Towards Green Revolution 2.0: cell-based phenotyping approach to improve abiotic stress tolerance in crops

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The overall losses in food and fiber production due to abiotic stresses such as salinity, drought or flooding exceed US$120 billion p.a. and rising, largely as a consequence of past trends in breeding for higher yield on expense of tolerance. This threatens global food security and calls for a major rethinking of the current paradigms in crop breeding. Given the fact that the future agriculture will need to move to marginal land, due to both increasing urbanization and global climate change, there is an urgent call for the Green Revolution 2.0 that will correct for those limitations and unintended consequences. In this talk, I argue that the tolerance to abiotic stresses were present in wild ancestors but have been lost during domestication of crop species during the selection for higher yield over the last 100 years and promote a concept of crop "rewilding", by revealing the most crucial adaptive traits employed by extremophiles and then incorporating them into elite cultivars. Using salinity and drought stresses as an example, I will show how learning from halophytes may open new and previously unexplored prospects of improving salinity stress tolerance in crops. I will also show that one of the major hurdles limiting the success of transgenic manipulations to increase abiotic tolerance is due to the high tissue- and cell-specificity of operation of key contributing genes, and a lack of suitable phenotyping tools to evaluate their performance in planta. I then will advocate for cell-based phenotyping, a hypothesis-driven approach that implies usage of the cutting-edge cell-based techniques to monitor operation of a specific protein in planta. Using salinity and flooding stresses as an example, I will show how novel electrophysiological and imaging techniques can be used to overcome the above limitations and allow discovery of the candidate genes and/or QTLs conferring abiotic tolerance traits.