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Sommario/riassunto

The life of proteins starts and ends as amino acids. In addition to the primary function as protein building blocks, amino acids serve multiple other purposes to make a plant's life worth living. This is true especially for the amino acids of the glutamate family, namely glutamate (Glu), glutamine (Gln), proline (Pro) and arginine (Arg), as well as the product of Glu decarboxylation, ?-aminobutyric acid (GABA). Synthesis, accumulation, interconversion and degradation of these five compounds contribute in many ways to the regulation of plant development and to responses to environmental challenges. Glu and Gln hold key positions as entry points and master regulators of nitrogen metabolism in plants, and have a pivotal role in the regulatory interplay between carbon and nitrogen metabolism. Pro and GABA are among the best-studied compatible osmolytes that accumulate in response to water deficit, yet the full range of protective functions is still to be revealed. Arg, with its exceptionally high nitrogen-to-carbon ratio, has long been recognized as a major storage form of organic nitrogen. Most of the enzymes involved in metabolism of the amino acids of the glutamate family in plants have been identified or can be predicted according to similarity with animal or microbial homologues. However, for some of these enzymes the detailed biochemical properties still remain to be determined in order to understand activities in vivo. Additionally, uncertainties regarding the subcellular localization of proteins and especially the lack of knowledge about

intracellular transport proteins leave significant gaps in our understanding of the metabolic network connecting Glu, Gln, Pro, GABA and Arg. While anabolic reactions are distributed between the cytosol and chloroplasts, catabolism of the amino acids of the glutamate family takes place in mitochondria and has been implicated in fueling energy-demanding physiological processes such as root elongation, recovery from stress, bolting and pollen tube elongation. Exceeding the metabolic functions, the amino acids of the glutamate family were recently identified as important signaling molecules in plants. Extracellular Glu, GABA and a range of other metabolites trigger responses in plant cells that resemble the actions of Glu and GABA as neurotransmitters in animals. Plant homologues of the Glu-gated ion channels from mammals and protein kinase signaling cascades have been implicated in these responses. Pollen tube growth and guidance depend on GABA signaling and the root architecture is specifically regulated by Glu. GABA and Pro signaling or metabolism were shown to contribute to the orchestration of defense and programmed cell death in response to pathogen attacks. Pro signaling was additionally proposed to regulate developmental processes and especially sexual reproduction. Arg is tightly linked to nitric oxide (NO) production and signaling in plants, although Arg-dependent NO-synthases could still not be identified. Potentially Arg-derived polyamines constitute the missing link between Arg and NO signaling in response to stress. Taken together, the amino acids of the glutamate family emerge as important signaling molecules that orchestrate plant growth and development by integrating the metabolic status of the plant with environmental signals, especially in stressful conditions. This research topic collects contributions from different facets of glutamate family amino acid signaling or metabolism to bring together, and integrate in a comprehensive view the latest advances in our understanding of the multiple functions of Glu-derived amino acids in plants.