Abstract

The acid growth model, also known as the acid growth hypothesis proposed by Hager in 1971, has been a topic of debate among scientists, having both proponents and opponents. Plant growth is complex and depends on biomechanics, cell wall structure, and modifying proteins. In this dissertation, I aimed to verify this hypothesis. For this purpose, I researched coleoptile segments and whole intact seedlings of selected plant species in the presence of endogenous auxin and after treatment with exogenous growth factors and a growth inhibitor.

The studies demonstrated that the acid growth hypothesis is valid for both auxin (IAA) and fusicoccin (FC). *Ex vivo* experiments on maize (*Zea mays* L.) segments confirmed that the thickness of the cuticle layer significantly affects the intensity of proton efflux, altering the pH level of the surrounding solution. Monte Carlo simulations accepted a simplified model of the coleoptile, showing agreement between experimental results and numerical predictions.

A non-invasive growth measurement technique was used in studies on whole maize seedlings, recording time-lapse macroscopic images with a CCD camera and monitoring pH changes with a meter. The results showed that growth substances absorbed by the root influenced coleoptile growth and acidification, reflecting actual agricultural conditions. Data analysis using a growth functional confirmed the acid growth hypothesis for growing intact plants.

Pollen tubes serve as a model for studying ion dynamics at the cellular level. Despite numerous scientific studies, the role of all incoming and outgoing ions involved in pollen tube elongation is not fully understood. The research focused on pollen tubes of the eastern hyacinth (*Hyacinthus orientalis* L.). A measurement method based on a photovoltaic system (ELoPvC) was developed, enabling the registration of periodic ion currents of H^+, K^+, Ca^{2+}, and Cl^- in the growing pollen tube. Experiments confirmed the existence of ionic oscillations accompanying pollen tube elongation, providing a comprehensive spectrum of gradient and ion flux analysis. This approach opens new possibilities for studying the physiology of growing plant cells in disturbed and undisturbed environmental conditions.

The final part of the studies concerned the effects of various stress factors on extracellular ion fluxes in growing pollen tubes of *H. orientalis* and tobacco (*Nicotiana tabacum* L.). The results suggest that hypertonic, hypotonic stress and low temperatures significantly inhibit ion fluxes, and auxins influence these fluxes. These observations indicate the existence of a subtle balance regulating life processes and potential self-organizing criticality properties of plant cells, which are crucial for understanding life processes.

The findings of this research may serve as a basis for further analysis of plant growth and the action of phytohormones, as well as contribute to a better understanding of the mechanisms regulating plant growth under various environmental conditions.