

The project aims to determine whether alarmones – signal molecules are involved in regulating the plant's response to metal starvation. Metals such as zinc (Zn), iron (Fe), copper (Cu), or manganese (Mn) belong to microelements. Microelements are taken up by plants from the soil and are involved in all plants' growth and development processes. About 10% of plant proteins require zinc to function properly. Iron is a part of chlorophyll, and copper and manganese are also necessary for the plant to carry out photosynthesis effectively. The deficiencies of these micronutrients lead to dysfunction of the photosynthetic apparatus and, therefore, negatively affect the development and growth of plants. Microelements in the soil may be present in insufficient quantities or remain in the soil in forms inaccessible to plants. Factors affecting the availability of microelements in soil solution include pH, humidity, and organic matter content. Due to the agricultural techniques used, soil is impoverished in terms of the content and availability of microelements. Plants grown on this type of soil may show delayed growth, development, reduced yield, and edible parts, such as cereals, may contain reduced amounts of nutrients. The low content of microelements in edible parts of plants contributes to microelement deficiencies in humans or animals. Zinc deficiency leads to, among others, an impaired immune system, and iron deficiency is a leading cause of anemia.

Alarmones are unusual guanosine nucleotides that regulate the metabolism and expression of genes in bacterial and plant cells. Alarmones are produced and decomposed by RSH proteins (RelA/SpoT homologs), and they regulate the effectiveness of the photosynthesis process and the level of secondary metabolites, phytohormones, and lipids in plant cells. The presence of stress factors leads to increased production of alarmones and their accumulation, which triggers an adaptive mechanism – stringent response. Stringent response allows the plant organism to adapt to acting stressors such as injury, salinity, drought, the presence of heavy metals, as well as nitrogen deficiency.

The study aims to verify whether alarmones are involved in mechanisms triggered by plants in conditions of microelement deficiency. Planned studies include analyses of changes occurring in transcriptome during metal starvation, testing of cell wall modifications, and measurements of the content of photosynthetic pigments, metabolites, as well as metal content in plant organs and organelles. The molecular mechanisms behind the adaptation of plants to nutrient deficiencies remain poorly understood, making it challenging to obtain varieties of cultivated plants with high micronutrients. Identifying the key components of this puzzle will allow to obtain varieties of plants more resistant to micronutrient deficiency and/or plants that are more efficient in extracting metals from soil.