

## PHD PROPOSAL FOR THE DOCTORAL SCHOOL « Ecologie, Géosciences, Agronomie, ALimentation »

### GENERAL INFORMATION

<b>Thesis title:</b> Exploit the diversity of signalling peptides in Solanaceae in response to stress.
<b>Acronym:</b> SolPep
<b>Disciplinary field 1:</b> Agronomy <b>Disciplinary field 2:</b> Select an element
<b>Three keywords:</b> phyto cytokines, functional genomics, biotic and abiotic stresses
<b>Research unit :</b> IRHS, UMR 1345
<b>Name of the thesis director:</b> Jean-Pierre Renou <b>Email address of the thesis director :</b> jean-pierre.renou@inrae.fr <b>Name of the thesis co-supervisor 1 (if applicable):</b> Sébastien Aubourg <b>Email address of the thesis co-supervisor 1 (if applicable):</b> sebastien.aubourg@inrae.fr <b>Name of the thesis co-supervisor 2 (if applicable):</b> <b>Email address of the thesis co-supervisor 2 (if applicable):</b>
<b>Thesis grant (funding origin and amount):</b> EGAAL doctoral grant requested (96.8 k€), functioning resources acquired (26 k€, INRAE SPE dpt)
<b>Contact(s) (mailing address and E-mail):</b> IRHS, 42 rue G. Morel, 49071 Beaucouzé Cedex
<b>Recruitment process:</b> Recruitment process depends on thesis funding. To select the corresponding recruitment process, please visit the EGAAL website <a href="#">here</a> . This information is needed for proposal publication. <input checked="" type="checkbox"/> <b>Doctoral school contest</b> <input type="checkbox"/> <b>Interview</b> <input type="checkbox"/> <b>Other (indicate) :</b>

**All sections must be filled. Once filled, please save the proposal form in pdf format using the following naming: Supervisor Name\_Unit\_Subject Acronym\_EN.pdf**

#### ED EGAAL

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## SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

### Socio-economic and scientific context : (10 lines)

The search for new ways in plant defence is crucial to find alternatives to chemical pesticides. In this context, small secreted peptides, also named phyto cytokines, are key targets since they are major players in the response to biotic and abiotic stresses, but also because only a small fraction of them have been identified or functionally characterized to date. In tomato, for example, currently affected by the dispersion of ToBRFV, more than 1700 genes have the structural features of secreted peptide precursors, most of them with unknown biological function. Using a combination of bioinformatic, transcriptomic and genetic approaches, we have identified in Arabidopsis a new family of precursors of phyto cytokines, named PROSCOOP, in which at least one member is involved in the control of defence pathways via the regulation of reactive oxygen species (Gully, Pelletier *et al.*, 2019). The exploitation of this unknown gene space opens up new prospects for alternatives to pesticides (*p.e.* flurochloridone) and more generally for biocontrol.

### Assumptions and questions (8 lines)

Given the small size of these genes/peptides and their poor sequence conservation, bioinformatics predictions alone are not sufficient to identify them with high confidence and to provide accurate functional predictions by comparative genomics. Therefore, a combination of biological and bioinformatics approaches is necessary to identify the peptide fraction involved in plant defence. Based on our experience in Arabidopsis, we have thus identified a series of experimental conditions that can be highlighted by a transcriptomic approach coupled with expert annotation. We propose to apply this protocol on two *Solanaceae* species (tomato, black nightshade) to characterize the stress-reactive peptidome in this major plant family and identify good candidate genes/peptides for new biocontrol solutions.

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

Exploring the diversity of secreted peptides requires the production of expression data under discriminating conditions in each target species, in order to identify the whole "oxidative stress responsive" transcriptome and then to select the genes/transcripts sharing the structural features of secreted peptide precursors. This specific transcriptome will be enriched by data from each organ of the plant to make easier the identification of paralogues in each gene family and the prediction of the conserved C-terminal motifs corresponding to the functional mature peptides. The next step will be to synthesize promising candidate peptides and to test their potential effect on plants by external treatment. The two target species, a cultivated "model" species and a wild species of the same family have already been studied by RNAseq analysis, so we minimize the technical risks by this choice. The time required for a PhD thesis does not allow us to envisage an exhaustive identification of all signaling peptides in the target *Solanaceae*, but our objective is to exploit the most obvious candidates to validate the portability of this approach, beyond that we already highlighted in Arabidopsis and *Brassicaceae*.

### Methodological and technical approaches considered (4-6 lines)

Adjustement of biotic and abiotic stress conditions on each target species and production of transcriptomes by RNA-seq under the selected conditions (3 biological repet., 30M reads, PE 2x100). Statistical and bioinformatic analyses of RNA-seq data and curated annotation to identify the stress-reactive transcriptome and its fraction likely to produce secreted peptides. Identification of candidate mature peptides by motif prediction, and testing of synthetic peptides on plants and impact on their stress response: phenotyping and metabolic characterization under selected conditions.

### Scientific and technical skills required by the candidate

Candidate should have a good knowledge of plant physiology and molecular biology/genomics, and a strong interest in plant defence pathways and underlying signalling processes. Skills in bioinformatics will be appreciated.

## THESIS SUPERVISION<sup>1</sup>

<b>Unit name:</b> Institut de Recherche en Horticulture et Semences	<b>Team name:</b> BIDefI (Bioinformatics for plant Defense Investigation)
<b>Unit director name:</b> Jean-Pierre Renou	<b>Team director name:</b> Claudine Landès
<b>Mailing address of the unit director:</b> jean-pierre.renou@inrae.fr	<b>Mailing address of the team director:</b> claudine.landes@inrae.fr
<p><b>Thesis director</b></p> <p>Surname, first name: Renou Jean-Pierre</p> <p>Position: Research Director</p> <p>Obtained date of the HDR (Habilitation thesis to supervise research): 2007</p> <p>Employer: INRAE</p> <p>Doctoral school affiliation: EGAAL</p> <p>Rate of thesis supervision in the present project (%): 50%</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 50%</p> <p>Number of current thesis supervisions/co-supervisions: 1</p>	
<p><b>Thesis co-supervisor 1 (if applicable)</b></p> <p>Surname, first name: Aubourg Sébastien</p> <p>Position: Research Director</p> <p>Habilitation thesis to supervise research <input checked="" type="checkbox"/> yes <input type="checkbox"/> no If yes, date diploma received: 2008</p> <p>Employer: INRAE</p> <p>Doctoral school affiliation: EGAAL</p> <p>Rate of thesis supervision in the present project (%): 50%</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 50%</p> <p>Number of current thesis supervisions/co-supervisions: 1</p>	
<p><b>Thesis co-supervisor 2 (if applicable)</b></p> <p>Surname, first name:</p> <p>Position:</p> <p>Habilitation thesis to supervise research <input type="checkbox"/> yes <input type="checkbox"/> no If yes, date diploma received:</p> <p>Employer:</p> <p>Doctoral school affiliation:</p> <p>Rate of thesis supervision in the present project (%):</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%):</p>	

<sup>1</sup> In EGAAL Doctoral School, if only one scientist in thesis supervision = 100% of supervision rate; if 2 people involved in thesis supervision = from 50% to 70% of supervision rate for the director; if 3 people involved in thesis supervision = 40% / 30% / 30% of supervision rate distribution among supervisors.

Number of current thesis supervisions/co-supervisions:

**Private partner (if CIFRE funding, private funding,...)**

Surname, first name:

Position:

Employer:

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

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

Number of current thesis supervisions/co-supervisions:

**International partner (if Cotutelle thesis)**

Surname, first name:

Position:

Employer:

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

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

Number of current thesis supervisions/co-supervisions:

**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: Marc Mathieu

Date of PhD beginning and PhD defence: Nov 2016-May 2020

Thesis supervision: Jean-Pierre Renou (IRHS)

Professional status and location: PhD defence in May 2020

Contract profile (post-doc, fixed-term, 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. and Orsel M. 2020. Pre-harvest climate and post-harvest acclimation to cold prevent from superficial scald development in Granny Smith apples. Scientific reports. In Press.

Surname, first name: Legeay Marc

Date of PhD beginning and PhD defence: Sept 2015-Dec 2018

Thesis supervision: Jean-Pierre Renou (IRHS) and Béatrice Duval (LERIA)

Professional status and location: Bioinformatician, University of Copenhagen

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

List of publications from the thesis work:

- Legeay M, Aubourg S, Renou JP, Duval B (2018) Large scale study of anti-sense regulation by differential network analysis. BMC Syst Biol. 12(Suppl 5):95.
- Legeay M, Duval B, Renou JP (2017) Differential network analysis of anti-sense regulation. In I. Rojas and F. M. Ortuño Guzman, editors, Bioinformatics and Biomedical Engineering - 5th International Work-Conference, IWBBIO 2017, Granada, Spain, April 26-28, 2017, Proceedings, Part II , volume 10209 of Lecture Notes in Computer Science, pages 277-288. DOI : [https://doi.org/10.1007/978-3-319-56154-7\\_26](https://doi.org/10.1007/978-3-319-56154-7_26)
- Legeay M, Duval B, Renou JP (2016) Inference and differential analysis of extended core networks: A way to study anti-sense regulation. In T. Tian, Q. Jiang, Y. Liu, K. Burrage, J. Song, Y. Wang, X. Hu, S. Morishita, Q. Zhu, and G. Wang, editors, IEEE International Conference on Bioinformatics and Biomedicine, BIBM 2016, Shenzhen, China, December 15-18, 2016, pages 284-287. IEEE Computer Society, 2016. DOI : <https://doi.org/10.1109/BIBM.2016.7822532>
- Legeay M, Duval B, Renou JP (2016) Differential functional analysis and change motifs in gene networks to explore the role of anti-sense transcription. In A. G. Bourgeois, P. Skums, X. Wan, and A. Zelikovsky, editors, Bioinformatics Research and Applications - 12th International Symposium, ISBRA 2016, Minsk,

Belarus, June 5-8, 2016, Proceedings, volume 9683 of Lecture Notes in Computer Science, pages 117-126. Springer, 2016. DOI : [https://doi.org/10.1007/978-3-319-38782-6\\_10](https://doi.org/10.1007/978-3-319-38782-6_10)

Surname, first name: Dheilily Emmanuelle

Date of PhD beginning and PhD defence: Nov 2012-Oct 2016

Thesis supervision: Jean-Pierre Renou (IRHS) and Marc Lahaye (BIA)

Professional status and location: Arvalis, Ile-de-France region

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

List of publications from the thesis work:

- Dheilily E, Le Gall S, Guillou MC, Renou JP, Bonnin E, and Orsel M, Lahaye M (2016) Cell wall dynamics during apple development and storage involves hemicellulose modifications and related expressed genes. *BMC Plant Biology*. 16(1):201.
- Celton JM, Dheilily E, Guillou MC, Simonneau F, Juchaux M, Costes E, Laurens F, Renou JP (2014) Additional amphivasal bundles in pedicel pith exacerbate central fruit dominance and induce lateral fruitlet abscission in apple. *Plant Physiology*. 164(4):1930-51.

#### Five main recent publications of the supervisors on thesis subject:

- Gully K, Pelletier S, Guillou MC, Ferrand M, Aligon S, Pokotylo I, Perrin A, Vergne E, Fagard M, Ruelland E, Grappin P, Bucher E, Renou JP, Aubourg S (2019) The SCOOP12 peptide regulates defense response and root elongation in *Arabidopsis thaliana*. *J. Experimental Botany*, 4:1349-1365.
- Hibrand Saint-Oyant L, [...], Aubourg S, Sakr S, Smulders MJM, Schijlen E, Bucher E, Debener T, De Riek J, Foucher F (2018) A high-quality genome sequence of *Rosa chinensis* to elucidate ornamental traits. *Nature Plants*, 4:473-484.
- Legeay M, Aubourg S, Renou JP, Duval B (2018) Large scale study of anti-sense regulation by differential network analysis. *BMC Systems Biology*, 12:95.
- Daccord N, Celton J-M, [...], Aubourg S, Quesneville H, Weigel D, van de Weg E, Troglio M, Bucher E (2017) High-quality de novo assembly of the apple genome and methylome dynamics of early fruit development. *Nature Genet*. 49(7): 1099-1106.
- Zaag R, Tamby J-P, Guichard C, Tariq Z, Rigai G, Delannoy E, Renou JP, Balzergue S, Mary-Huard T, Aubourg S, Martin-Magniette ML, Brunaud V (2015) GEM2Net: From gene expression modeling to -omics networks, a new CATdb module to investigate *Arabidopsis thaliana* genes involved in stress response. *Nucleic Acids Res*. 43(Database issue): D1010-7.

## THESIS FUNDING

**Origin(s) of the thesis funding:** University of Angers (PhD grant, requested), INRAE (working budget, acquired)

**Gross monthly salary:** 1770 €

**Thesis funding state :** Non acquired

**Funding beginning date/Funding ending date:** 1<sup>st</sup> November 2021, 3 years

**Date:** 10/03/2021

**Nom, signature du directeur d'unité :** Renou Jean-Pierre



**Nom, signature du responsable de l'équipe :** Claudine Landès



**Nom, signature du directeur de thèse :**

Renou Jean-Pierre

Sébastien Aubourg

