PhD PROPOSAL FOR THE DOCTORAL SCHOOL
« Végétal, Animal, Aliment, Mer, Environnement »

GENERAL INFORMATION

Thesis title: Adaptation of existing models to optimise the combination of immune and agro-ecological levers in apple orchards
Acronym of the project: ModIV
Disciplinary field 1: Agronomy **Disciplinary field 2:** Phytopathology
Three keywords: Apple tree- Pests and diseases- levers combination
Registration establishment: University of Angers
Research unit: IRHS
Name of the thesis director HDR (Accreditation to supervise research) required: Perchepied Laure **Email address of the thesis director:** laure.perchepied@univ-angers.fr **Name of the thesis co-supervisor 1:** Delaire Mickaël **Email address of the thesis co-supervisor 1:** Mickael.Delaire@Agrocampus-Ouest.Fr **Name of the thesis co-supervisor 2:** Robin Marie-Hélène **Email address of the thesis co-supervisor 2:** mh.robin@purpan.fr
Contact(s) (mailing address and E-mail):
☐ **Doctoral school contest** ☒ **Interview** ☐ **Other (specify):**

SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

Socio-economic and scientific context: (10 lines)

Apple trees are attacked by many pests, including aphids, codling moths, the fungus *Venturia inaequalis* (apple scab), and the bacterium *Erwinia amylovora* (fire blight). The massive use of pesticides is still the most common method to control apple pests today. In a context of sustainable protection of orchards and in response to strong societal demand, there is an urgent need to identify alternative levers to the use of pesticides and to understand how to combine them to achieve sufficient effectiveness.

Two complementary modelling approaches developed as part of the ODACE project (IPSIM and Qualitree), combined with the advances made in the CapZéroPhyto project, has led to the proposal of a thesis project on the development of a modelling approach aimed at optimising apple tree immunity in orchards through combinations of practices.

Assumptions and questions (8 lines)

The main scientific question is to understand how can apple tree immunity and the factors likely to influence it be integrated into an agroecological approach to orchard protection. This research question can be divided into 3 sub-questions: i) How can we model pest damage in apple orchards, taking into account the level of plant immunity and the factors that influence it ? ii) How validate the models integrating immunity with very few field data sets? iii) How can we best combine immune and agro-ecological levers to achieve a good compromise between ecosystem services?

The main steps of the thesis and scientific procedure (10-12 lines)

1. Creation of a prototype model from IPSIM models (scab and aphids) developed from the ODACE project. This step will include: i) a bibliographic review, ii) consideration of the results of the CapZéroPhyto project, iii) construction of a conceptual model, iv) implementation of the model in the DEXi application et v) assessment of the model's predictive qualities in a workshop with experts.
2. Validation of the IPSIM-apple immunity model by a set of data progressively acquired from producers. It will involve: i) to use and enhance an existing database, ii) to create a network of producers to monitor decision rules, technical interventions and the health status of orchards over two seasons and iii) to evaluate the model's prediction using this dataset.
3. Coupling between models IPSIM-Immunity and Qualitree, requiring interface work and the integration of new evaluation indicators into Qualitree.

Methodological and technical approaches considered (4-6 lines)

Workshops with experts

Bibliographical research

Creation of a network of arboriculturists

Monitoring and scoring within this network over 2 years

Work with modellers

Scientific and technical skills required by the candidate
Knowledge of agronomy and plant pathology.
Interest in data analysis and modelling.
Experience in multi-scale integrative biology.
Taste for working in a network.
Ability to communicate and bring working groups together.
Ability to summarise.
Knowledge of orchard protection issues appreciated.

THESIS SUPERVISION

Unit name: IRHS	**Team name:** ResPom
Unit director name: Jacques Marie-Agnès	**Team director name:** Brisset Marie-Noëlle
Mailing address of the unit director: marie-agnes.jacques@inrae.fr	**Mailing address of the team director:** marie-noelle.brisset@inrae.fr

Thesis director

Surname, first name: Perchepied, Laure

Position: Assistant professor

Obtained date of the HDR (Accreditation to supervise research): 25/10/2023

Employer: University of Angers

Doctoral school affiliation: VAAME

Rate of thesis supervision in the present project (%): 40

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 0

Number of current thesis supervisions/co-supervisions: 0

Thesis co-supervisor 1

Surname, first name: Delaire, Mickaël

Position: Assistant professor

Accreditation to supervise research ☐ yes ☒ no If yes, date diploma received:

Employer: Institut Agro Rennes-Angers

Doctoral school affiliation: VAAME

Rate of thesis supervision in the present project (%): 30

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 30

Number of current thesis supervisions/co-supervisions: 1

Thesis co-supervisor 2

Surname, first name: Robin Marie-Hélène

Position: Assistant professor

Accreditation to supervise research ☐ yes ☒ no If yes, date diploma received:

Employer: INP Purpan

Doctoral school affiliation: SEVAB

Rate of thesis supervision in the present project (%): 30

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 25

Number of current thesis supervisions/co-supervisions: 1

Professional status of previous PhD students supervised by both director and co-supervisors (from 5 years)

Please provide the following information for each PhD students supervised

Surname, first name: BENEJAM Juliette

Date of PhD beginning and PhD defence: 1/11/2017 au 12/02/2021

Thesis supervision: Durel Charles-Eric

Professional status and location: INRAE Bordeaux

Contract profile (post-doc, fixed-term, permanent): Post-doc

List of publications from the thesis work:
Bénéjam J., Ravon E., Gaucher M., Brisset M.N., Durel C.E., **Perchepied L. 2020**. Acibenzolar-S-méthyl and resistance quantitative trait loci complement each other to control apple scab and fire blight. Plant disease 105:1702-1710. https://doi.org/10.1094/PDIS-07-20-1439-RE

Surname, first name: MARC Mathieu

Date of PhD beginning and PhD defence: 01/11/2016 _ 26/05/2020

Thesis supervision: Renou Jean-Pierre

Professional status and location: Chef de produit gamme SVT, Jeulin, Evreux

Contract profile (post-doc, fixed-term, permanent): permanent

List of publications from the thesis work:

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. 2020. Pre-harvest climate and post-harvest acclimation to cold prevent from superficial scald development in Granny Smith apples. Scientific Reports 10, 6180. https://doi.org/10.1038/s41598-020-63018-3

Surname, first name: EHMIG Muriel

Date of PhD beginning and PhD defence: 09/2018 _ 12/2021

Thesis supervision: BRIN Antoine

Professional status and location: SNCF Paris

Contract profile (post-doc, fixed-term, permanent):

List of publications from the thesis work: 0

Surname, first name: VEDY-ZECCHINI Marianne

Date of PhD beginning and PhD defence: 10/2016 _ 11/2019

Thesis supervision: AUBERTOT J.N

Professional status and location: seed ingeneer, Toulouse

Contract profile (post-doc, fixed-term, permanent):

List of publications from the thesis work: 0

Publications majeures des 5 dernières années du·de la directeur·rice de thèse et co-directeur(s)/co-encadrant(s) sur le sujet de thèse :

Bénéjam J., Ravon E., Gaucher M., Brisset M.N., Durel C.E., **Perchepied L. 2020**. Acibenzolar-S-méthyl and resistance quantitative trait loci complement each other to control apple scab and fire blight. Plant disease 105:1702-1710. https://doi.org/10.1094/PDIS-07-20-1439-RE

Lacroix O., Aubertot J.N., Bohanec M, Cordeau S., Camilo Corrales D., **Robin M.H. 2021**.IPSIM-Cirsium, a Qualitative Expert-Based Model to Predict Infestations of *Cirsium arvense.* Frontiers in Agronomy, 3. https://www.frontiersin.org/articles/10.3389/fagro.2021.655383

THESIS FUNDING

Origin(s) of the thesis funding: University of Angers 50% _ Region funding 50%
Gross monthly salary: 2100€
Thesis funding state: Acquired
Funding beginning date/duration of the thesis funding: 04/11/2024_3 years

Date: 30/05/2024

Name, signature of unit director: Jacques Marie-Agnès

Name, signature of team director: Brisset Marie-Noëlle

Name, signature of thesis project director: Perchepied Laure