To grow or not to grow: How do plants know when the environment is suitable for growth and when it is not?

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Plants use photosynthesis to convert sunlight, water and carbon dioxide to the sugars they need to grow and that ultimately feed our planet.

Water is also essential for transporting nutrients from the soil and for providing rigidity to the tissues (turgor) so the plant can remain upright. Lack of water leads to drought and ultimately to plant death. Being such an essential factor, plants have developed mechanisms to monitor water availability in the soil and to communicate this information to distant tissues to induce appropriate adaptive responses. When water is scarce, the phytohormone abscisic acid is produced, inducing a very rapid closure of the pores in the leaves (stomata) to prevent water loss through transpiration. In addition, growth of most organs stops, so that resources can instead be used in protective measures. Until now how the lack of water resulted in growth arrest remained largely unknown.

A study led by Elena Baena-González, IGC principal investigator and member of the GREEN-IT Research Unit, uncovered the mechanisms by which this happens: abscisic acid signals are linked to a highly conserved regulatory system constituted by two protein kinases (SnRK1 and TOR), that control growth in all eukaryotes(animals, plants, fungi, and protists). "When conditions are favorable the accelerator of the system (TOR) is active, inducing biosynthetic processes, cell proliferation and growth. When conditions are unfavorable the break of the system (SnRK1) becomes active, inhibiting TOR and consequently growth" says Elena Baena-González. This ancient system is controlled in all eukaryotes by nutrient signals, resulting in growth arrest when nutrient levels ("fuel") are low.

"However, we found that in plants this system is controlled by additional signals related to the water status (ABA), conferring plants the unique capacity to regulate growth not only in response to nutrient signals but also in response to water availability" explains the researcher. The team believes that this system may have been crucial for the establishment of terrestrial life by maintaining resource spending and growth to a minimum when water was scarce.

Using the model plant Arabidopsis thaliana, the researchers observed that when the SnRK1 kinase is genetically inactivated, plants develop larger roots under suboptimal conditions. Although such uncontrolled growth may be fatal under severe drought, it is likely to increase the capacity to absorb water from the more superficial soil layers, potentially improving plant growth when water is moderately limited. Future experiments work will aim to address these questions and to identify downstream factors that could be more amenable for manipulation of this trait also in crops.

More information: Borja Belda-Palazón et al. A dual function of SnRK2 kinases in the regulation of SnRK1 and plant growth, *Nature Plants* (2020). DOI: 10.1038/s41477-020-00778-w

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