PhD position : analysis and modelling of the plant metabolome in the course of a plant-necrotroph interaction

Context

New plant protection methods are required as a substitute to unsustainable techniques such as pesticide applications. Recent literature on plant-pathogen interactions suggests that the activity of the host primary metabolism before and in the course of infection by a necrotrophic fungus can be used to predict the intensity of the symptoms caused by the pathogen. However the dynamics of metabolic evolutions following infection are not fully understood, and in particular the set of favourable metabolic pathways that confers host resistance are still poorly described. The modelling of metabolic fluxes during plant pathogen interactions is a promising opportunity to clarify the link between metabolic dynamics and efficient plant defence. A group of research teams from INRA and the University of Avignon, specialised in the analysis of plant-pathogen interactions, plant OMICS and metabolic modelling, is willing to pursue its collaboration on this topic and offers a PhD position that aims at analysing and modelling the metabolism of tomato tissues before and during the course of an infection by *Botrytis cinerea*. Ultimately, these researches aim at providing new guidelines for the control of plant metabolism in agricultural production in order to minimize pathogen damages.

Objectives

(i) Design, calibration and resolution of a metabolic model of tomato tissues before and after infection by *B. cinerea*: flux balance analysis (FBA) modelling

(ii) Metabolic profiling of targeted molecules used in the model

(iii) Analysis of metabolic fluxes and determination of the optimal metabolic maintenance leading to resistance

Methods: The candidate will take over a set of experimental samples, obtained from a tomato crop grown in greenhouse, combining 5 different levels of nitrogen (N) nutrition. Different N levels cause contrasted metabolic responses in the host, as well as contrasted susceptibility to *B. cinerea*. The student will examine various options regarding the size of the metabolic

network (including primary and secondary metabolites), the constraints assigned to the model, and the objective function used. In parallel, she/he will develop adapted protocols to quantify the metabolites by GC-MS, LC-MS, HPLC, microplate absorbance and other analytical methods. Following metabolite determination, the model will be used to provide series of flux maps describing the evolution of metabolism in the host plants, in the various conditions of response and susceptibility obtained through the different N nutrition regimes. An analysis by RT-qPCR of the expression of key genes regulating the metabolic network will also be conducted.

Location : INRA PACA, Avignon (France) - Plants and cropping Systems in Horticulture research unit (PSH). Part of the modelling activity will be performed at INRA Aquitaine, UMR Biologie du Fruit et Pathologie (BFP), Bordeaux (France).

Thesis direction

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Conditions

A 3-year PhD fellowship, starting **September 2018** is granted by the Federative Research Structure (SFR) Tersys. The student will be affiliated to the Doctoral School of the University of Avignon (ED 536 SAS).
Gross Salary : 1800 € / month with possible additional stipend associated to teaching at the University of Avignon.

Application

Applicants will hold a Master's degree or equivalent in Plant sciences, Physiology, Metabolomics or Biochemistry. Candidates holding degrees in agronomical sciences are also welcome if they show basic knowledge or experience in metabolomics/fluxomics. Applicants will have a solid background in mathematics and statistics, and possibly mathematical programming. The working language will be French or English. Applicants should have interest in multidisciplinary research projects and excellent abilities for collaborative work.

Applications must be sent by e-mail or regular mail **before May 18th, 2018** to François Lecompte, INRA, UR PSH, 228 route de l'aérodrome, 84914 Avignon cedex 9; +33432722674 ,

françois.lecomte.2@inra.fr. The application file will contain a complete CV, certificates of diplomas and awards, a cover letter and one or two recommendation letters.

Applicants will be convened to an oral competitive examination organized by the University of Avignon, which will be held on June 1st, 2018 in Avignon, France.

Recent selected bibliography from members of the consortium:

Colombie, S., et al., *Respiration climacteric in tomato fruits elucidated by constraint-based modelling.* New Phytologist, 2017. **213**(4): p. 1726-1739.

Colombié, S., et al., *Modelling central metabolic fluxes by constraint-based optimization reveals metabolic reprogramming of developing Solanum lycopersicum (tomato) fruit.* The Plant Journal, 2015. **81**(1): p. 24-39.

Lecompte, F., M.A. Abro, and P.C. Nicot, *Can plant sugars mediate the effect of nitrogen fertilization on lettuce susceptibility to two necrotrophic pathogens: Botrytis cinerea and Sclerotinia sclerotiorum?* Plant and Soil, 2013. **369**(1-2): p. 387-401.

Lecompte, F., et al., *Reduced susceptibility of tomato stem to the necrotrophic fungus Botrytis cinerea is associated with a specific adjustment of fructose content in the host sugar pool.* Annals of Botany, 2017. **119**(5): p. 931-943.

Lugan, R., et al., *Metabolome and water homeostasis analysis of Thellungiella salsuginea suggests that dehydration tolerance is a key response to osmotic stress in this halophyte.* The Plant Journal, 2010. **64**(2): p. 215-229.