

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

### GENERAL INFORMATION

<b>Thesis title:</b> Unraveling seed defense regulation in dormant seeds
<b>Acronym:</b> SEEDDEFENSE
<b>Disciplinary field 1:</b> Agronomy
<b>Disciplinary field 2:</b> Select an element
<b>Three keywords:</b> seeds, defense, dormancy
<b>Research unit :</b> IRHS
<b>Name of the thesis director HDR (Habilitation thesis to supervise research) required:</b> BUITINK Julia <b>Email address of the thesis director:</b> <a href="mailto:julia.buitink@inrae.fr">julia.buitink@inrae.fr</a>
<b>Name of the thesis co-director (if applicable): HDR (Habilitation thesis to supervise research) required:</b> LEPRINCE Olivier <b>Email address of the thesis co-director (if applicable):</b> <a href="mailto:olivier.leprince@agrocampus-ouest.fr">olivier.leprince@agrocampus-ouest.fr</a>
<b>Thesis grant (funding origin and amount):</b> PPR SUCSEED, 126k€
<b>Contact(s) (mailing address and E-mail):</b> Institut de Recherche en Horticulture et Semences UMR 1345 (INRAE/Institut Agro/Université d'Angers) Campus du végétal Bâtiment A, 42 rue Georges Morel – CS 60057 - 49071 Beaucouzé cedex – France
<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 type="checkbox"/> <b>Doctoral school contest</b> <input checked="" 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**

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## SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

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

Seed dormancy is a physiological state that blocks germination. It is an adaptive strategy that allows the seeds to remain quiescent until environmental conditions are favorable for germination and dispersal of the species. Dormant seeds can persist in the soil for months or even years without being attacked by pathogens, while non-dormant seeds gradually become susceptible during imbibition and subsequent germination. Our group has shown that in the model legume *Medicago truncatula* the Sucrose non-fermenting Related Kinase complex (SnRK1) connects the dormant state of seeds to the activation of a defense program against pathogens by induction of the expression of genes encoding PR proteins and enzymes involved in the synthesis of secondary metabolites such as phytoalexins. A better understanding of the seed-specific pathways leading to defense activation is a first step in identifying alternative pathways for phytosanitary treatment of seeds.

### Assumptions and questions (8 lines)

The objective of the thesis is to identify the genes constituting the defense program set up during the imbibition of dormant tomato seeds and to study the (epi)genetic mechanisms that regulate its activation.

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

The thesis will exploit the wide genetic diversity in the depth of dormancy in tomatoes using the MAGIC multi-parental population that has been previously characterized by the team. After a screening based on the expression of defense marker genes (Master 2 course in progress), two contrasting genotypes showing a low and high level of defense activation will be selected for a study of the transcriptome / epigenome during the imbibition of the dormant seeds to identify the genes or gene modules that are involved in defense and study their epigenetic regulation. The function of one or two candidate genes inferred by the analysis of the gene co-expression network as well as the *LeSNF4* gene encoding an activating subunit of SnRK1 will be studied in detail by generating Crispr-Cas9 mutants and over-expressors. Next, we will study how activating the defense program contributes to germination vigor on the one hand and to the extent that it contributes to antimicrobial activity and prevents damping-off.

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

Functional genomics and physiology of seed dormancy, study of the transcriptome and epigenome, gene co-expression networks, molecular biology (cloning, qPCR, ChIP, westernblots), microbiology, antimicrobial activity tests

### Scientific and technical skills required by the candidate

Molecular biology ,phytopathology and/or plant physiology. Skills in R and bioinformatics tools, Proficiency in English

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

<b>Unit name:</b> UMR1345 IRHS	<b>Team name:</b> SEED
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<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.

<p><b>Unit director name:</b> RENOU Jean-Pierre</p>	<p><b>Team director name:</b> LEPRINCE Olivier</p>
<p><b>Mailing address of the unit director:</b>                  UMR1345 - IRHS                  42 rue Georges Morel – CS 60057 49071 Beaucouzé                  cedex - France  <a href="mailto:jean-pierre.renou@inrae.fr">jean-pierre.renou@inrae.fr</a>                  Tél : 02 41 22 57 74</p>	<p><b>Mailing address of the team director:</b>                  UMR1345 - IRHS                  42 rue Georges Morel – CS 60057 49071 Beaucouzé                  cedex - France  <a href="mailto:olivier.leprince@agrocampus-ouest.fr">olivier.leprince@agrocampus-ouest.fr</a>                  Tél : 02 41 22 55 16</p>
<p><b>Thesis director</b>                  Surname, first name: BUITINK Julia                  Position: DR                  Obtained date of the HDR (Habilitation thesis to supervise research): 2002                  Employer: INRAE                  Doctoral school affiliation: EGAAL                  Rate of thesis supervision in the present project (%): 60                  Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 30                  Number of current thesis supervisions/co-supervisions: 1 codirection à l'IGEPP (fin de contrat juin 2021)</p>	
<p><b>Thesis co-director</b>                  Surname, first name: Leprince Olivier                  Position: ProfessOr                  Obtained date of the HDR (Habilitation thesis to supervise research):2000                  Employer: L'Institut Agro - AGROCAMPUS OUEST                  Doctoral school affiliation: EGAAL                  Rate of thesis supervision in the present project (%): 40                  Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 100 (defense 11/05/2021)                  Number of current thesis supervisions/co-supervisions:1 (0 starting from 11/05/2021)</p>	
<p><b>Thesis co-supervisor 1 (if applicable)</b>                  Surname, first name:                  Position:                  Habilitation thesis to supervise research <input type="checkbox"/> yes <input type="checkbox"/> no If yes, date diploma received:                  Employer:                  Doctoral school affiliation:                  Rate of thesis supervision in the present project (%):</p>	

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

Number of current thesis supervisions/co-supervisions:

**Thesis co-supervisor 2 (if applicable)**

Surname, first name:

Position:

Habilitation thesis to supervise research  yes  no If yes, date diploma received:

Employer:

Doctoral school affiliation:

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:

**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: Bizouerne Elise

Date of PhD beginning and PhD defence: : 1/11/2017 – 9/2/2021

Thesis supervision: O. LEPRINCE, co-direction : J. Buitink

Professional status and location: applying for jobs

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

List of publications from the thesis work:

Bizouerne E, Buitink J, Ly Vu B, Ly Vu J, Esteban E, Pasha A, Provart N, Verdier V, Leprince O (2021) Gene co-expression analysis of tomato seed maturation reveals tissue-specific regulatory networks and hubs associated with the acquisition of desiccation tolerance and seed vigour. *BMC Plant Biology*, 21: 124. <https://doi.org/10.1186/s12870-021-02889-8>

Bizouerne E, Ly Vu B, Ly Vu J, Verdier J, Buitink J, Leprince O (2021) Dataset for transcriptome and physiological response of mature tomato seed tissues to light and heat during fruit ripening. *Data in Brief* 34:106671. DOI: 10.1016/j.dib.2020.106671.

Surname, first name: Zinsmeister Julia

Date of PhD beginning and PhD defence: : 1/11/2013 – 12/12/2016

Thesis supervision: O. LEPRINCE, co-direction : J. Buitink

Professional status and location: Researcher at the Polish Academy of Sciences, Warsaw.

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

List of publications from the thesis work:

Zinsmeister J (2017), Médaille d'Argent de l'Académie d'Agriculture de France

Zinsmeister J, Terrasson E, Chatelain E, Vandecasteele C, Lalanne D, Ly Vu B, Dubois-Laurent C, Geoffriau E, le Signor C, Dalmais M, vom Dorp K, Dörmann P, Gallardo K, Bendahmane A, Buitink J, Leprince O (2016) ABI5 plays a major role in regulating seed maturation and longevity in legumes. *The Plant Cell* 28: 2735-2754. doi.org/10.1105/tpc.16.00470

Zinsmeister J, Berriri S, Puntel Basso D, Ly-Vu B, Dang TT, Lalanne D, da Silva EAA, Leprince O, Buitink J. (2020) The seed-specific heat shock factor A9 regulates the depth of dormancy in *Medicago truncatula* seeds via ABA signalling. *Plant, Cell & Environment* 43:2508-2522. doi: 10.1111/pce.13853.

Zinsmeister J, Leprince O, Buitink J. (2020) Molecular and environmental factors regulating seed longevity. *Biochemical Journal* 477:305-323. doi: 10.1042/BCJ20190165.

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

Terrasson E, Darrasse A, Righetti K, Buitink J, Lalanne D, Ly Vu B, Pelletier S, Bolingue W, Jacques M-A, Leprince O (2015) Identification of a molecular dialogue between developing seeds of *Medicago truncatula* and seedborne xanthomonads. **Journal of Experimental Botany**, 66: 3737-3752. doi: 10.1093/jxb/erv167

Bolinque W, Rosnoblet C, Ly Vu B, Leprince O, Aubry C, Buitink J (2010) MtSNF4b connects after-ripening and constitutive biotic defense responses in seeds of *Medicago truncatula*. **Plant Journal** 61: 792-803

Zinsmeister J, Terrasson E, Chatelain E, Vandecasteele C, Lalanne D, Ly Vu B, Dubois-Laurent C, Geoffriau E, le Signor C, Dalmais M, vom Dorp K, Dörmann P, Gallardo K, Bendahmane A, Buitink J, Leprince O (2016) ABI5 plays a major role in regulating seed maturation and longevity in legumes. **The Plant Cell** 28: 2735-2754. Doi.org/10.1105/tpc.16.00470

Leprince O, Pellizzaro A, Berriri S, Buitink J (2017) Late seed maturation: drying without dying. **Journal of Experimental Botany** 68:827-841. Doi.org/10.1093/jxb/erw363

Pecrix Y, Staton S, Sallet E, et al (2018) Whole-genome landscape of *Medicago truncatula* symbiotic genes. **Nature Plants** 4(12):1017-1025. doi.org/10.1038/s41477-018-0286-7

Pellizzaro A, Neveu M, Lalanne D, Ly Vu B, Kanno Y, Seo M, Leprince O, Buitink J (2020) A role for auxin signaling in the acquisition of longevity during seed maturation. **New Phytologist** 225: 284-296 doi.org/10.1111/nph.16150

Zinsmeister J, Berriri S, Puntel Basso D, Ly-Vu B, Dang T-T, Lalanne D, da Silva EAA, Leprince O, Buitink J (2020) The seed-specific heat shock factor A9 regulates the depth of dormancy in *Medicago*

Bizouerne E, Julia Buitink, Benoît Ly Vu, Joseph Ly Vu, Eddi Esteban, Asher Pasha, Nicholas Provart, Jérôme Verdier, Olivier Leprince (2021) Gene co-expression analysis of tomato seed maturation reveals tissue-specific regulatory networks and hubs associated with the acquisition of desiccation tolerance and seed vigour. **BMC Plant Biology** 21:124. <https://doi.org/10.1186/s12870-021-02889-8>

## THESIS FUNDING

<b>Origin(s) of the thesis funding:</b> PPR SUCSEED
<b>Gross monthly salary:</b> 1769€
<b>Thesis funding state :</b> Acquired
<b>Funding beginning date/Funding ending date:</b> 1/10/2021 – 3 years

**Date:** 22 March 2021

**Name, signature of unit director:**RENOU JP



**Name, signature of team director:** LEPRINCE O



**Name, signature of thesis project director:** BUITINK J

