Local electrical responses in leaves make photosynthesis heat-tolerant

December 27 2017

Plants exist in variable and often unfavorable environmental conditions, which requires the functioning of a variety of adaptive mechanisms for their survival under the action of stressors. The study of such adaptive mechanisms and identifying ways to control them opens up broad prospects for saving agricultural crops under drought and high temperatures, disease development, pests and other factors that threaten plant life. Currently, the vast majority of researchers are involved in the study of relatively slow adaptation processes that develop in the course of hours, days and weeks. However, in the case of a rapid development of stressors, such adaptive responses may not be effective enough. Therefore, it is important to identify mechanisms that lead to the development of adaptive changes within minutes or tens of minutes after the onset of the stress factor.

One such mechanism is related to the electrical responses of plants, which are the object of research done by Vladimir Sukhov, associate professor at the Department of Biophysics, Lobachevsky State University of Nizhny Novgorod, and his colleagues. They have published an article, "High-temperature tolerance of photosynthesis can be linked to local electrical responses in leaves of pea," in *Frontiers in Physiology*, as part of a separate research topic focused on the role of intercellular electric signals in the adaptation and communication of plants.

The researchers have shown for the first time that a moderate increase in leaf temperature induces the development of small electrical responses that last for several minutes. In about half of the experiments, such

responses are observed even when leaf temperature increases to only 30°C, i.e. in conditions typical of the summer period. A more intense heating (up to 40°C and 45°C), which corresponds to extremely high temperatures during the summer season, causes additional electrical responses in plant leaves. This result is of fundamental importance, since in previous studies, the electrical responses were induced by heating the plant parts to a temperature above 50°C. The researchers wondered whether electrical responses that arise under strong heating can be observed under natural conditions or in the field. The findings of Nizhny Novgorod scientists show that this is very likely.

However, the fact that an electrical response is generated does not prove that it takes part in the adaptation process. Previous research showed that electrical responses caused by preliminary strong heating of a plant portion have a notable effect on the photosynthetic process in the plant as a whole and, in particular, increase its resistance to the subsequent action of high temperatures. At the same time, the possibility of a positive effect of the heat-induced electrical responses on the heat resistance of the photosynthetic process required additional analysis, which was carried out by Dr. Sukhov and his group. It was shown that the parameters of electrical signals are closely related to the thermal stability of the photosynthetic process. A higher heat resistance is observed for a higher amplitude of electrical responses, with a greater number of such responses occurring during heating, and also in the case of a lower temperature threshold for the development of the electrical response. The results show that the generation of electrical responses plays an essential role in increasing the thermal stability of photosynthetic processes in plant leaves. Additionally, the development of such an effect does not require extremely high temperatures, and can occur in the conditions of a usual hot day.

The results of this research open wide prospects for developing methods to control the resistance of agricultural plants to high temperatures by

controlling their ability to generate electrical responses. In particular, when there is a threat of high temperatures, which can be estimated on the basis of a weather forecast, or in case of the early detection of thermal damage in plants under field conditions, it is advisable to use methods that facilitate the generation of electrical responses to moderate heating of plant leaves. One such method consists of treating plants with stress hormones, which can significantly affect the state of plants even at very low active concentrations.

Thus, the research work of the Nizhny Novgorod scientists opens the way to controlling plant resistance by regulating electrogenesis. However, for achieving this type of control, it is necessary to implement a feedback system that will allow early diagnosis of the temperature damage of a particular plant (or a group of plants) in field conditions for taking the necessary measures. The main current task of Dr. Sukhov and his team is to create such a system based on the registration of reflective index of leaves.

More information: Vladimir Sukhov et al. High-Temperature Tolerance of Photosynthesis Can Be Linked to Local Electrical Responses in Leaves of Pea, *Frontiers in Physiology* (2017). DOI: 10.3389/fphys.2017.00763

Provided by Lobachevsky University