiation demonstrated significant complexity of effects.

Conclusions. This study showed that low doses of γ-radiation (0.5-3 Gy) stimulate root growth of *Arabidopsis* plants, while high doses (5-30 Gy) inhibit this process. Different ecotypes and genotypes demonstrate specific response to radiation which requires further detailed investigation.
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Closer look on chernobyl area-grown soybean seeds and their adaptation to increased level of ionizing radiation

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Despite of remaining ionizing radiation plants keep growing and reproducing in the radioactive Chernobyl area. However a comprehensive characterization of these mechanisms was missing. Our study reveals that adaptation of investigated soybean plants in this radioactive environment has led to alteration of the developing soybean seed proteome in a specific way that resulted in the production of fertile seeds with low levels of oil and β-conglycinin seed storage proteins. Soybean seeds were harvested from plants grown in non-radioactive (control) and radioactive plots in the Chernobyl area at different stages: four, five, and six weeks after flowering, and at maturity. The abundance of 211 proteins was determined. The results also confirmed previous data indicating that alterations in the proteome include adaptation to heavy metal stress and mobilization of seed storage proteins. The results also suggest that the carbon metabolism in the cytoplasm and plastids has been modified, the activity of the tricarboxylic acid cycle increased and the malonyl-acyl carrier protein condensation decreased during the fatty acid biosynthesis.

Ethylene is involved in the actin cytoskeleton rearrangement during the root gravitropic response of *Arabidopsis thaliana*

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Gravitropism, the directed plant growth with respect to the gravity vector, is regulated by auxin and its polar transport system, several secondary messengers, and by the cytoskeleton. Recently we have shown that the actin cytoskeleton in the root transition zone of *Arabidopsis thaliana* (L.) Heynh was rearranged after gravistimulation (rotation by 90°): the fraction of axially aligned microfilaments decreased and the fraction of oblique and transversally-oriented microfilaments increased. In the present research we have studied the effect of ethylene and inhibitors of its synthesis on actin cytoskeleton rearrangement during the gravitropic response. Application of the ethylene releasing substance ethephon to *A. thaliana* seedlings led to the disassembly of actin microfilaments as well as their broad angle distribution in cells of the root transition zone. This actin rearrangement was escaped by treatment with the ethylene synthesis inhibitor aminoethoxyvinylglycine (AVG). Another negative regulator of ethylene, salicylic acid, was shown to disturb actin microfilament rearrangement as well. We conclude that ethylene is essential for the process of actin cytoskeleton rearrangement in root cortex cells during the gravitropic bending response.
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