Radiation and plants: From soil remediation to interplanetary flights
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According to Professor Vladimir Vodeneev, Head of the Department of Biophysics at Lobachevsky University, the activity of physiological processes, on the one hand, determines the growth of plants, and on the other, is determined by changes at the genetic level. Thus, the study of the physiological and biochemical effects of ionizing radiation can give the most complete and comprehensive picture of the effect of ionizing radiation on plants.

Diagram of the ways in which ionizing radiation influences the activity of physiological processes. Credit: Lobachevsky University

"In the present study, attention is focused on the effect of radiation on the most important physiological processes, including photosynthesis, respiration, long-range transport, the functioning of the hormonal system, and biosynthesis of various compounds. Based on a large amount of experimental data, an analysis was performed of the dose and time dependences of ionizing radiation effects, which show qualitative similarity in relation to various physiological and biochemical processes. The sequence of the stages of these
processes, their mechanisms and cause-effect relationships between them were examined," Vladimir Vodeneev notes.

Primary physico-chemical reactions caused by ionizing radiation, including the formation of various reactive oxygen species (ROS), are the cause of the changes in the functional activity of plants. The study emphasized the role of the long-lived ROS hydrogen peroxide, which mediates the effect of ionizing radiation. It acts not only as a damaging molecule, but also as a universal intracellular messenger and a molecule playing the role of a long-range signal. Thus, in addition to the negative factors of ROS influence on plants, it illustrates some positive aspects of ROS as a source of information transfer at the molecular level.

Nizhny Novgorod scientists have suggested that the influence of ionizing radiation on physiological processes occurs mainly through dysregulation of their activity. Such a dysregulation is apparently due to the existence of cross-talk between plant signaling systems, such as ROS, calcium, hormonal and electrical systems.

The obtained results open up a new stage in studying the possibilities of plant survival under the influence of various adverse factors, including extreme conditions of outer space.


An increase in the level of ROS induced by both acute and chronic irradiation may affect the activity of a wide range of physiological processes through regulation both at the genetic and physiological levels, which ultimately affects the process of plant adaptation to changing environmental conditions.

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