

Year of CfP: 2010 Grand federative project

Project 1001-005

Project title: RHIZOPOLIS: A federative project for plant root research
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Unit managing the project: UMR BPMP Plant Molecular Physiology and Biochemistry (CNRS, INRA, Montpellier SupAgro, UMII)

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Countries involved in the project: Japan, Deutschland, Chile, USA, Australia

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Research units from the Foundation's scientific network involved: AMAP, ECO&SOLS, DIADE, LSTM, AGAP, EMMAH, LEPSE, LAMETA

Subthematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*), STDI-1 (Socio-Technical Dynamics of Innovation 1: *Agri-environmental innovations, agri-ecosystems, resources management*), STDI-3 (Socio-Technical Dynamics of Innovation 3: *Innovation processes, social management of innovations*)

Objectives:

We propose a multidisciplinary project on the biology and ecology of the plant root that will address the broad roles of this organ in mineral nutrient and water acquisition. The green revolution that started in the 1960's was based on the combined use of high inputs (e.g., irrigation water and fertilisers) and high-yielding genotypes, and thereby dramatically improved crop yields worldwide. Most plant breeding schemes have thus been based on identifying best performing plant genotypes under optimal conditions, in particular in terms of water and nutrient availability. The global changes we are now facing and the need for an ecological intensification of agroecosystems require revising these breeding strategies towards the production of more water- and nutrient efficient genotypes, as pointed in the paper "Roots of the second Green Revolution" by Lynch (2007)

We will address central issues in this context:

(1) **Integration of membrane transport activity and structure-function relationships in roots and root symbioses.** We will exploit the molecular knowledge and the genomic resources acquired in two model plants, *Arabidopsis* and rice, to carry out, for the first time, an integrative study of the transport of major nutrient ions and water, and of their interactions. The approach will combine extended functional analyses and modelling of transport capacities, taking radial root structure and tissue localisation of transport systems into account. In parallel, we will develop a cutting-edge methodology, based on new pH sensing fluorescent proteins, in order to probe the pH in cell compartments. We will thus investigate the role of local pH gradients in membrane transport energization and interactions with symbiotic microorganisms favoring the mineral nutrition of the plant.

(2) **Root development and architecture and their responses to environmental signals.** Root growth and development crucially determine the plant efficiency to acquire water and nutrient resources, by optimizing the exploration of the soil areas where nutrients or water are available. A major objective of our consortium in this domain is to develop two key tools: (i) a world unique platform for 4D imaging of meristem activity and primordia formation in primary and lateral roots, and (ii) an innovative image analysis software for high-throughput phenotyping of root system architecture. These tools will be used to identify mechanisms and traits associated with root system efficiency and plasticity in response to environmental cues.

(3) Integrating root-soil interactions in the rhizosphere at the whole root system level – application to water and nutrient acquisition by plants. Current models of root-soil interactions and biogeochemical processes in the rhizosphere do not account for spatial or temporal heterogeneities of root-soil interactions and thus fail at predicting plant nutrition in nutrient-poor soils. In order to fill this gap, we will develop two major approaches: (i) to evaluate the spatial/temporal heterogeneity of water and nutrient (N, P, K) acquisition along the whole root system, and (ii) to assess its impact when up-scaling knowledge from root segment to the whole plant scale.

Total Agropolis Fondation funding: € 1,000,000

Funding categorie(s): Post-doctoral Fellowship (7); Visiting Fellowship for short period of stay < 12 months (15) ; Sponsorship of international training courses (2); Support for the organization of high-level scientific events (Conferences, seminars, workshops, etc.) (4); Support for the preparation of application to international Calls for Proposals (1); Overseas travel grants for Doctoral and Post doctoral scientists (15); Support for publication and dissemination of research results; Support to hosting pre-doctoral students (28)

Project duration: 01 January 2011 – 31 December 2013

Keywords: root, root symbioses, root development and architecture, rhizosphere, water and nutrient