Call for 6 month internship from January to June 2023

1 Information on research team

Name of the team: ResPom

Head of the team: M.N. Brisset, PhD

Number of researchers: 15

Description of the research program (10 lines max)

The main objective of ResPom team is the improvement of apple and pear resistance against the major pathogens and pests of these two crops. The research strategy is to deeply investigate the different levels of plant resistance, from pathogen/pest perception to downstream defenses, with the clear goal to put knowledge into practice, either through the selection of total/partial resistance and/or the use of plant resistance inducers (PRIs) in disease/pest management programs. This leads the team to develop a translational approach, from gene to field. Basic research covers genetic diversity and architecture, gene expression, synthesis of proteins and metabolites, with the development of specific tools and methodologies when needed (targeted molecular arrays, plant material, genetic engineering, marker-assisted and genomic selection). Source of variability of intrinsic (i.e. genetic) and induced resistance are investigated alone or in combination (genotype x PRIs x abiotic factors).

Website: https://www6.angers-nantes.inrae.fr/irhs_eng/Research/Apple-and-pear-resistance-to-diseases-and-pests/Research-topics

Publications of the research team:

Gaucher, M.; Heintz, C.; Cournol, R.; Juillard, A.; Bellevaux, C.; Cavaignac, S.; Coureau, C.; Giraud, M.; Lemaguet, J.; Berud, M.; Koké, E.; Crété, X.; Lemarquand, A.; Orain, G.; Brisset, M.-N. The Use of Potassium Phosphonate (KHP) for the Control of Major Apple Pests. *Plant Disease* 2022. https://doi.org/10.1094/PDIS-01-22-0183-RE.

Chavonet, E.; Gaucher, M.; Warneys, R.; Bodelot, A.; Heintz, C.; Juillard, A.; Cournol, R.; Widmalm, G.; Bowen, J. K.; Hamiaux, C.; Brisset, M.-N.; Degrave, A. Search for Host Defense Markers Uncovers an Apple Agglutination Factor Corresponding with Fire Blight Resistance. *Plant Physiology* 2022, *188* (2), 1350–1368. https://doi.org/10.1093/plphys/kiab542.

Bénéjam, J.; Ravon, E.; Gaucher, M.; Brisset, M.-N.; Durel, C.-E.; Perchepied, L. Acibenzolar-S-Methyl and Resistance Quantitative Trait Loci Complement Each Other to Control Apple Scab and Fire Blight. *Plant Dis* 2021, *105* (6), 1702–1710. https://doi.org/10.1094/PDIS-07-20-1439-RE.

Marolleau, B.; Gaucher, M.; Heintz, C.; Degrave, A.; Warneys, R.; Orain, G.; Lemarquand, A.; Brisset, M.-N. When a Plant Resistance Inducer Leaves the Lab for the Field: Integrating ASM into Routine Apple Protection Practices. *Front. Plant Sci.* 2017, *8*, 1938. https://doi.org/10.3389/fpls.2017.01938.

2 Information about training period supervisors

Name Surname, Title : Dr. Romain Larbat
Dr. Florent Pantin

Address: IRHS - Institut de Recherche en Horticulture et Semences
UMR1345 INRAE / Institut Agro Rennes-Angers / Université d'Angers
Centre Angers-Nantes INRAE, IRHS bâtiment B
42, rue Georges Morel – CS 60057 - 49071 Beaucouzé cedex – France

Phone

Email : romain.larbat@inrae.fr; florent.pantin@inrae.fr

3 Description of the training project

3.1 Scientific context

Societal demand and the commitments made by French and European governments concerning the agriculture of tomorrow require a significant evolution of practices in order to maintain a high-performance production in an increasingly restrictive framework of pesticide reduction. This agro-ecological transition requires the development of action levers whose combined use should allow to reach a level of protection economically acceptable to producers (Bertand et al., 2020). Stimulation of plant immunity is one of the strategies being explored to meet the socio-economic challenge of our dependence on synthetic biocides for crop protection. To this end, the application of Plant Resistance Inducers (PRI) is a lever of biocontrol actively studied. PRIs mimic the attack of a bioaggressor by activating recognition and/or signaling mechanisms, causing the induction of the plant's defense system (thickening of the cuticle and cell walls, accumulation of defense proteins and specialized metabolites...), likely to increase its resistance against one or more bioaggressors (Walters et al. 2013).

The ResPom team at IRHS aims at optimizing apple tree immunity, genetically or by applying PRIs to overcome the use of pesticides against three major apple pests, *Venturia inaequalis* (apple scab), *Erwinia amylovora* (fire blight) and *Dysaphis plantaginea* (apple rosy aphid). The ResPom team has identified several PRIs that are effective on apple trees, under controlled conditions, against the three above mentioned pests: (Brisset et al., 2000, Dugé de Bernonville et al., 2014, Marolleau et al., 2017, Warneys et al., 2018). The main PRI model used in the team is Bion® (acibenzolar-*S*-methyl, ASM), a functional analog of salicylic acid - the major plant immunity hormone (Peng et al., 2021). In apple tree, Bion® is the most effective defense inducer to date, with significant transcriptomic reprogramming in the absence of any biotic or abiotic stress (Warneys et al., 2018). In the orchard, Bion® induces significant protective effects against scab, but these effects remain too variable for Bion® to be a reliable alternative to fungicides. Climatic conditions and cultural practices are likely to modify the physiological state of the tree and potentially its immune response. Among these factors, we suspect a major effect of temperature. Preliminary results obtained at ResPom show a loss of protection conferred by Bion® when applied at high temperature (>35°C). Nevertheless, the temperature scenario tested is not representative of the spring temperatures encountered in the orchard during the main peaks of infection risk. Thus, there is a need to better characterize the spring thermal conditions that may impact the induction of immunity.

3.2 Objectives

The goal of this Master project is to explore the effect of extreme thermal conditions (low/high temperature; high diurnal amplitude) encountered during the spring season on the efficiency of Bion® to stimulate immunity of young apple trees.

3.3 Implementation

The project will start with a retrospective analysis of the thermal conditions encountered in the three main apple production regions in France (NW, SW, SE). This analysis will help to select several temperature conditions (4 to 6) that will be assayed for their impact on Bion® efficiency. Then, the selected temperature regimes will be applied on young apple trees grown under controlled conditions. The efficiency of the immunity stimulation by Bion® will be followed by transcriptional analysis of already known responsive genes, and by evaluation of plant protection after inoculation of pathogens (apple scab; fire blight).

The temperature conditions that best impact the efficiency of Bion® will be used to further explore the metabolic and transcriptional bases of the temperature x PRI interaction (including metabolomics and transcriptomics analyses). Since

this question is too large to be addressed by only on master stage, the team is currently building a PhD project on this topic, which will clearly benefit from the developments achieved during this Master internship (PhD funding requested).

Keywords: Apple protection; Plant Response Inducer (PRI), immunity, temperature

4 Desired techniques and skills

Training in ecophysiology/plant physiology/pathology, Master 2 level.
Skills in laboratory experimentation, data analysis and statistics.
Taste for teamwork, motivation, rigor and initiative

5 Information on proposed training period

6.1 Duration :

6 months

6.2 Anticipated starting date :

Starting date from January to early March 2023.

6.3 Stipend and indemnities :
Approximately 580€ /month

Access to the local canteen with subsidised INRAE price