

IRHS - UMR1345

Institut de Recherche en Horticulture et Semences
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Object: M2 6-months internship from January 2023

Title: Effect of Nitrogen fertilization on PRI efficiency for apple tree immunity

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1 Research institute

The Federative Research Structure “Plant Health and Quality” (**SFR 4207 QUASAV**) federates eight research units and one experimental unit, representing around 400 staff including 150 permanent scientists belonging to the Universities of Angers and Nantes, INRAE, Institut Agro Rennes-Angers, Anses and ESA. The scientific objectives of the SFR are the understanding and management of key characteristics and processes that govern plant health and quality of plant products, in a sustainable plant production perspective through three scientific axes: ‘**Sustainable Management of Plant Health**’, ‘**Seed Biology, Quality and Health**’ and ‘**Qualities of Specialized Plant Productions**’. Besides promoting research development through scientific policy of incitement and animation, the SFR offers six shared facilities devoted to cellular imaging, nucleic acid analysis, phytochemical analysis, microorganism collections, sensory analysis, and plant phenotyping.

The Research Institute of Horticulture and Seeds (**IRHS**) is a large laboratory of 250 staff members focusing on quality and health of horticultural crops and seeds under the auspices of INRAE, Institut Agro and University of Angers. Ongoing research projects are about ornamental and fruit quality, genetic diversity, epigenetics, sustainable resistance to pathogens, diseases emergence and microbial communities, evolutive ecology of pathogens, seed quality, bioinformatics and plant phenotyping. They apply to model plants like roses, pome-fruits or vegetables, and also seeds, pathogenic bacteria or fungi. Integrated approaches are developed thanks to the coordination of efforts and expertise from geneticists, breeders, plant pathologists, physiologists, biochemists, eco-physiologists, modelers and statisticians.

2 Research team

Name of the team: ResPOM « Apple and pear resistance to diseases and pests »

Head of the team: Marie-No lle Brisset, PhD

Number of researchers: 12 researcher/teacher/engineer

Number of PhD students present during the training period: 4

Description of the research program:

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:

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>.

Marc, M.; Cournol, M.; Hanteville, S.; Poisson, A.-S.; Guillou, M.-C.; Pelletier, S.; Laurens, F.; Tessier, C.; Coureau, C.; Renou, J.-P.; **Delaire, M.**; **Orsel, M.** Pre-Harvest Climate and Post-Harvest Acclimation to Cold Prevent from Superficial Scald Development in Granny Smith Apples. *Scientific Reports* **2020**, *10* (1), 6180. <https://doi.org/10.1038/s41598-020-63018-3>.

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>.

3 Supervisors

Mickaël Delaire PhD and Mathilde Orsel PhD.

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4 Description of the training project

4.1 Scientific context

The ongoing Ecophyto plan aim to reduce the use of pesticides in agricultural systems. In this context, the use of **plant resistance inducers** (PRI) offer a possible alternative for plant protection as they exhibit a low environmental impact and no biocide activity. Since several years, the ResPom team (UMR1345 IRHS Angers) deciphers their mode of action on apple trees in control conditions and investigate their use in orchard management. If their ability to induce plant defences has been well established in controlled conditions, their performance in controlling pathogens or pests in orchards often remains unsatisfactory, mainly due to high variations in the obtained results. Among several factors, apple variety, abiotic constraints or interactions with other input like nitrogen fertilizer could explain these variations. The internship offers the opportunity to participate in the evaluation of the nitrogen fertilisation impact on PRI efficacy to control apple tree pathogens.

4.2 Objectives

The student will conduct trials in controlled conditions in order to evaluate the impact of contrasted nitrogen regimes (N+ vs N-) on the balance between primary and secondary metabolism, and its consequences on plant growth and PRI efficacy against **apple scab** (*Venturia inaequalis*). Apple tree plantlets physiological status and defences induction will be characterised with molecular markers (RTqPCR gene expression) on one hand, plant growth phenotype and disease resistance test on the other hand. The expression of 28 defence genes is already routinely used by the team (qPFD®). The plant diagnostic will have to be enriched with marker genes for N status and induction of primary and secondary metabolisms.

An orchard trial with contrasted N fertilisation and integrated pest management program including PRI is also conducted in collaboration with the experimental unit Horti (INRAE Angers) and the student will contribute the evaluation of apple scab symptoms and data analyses.

4.3 Implementation

With the technical help and guidance of a PhD student and its supervisors, the master student will:

- Plan, organise and conduct greenhouse and orchard trials in collaboration with resource persons.
- Grow plants and microorganisms in controlled conditions,
- Carry out molecular characterisations of samples (RNA extraction, reverse transcription, PCR and qPCR), disease resistance tests, and morphometric characterisation.
- Perform statistical analyses, create reports and presents results.

Keywords: PRI, Nitrogen fertilisation, Apple scab, Immunity, disease resistance.

5 Desired techniques and skills

The candidate has strong/solid knowledge in plant physiology and/or phytopathology, plant cell and molecular biology. The candidate will organize and execute the different experimentations in controlled conditions and orchards. Being familiar with bioinformatics and/or statistic tools such as R will be appreciated. Good understanding of English, writing skills and appetite for team working are mandatory.

6 Information on proposed training period

6.1 Duration:

6 months

6.2 Anticipated starting date:

January 2023

6.3 Stipend & indemnities:

Approximately 500€ /month (3.60€/hour for 35h50/week)

Access to the local canteen with subsidised INRAE price.