CATION CHANNELS PLAY THE ROLE OF SENSORS FOR REACTIVE OXYGEN SPECIES IN PLANTS

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The reactive oxygen species (ROS) are involved in all major aspects of plant physiology. ROS are produced by intracellular and extracellular mechanisms and accumulate in the cell wall (apoplast), where the antioxidant capacity is much lower than in cytosol. The moderate generation of ROS is involved in normal plant physiology and adaptation needs but their overproduction, for example during the environmental stress, results in irreversible oxidative damage and dysfunction of cell components (Demidchik 2015, Environ Exp Bot). The question of sensing ROS is still debated in plant physiology. Here, it is demonstrated that the plasma membrane ion channels transporting cations, such as Ca^{2+} and K^+, function as prime targets of ROS in plants. These systems can catalyse early and rapid sensing of ROS in plants involved in a multitude of physiological reactions, such as adaptation to stresses, control of photosynthesis, cell elongation and gravitropic responses. In the plasma membranes of lower and higher plants, ROS instantaneously activate two major classes of ion channels: Ca^{2+}-permeable nonselective cation channels (NSCCs) and K^+ outwardly-rectifying channels (KORs encoded by GORK). Activation of cation channels by ROS leads to dramatic influx of Ca^{2+} for signaling, developmental and nutritional needs and K^+ loss (electrolyte leakage) inducing autophagic and necrotic cell death. Ca^{2+} entry also rearranges actin cytoskeleton and modifies vesicular transport. ROS-activated ion channels reveal complex nature of activation, depending on the developmental stage and oxidative capacity of tested ROS. The transition metal binding centres have recently been identified in some members of cyclic nucleotide-gated channels, a subclass of NSCCs (Demidchik *et al*. 2014, JXB). These centers potentially produce hydroxyl radicals from H_2O_2 (Haber-Weiss reaction) directly in the channel's macromolecule. Mutations in ROS-sensitive moieties in K^+ efflux GORK channel leads to the decrease of ROS-sensing capacity, suggesting that distinct molecular groups are responsible for ROS sensing by ion channels. These moieties probably confer physiological properties related to ROS, such as programmed cell death and autophagy. This study was supported by Russian Science Foundation grant#15-14-30008 to VD.