

PHD PROPOSAL FOR THE DOCTORAL SCHOOL

« Ecologie, Géosciences, Agronomie, ALimentation »

GENERAL INFORMATION

Thesis title: Dynamics of Fusarium populations responsible for Fusarium Head Blight and microbial communities among key components of the agroecosystem
Acronym: POPNCO
Disciplinary field 1: Agronomy Disciplinary field 2: Ecology
Three keywords: Fusarium Head Blight, Field Microbiome, Population
Research unit : LUBEM EA 3382
Name of the thesis director: Gaétan le Floch Email address of the thesis director : gaetan.lefloch@univ-brest.fr Name of the thesis co-supervisor 1 (if applicable): Email address of the thesis co-supervisor 1 (if applicable): Name of the thesis co-supervisor 2 (if applicable): Adeline Picot Email address of the thesis co-supervisor 2 (if applicable): adeline.picot@univ-brest.fr
Thesis grant (funding origin and amount): ANR, 280 k€
Contact(s) (mailing address and E-mail): Technopôle Brest Iroise 29280 Plouzané, lubem@univ-brest.fr
Recruitment process: Recruitment process depends on thesis funding. To select the corresponding recruitment process, please visit the EGAAL website here . This information is needed for proposal publication. <input type="checkbox"/> Doctoral school contest <input checked="" type="checkbox"/> Interview <input type="checkbox"/> Other (indicate) :

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

Fusarium Head Blight (FHB) is a devastating fungal disease of small-grain cereals including wheat resulting in yield loss and grain contamination with mycotoxins. Basic but yet unanswered questions regarding FHB epidemiology and the interactions between the field microbiome and *Fusarium* spp. (Fsp) remain. These fungi colonize various components of the field during their life cycle including previous crop residues, soil and grains. Although soil and residues constitute the main inoculum source, these components have received much less attention than grains. Studies on Fsp genetic diversity at the intraspecific level also constitute a second research gap. Yet, these knowledge are of paramount importance for the development of efficient control methods, including biocontrol, an environmentally-friendly alternative to chemical pesticides. Actually, the use of biocontrol agents (BCA) to reduce FHB has been intensively examined and, despite some promising results under laboratory or greenhouse conditions, field results are often disappointing. In addition to the aforementioned research gaps, several scientific and technical barriers can also account for such delay in the development of efficient BCA to FHB including the establishment of relevant screening methods and the design and use of appropriate tools for evaluating BCA efficacy.

Assumptions and questions

Overall, results of the PhD project will help us answer the following questions: i) which the main Fsp responsible for FHB are and where are they found? ii) What is the level of intraspecific diversity among Fg within fields? To which degree the soil and residue inoculum source contribute to the disease within a field? and iii) What are the diversity and dynamics of bacterial and fungal communities to which Fsp are confronted over time? And can isolates from the field microbiota be able to competitively displace toxigenic Fsp and reduce mycotoxin contamination in grains? Answers to these questions are central for the selection of appropriate biocontrol strategies in order to determine the predominant Fsp that should be targeted for BCA selection and the field components and wheat stages during which BCA application is more likely to affect pathogen population or its impact on the plant. In addition, results will contribute to gain a deeper insight into Fsp/field microbiota interactions and identify antagonistic isolates to Fsp to be implemented in biocontrol strategies.

The main steps of the thesis and scientific procedure & Methodological and technical approaches considered

To address these questions, we plan to thoroughly monitor, throughout the wheat cycle, 6 fields during 2 years. Samples from soil, wheat grains and maize residues, will be collected at different time-points over the wheat cycle (just after maize harvest, during the first wheat growth stages, at flowering and harvest). PhD project will be divided into 3 main tasks aiming to study i) the diversity and dynamics of bacterial, fungal and Fsp communities throughout the wheat cycle among the field components colonized by Fsp (i.e. residues, soil after residue decomposition and wheat heads and kernels); ii) the intraspecific variability, both phenotypic and genetic, within the predominant FHB species, that is *F. graminearum* (Fg); iii) the ability of isolates from the field microbiome to reduce Fsp growth and mycotoxin production using a bottleneck selection process.

Task 1. Fsp and field microbiota diversity and dynamics

On those samples, the diversity and dynamics of bacterial, fungal and Fsp communities will be determined using a metabarcoding approach.

Task 2. Fg Intraspecific diversity

A collection of Fg single-spore isolates from soil, maize residues and kernels will be constituted and genotyped using SNP-based markers in partnership with UR MycSA to study Fg intraspecific diversity at the field scale.

Task 3. Antagonistic activity to Fssp

A collection of 700 isolates (including both bacteria and fungi) will be generated and screened for their ability to reduce predominant Fssp growth using soil and plant-based media. Mesocosm experiments will finally be set up to determine the ability of a subset of the most active isolates, either alone or in combination, to colonize non-sterilized soil, maize residues and/or wheat grains, to displace predominant Fssp and reduce mycotoxin contamination in wheat grains.

Scientific and technical skills required by the candidate

The candidate will be graduated from an engineering school or hold a master 2 degree, with a 6-month internship related to phytopathology or microbial ecology. The candidate must have skills in molecular biology and microbiology. He/She must show ability to take initiative and work independently as well as in a team environment.

THESIS SUPERVISION¹

Unit name: LUBEM EA 3882	Team name: LUBEM site de Plouzané
Unit director name: Prof. Emmanuel Coton	Team director name: Prof. Jérôme Mounier
Mailing address of the unit director: emmanuel.coton@univ-brest.fr	Mailing address of the team director: jerome.mounier@univ-brest.fr
<p>Thesis director</p> <p>Surname, first name: Le Floch, Gaétan</p> <p>Position: Associate Professor</p> <p>Obtained date of the HDR (Habilitation thesis to supervise research): 2014</p> <p>Employer: UBO</p> <p>Doctoral school affiliation: ED 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) (%): 40%</p> <p>Number of current thesis supervisions/co-supervisions: 1</p>	
<p>Thesis co-supervisor 1 (if applicable)</p> <p>Surname, first name: Picot, Adeline</p> <p>Position: Associate Professor</p> <p>Habilitation thesis to supervise research <input type="checkbox"/> yes <input checked="" type="checkbox"/> no If yes, date diploma received:</p> <p>Employer: UBO</p>	

¹ 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.

Doctoral school affiliation: ED EGAAL

Rate of thesis supervision in the present project (%): 50%

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 60%

Number of current thesis supervisions/co-supervisions: 2

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: Legrand, Fabienne

Date of PhD beginning and PhD defence: 1/05/2014 au 16/10 2017

Thesis supervision: Gaétan Le Floch

Professional status and location: ANSES, Paris

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

List of publications from the thesis work:

1. Legrand, F., Chen, W., Cobo-Díaz, J. F., Picot, A. and Le Floch, G. Effects of agronomic practices and soil properties in soil fungistasis against *Fusarium graminearum*. *FEMS Microbial Ecology*. 95, fiz056.
2. Legrand, F., Picot, A., Cobo-Díaz, J.F., Carof M., Chen, W. and Le Floch, G. 2018 Effect of tillage and static abiotic soil properties on microbial diversity. *Applied Soil Ecology* 132 :135-145
3. Legrand, F., Picot, A., Cobo-Díaz, J. F., Delaunois, B., Cor, O., Barbier, G. and Le Floch, G. 2018 Development of qPCR assays to monitor the ability of *Gliocladium catenulatum* J1446 to reduce the cereal pathogen *Fusarium graminearum* inoculum in soils. *European Journal of Plant Pathology*, 152:285–295.
4. Legrand, F., Picot, A., Cobo-Díaz, J. F., Chen, W. and Le Floch, G. 2017 Challenges facing the biological control strategies for the management of *Fusarium* Head Blight of cereals caused by *F. graminearum*. *Biological Control* 113, 26–38.

Surname, first name: Guillaume DUBRULLE

Date of PhD beginning and PhD defence: 01.10.2016 – 30.09.2019

Thesis supervision: Gaetan LE FLOCH

Professional status and location: ATER, Univ. Toulouse

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

List of publications from the thesis work:

1. Dubrulle G, Picot A, Madec S, Corre E, Pawtowski A, Baroncelli R, Zivy M, Balliau T, Le Floch G, Pensec F. 2020. Deciphering the infectious process of *Colletotrichum lupini* in lupin through transcriptomic and proteomic analysis. *Microorganisms*, 8: 1621.
2. Dubrulle G., Pensec F., Picot A., Rigalma K., Pawtowski A., Nicolleau S., Harzic N., Nodet P., Baroncelli R., Le Floch G., 2020. Phylogenetic Diversity and Effect of Temperature on Pathogenicity of *Colletotrichum lupini*. *Plant Disease*, 104 (3)

Five main recent publications of the supervisors on thesis subject:

1. COBO-DÍAZ JF, BARONCELLI R, LE FLOCH G, PICOT A. 2019. A novel metabarcoding approach to investigate the composition of *Fusarium* species in soil and plant samples. *FEMS Microbial Ecology*. 95, fiz084. doi : 10.1093/femsec/fiz084
2. COBO-DÍAZ JF, BARONCELLI R, LE FLOCH G, PICOT A. 2019. Combined metabarcoding and co-occurrence network analysis to profile the bacterial, fungal and *Fusarium* communities and their interactions in maize stalks. *Frontiers in Microbiology*. 10, 61. doi: 10.3389/fmicb.2019.00261.
3. LEGRAND F, CHEN W, COBO-DÍAZ JF, PICOT A, LE FLOCH G. 2019. Co-occurrence analysis reveal that biotic and abiotic factors influence soil fungistasis against *Fusarium graminearum*. *FEMS Microbial Ecology*. 95, fiz056. doi :10.1093/femsec/fiz056
4. LEGRAND F, PICOT A, COBO-DÍAZ JF, CAROF M, CHEN W, LE FLOCH G. 2018 Effect of tillage and static abiotic soil properties on microbial diversity. *Applied Soil Ecology* 132 :135-145 doi : 10.1016/j.apsoil.2018.08.016
5. LEGRAND F, PICOT A, COBO-DÍAZ JF, CHEN W, LE FLOCH G. 2017. Challenges facing the biological control strategies for the management of *Fusarium* Head Blight of cereals caused by *F. graminearum*. *Biological Control*, 113: 26-38.

THESIS FUNDING

Origin(s) of the thesis funding: ANR
Gross monthly salary: 1770 euros
Thesis funding state : Acquired
Funding beginning date/Funding ending date: Oct 4 th 2021, 3 years

Date: April 14th 2021

Name, signature of unit director: Emmanuel Coton



Name, signature of team director: Jérôme Mounier

Name, signature of thesis project director: Gaétan Le Floch