Concept Note APLIM

Concept Note APLIM

ABSTRACT

Understanding how tropical and Mediterranean plants respond to their environment is a tremendous societal challenge in the implementing of adapted crop management practices, the breeding of new cultivars able to cope with environmental constraints and the maintaining of plant productivity in a context of climatic change. Many groups in the LabEx Agropolis community have to deal with these important issues at different scales i.e.molecular, cellular, organs, whole plant. Today, the most complex plant stress response related issue is the integration and co-ordination of these multi-scale processes. Whereas research has benefited from the development of cutting-edge technologies to investigate each of these levels, integrative studies are still at their early stages and need pluridisciplinary support. To tackle this important question, APLIM aims at federating the communities of plant physiologists, physicists, electronics engineers and chemist from LabEx Agropolis, Numev and CheMISyst, respectively. In synergy, the consortium will develop non-invasive integrative techniques, namely Nuclear Magnetic Resonance (NMR) spectroscopy, relaxometry and Imaging (MRI) which will meet the specific needs for plant studies and allow to map main physiological plant functions through a multi-scale approach i.e. from molecular, cellular to tissue and organ scales. For this purpose, two complementary scientific Work Packages will be interactively implemented: WP1 is devoted to the «development of innovative NMR and MRI tools and methods dedicated to plant research in laboratory, greenhouse and field conditions». In close collaboration with local and international expertise and user facilities available in the Montpellier research department of physics, chemistry and electronics, we will adapt the configuration of the experimental NMR/MRI setups to model plants (Arabidopsis, tomato, rice) and to a wide variety of crops by designing optimized NMR coils and sensors. Climatic chamber and soils compatible with magnetic resonance environment will be designed and elaborated for a careful control of the plant environment during NMR/MRI experimentation. A transportable NMR relaxometer will be built for crop field studies. The design and synthesis of new chemical nano-objects as innovative contrast agents to track water and molecular dynamics within the plants will address the concept of “smart nanoprobes” to tackle plant cell compartment and plant physiological function. WP2 stands for the applications of NMR spectroscopy, relaxometry and imaging to investigate plant responses to biotic and abiotic constraints. The first objective is to take advantage of the existing tools and the available NMR/MRI technologies to go beyond the limits of current approaches in plant physiology. In particular, we will attempt to measure in situ the short term dynamics of hydraulic and metabolic mechanisms involved in plant responses to environmental constraints and to assess the spatial distribution of the underlying molecules and elements (H2O, Na, P, C) at the plant, organ and cell levels. The second objective is to drive new technological developments in synergy WP1, to address unresolved questions related to multiscale transport and metabolism within the architecture of intact plants in controlled and field conditions. Five challenging scientific questions will be addressed in WP2: i) the spatial and temporal distribution of water flows at different scales, from gene to whole plant, in response to water and heat stresses, ii) their impact on the development of young reproductive organs and their final composition, iii) the absorption of phosphorus and water in response to soil/mycelium/root interactions, iv) the mechanisms involved in plant adaptation to high salinity, and v) the local metabolic and anatomical responses induced by pathogens (fusarium and botrytis). Two other Work Packages will take care of operative collaborations and results dissemination during the project and will support commercial and technological developments for the perpetuation of the project outputs. WP3 will create conditions for intensive collaboration between plant scientists, physicists and chemists, and foster capacity building, coordinate the overall project and ensure efficient networking; a coordination committee will be established. The APLIM consortium of academics and private companies will speed up integrative research and provide a comprehensive view of plant responses to both abiotic and biotic constraints. In WP4, significant efforts will be made to promote the commercialization of the new-established technologies across this project andensure their availability for plant physiologists beyond the project lifetime. The development of Innovative NMR/MRI tools and specific biomarkers ideally suited to study plant physiology, as well as the calibration of NMR/MRI methods to measure and monitor water and carbon transport in intact plant cells,

tissues and organs are the main scientific outputs of the project. The collaborative use of these tools and methods to phenotype plants at different scales, from gene to plant, under controlled environment will have a major impact on our understanding of plant adaptation to drought, heat, salinity and pathogen attacks at the short (minute to hour) and long (day to week) time scales. As such, significant scientific breakthroughs are expected in this field during and beyond the project. New knowledge will be gained at the molecular and process levels, the integration of which will allow refining conceptual and predicting models from the cell to the plant.
Finally new relevant physiological traits/indicators will be identified that will be determinant in the guidance of future strategies of plant breeding and cultural management to face the expected environmental challenges. In that way, APLIM will strongly reinforce the international attractiveness of the plant research community in Montpellier and Avignon. In addition the APLIM project will create, under the French 1901 Act status, a foundry for Innovation in Plant Sciences, an initiative to support transdisciplinary research on
methodological approaches in behalf of plant science. This foundry, of which institutions will be members, as well as private companies (RS2D, INTRASENSE, ANESTEO), will allow the perpetuation of activities beyond the APLIM funding and scientific exchanges between plant science, physics, electronics and chemistry around the development of new methodologies and their integration within plant Sciences and agronomy issues. It will also drive the co construction of future innovative joint projects. Keywords: plant response to biotic and abiotoic constraints, plant imaging metrology, nanoprobes, MRI, NMR spectroscopy and relaxometry, Mediterranean and tropical crops, Water and mineral equilibrium, foundry for innovation in plant science, knowledge-based economy.

Year : 2014
Project number : 1405-010
Type of funding : AAP
Project type : AAI
Research units in the network : BPMP DIADE ECO&SOLS IPME-PHIM LEPSE PSH
Start date : 2014-12-01
End date : 2015-03-15
Flagship project : no

Project leader : Jean-Luc Verdeil
Project leader's institution : CIRAD
Project leader's RU : AGAP

Budget allocated : 10000 €
Total budget allocated (including co-financing) : 10000 €
Funding : Labex