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Letter to Editor

Novel Approach for Eco-Physiological and Biogeographic Understanding of Signaling Systems in Plants

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Letter to Editor

The role of ion channels in the implementation of complex cellular signaling in plants is well known and undeniable. Since the review by Zimmerman et al [1], the use of local voltage clamp methods (patch clamp) in the study of complex and controlled environmental conditions (pH, salt concentration / conductivity, ion concentrations and osmotic parameters, etc. has become widespread) signaling characteristics, which are, in essence, characteristics and descriptors of the response to these regulators. It has been shown that a number of ions, such as Ca^{2+}, are involved in regulation in signaling networks mediated by redox factors (including reactive oxygen species) and specific conductance / conductivity [2]. Thus, the response of the channelome (a complete set of membrane ion channels and porins) and associated plant signaling pathways depends on environmental conditions, which are determined by environmental and biogeographical factors.

Already at the Plant Signaling 2000 symposium (Pennsylvania State University, May 2000) more than a decade and a half ago, the emphasis was placed on an ecophysiological understanding of signaling systems. It is obvious that the salt and acid properties of soils depend on geographic zonation, and the time of germination and vegetation, regulated by external factors, is different for different biogeographic zones, which makes it possible to formulate certain correlations between the biogeographic properties of the environment, the phenological ecophysiological characteristics of plants and the signaling parameters of ion channels on based on multivariate statistical analysis methods (including MANOVA and MANCOVA).

The difference in salt concentration is associated with the adjustment of signaling to different stages of plant growth and development [3], for this reason, it is also possible to classify the stages at which the plant is at one time or another within the framework of phenospectral periodization, according to the response to salts / their constituent ions (at least within the framework of the "black box" model, comparing the initial and induced states of signaling activity). Clustering and phenospectral classification of these states, being a method of multidimensional clustering, due to the dependence of signal response pathways on many stressors or factors simultaneously (which is currently considered a significant difficulty in the field of data mining, data mining - this is conclusively described in the article [4]), must take into account a complex of criteria of normal and exogenous origin, often competing with each other and leading to counter-directional response effects [5].

In April 2012, "Nature Chemical Biology" published a response to the article "A combinatorial TIR1/AFBAux/IAA co-receptor system for differential sensing of auxin", in which, from a reaction-diffusion, essentially gradient position examined the influence of complexes including auxin and a transcriptional repressor on the diversity of transcriptional programs activated by gradient levels of auxin in different developmental modalities ("Deconstructing auxin sensing" [6]). From the standpoint of plant channelomics, studied by patch clamp methods borrowed from neurophysiology: if we interpret plant signaling systems as "plant neurobiology" within the framework of the concept of Brenner et al. ("Plant neurobiology: an integrated view of plant signaling" [7]), the task of assessing such counter-directional mechanisms can be reduced to assessing the phyto electro physiological effect of the corresponding factors (such as irradiation and concentration of electrobiochemical genesis associated with changes in membrane potentials during the restructuring of signaling pathways).

However, the problem cannot be solved by a simple visual or monofactorial metric assessment of the response due to the diversity of inducing factors and the multifactorial nature of the response to a complex of inducing environmental factors under conditions of phenologically interpreted chemistry of germination, vegetation, etc. processes, in connection with which we propose a radically new approach to assessing these effects, based on multidimensional analysis and pseudospectral processing of data from patch-clamp registries, including in real time in situ, in correlation with registry grams and machine grams of factor clustering, inducing or accompanying changes in bioelectrogenesis in these plants ("phenospectral" data; concentrations of auxins in the environment and target ions in the soil and/or liquid; conductometric and redoxmetric data on the environment, etc.).

Due to the adaptability of plants to environmental conditions and the specificity of the response of these plants to environmental changes, adequate to changes in phenological or biogeographical position, the results of applying this approach (after training the created expert system on a large sample of data based on known examples of correlations) can be used as a taxonomic criterion or as criterion for biogeographic or phenological analysis [8-15].

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