objectif végétal
Research, Education and Innovation in PAYS de la LOIRE

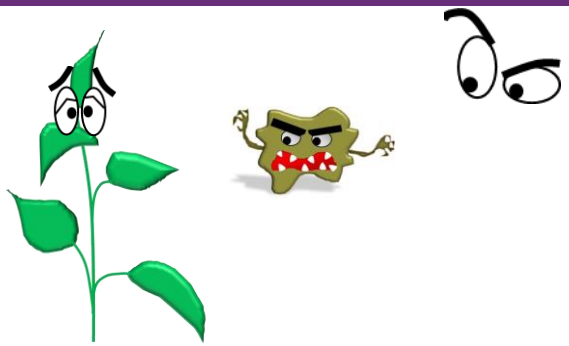
The innovation box of
Objectif Végétal

Move closer to academic research to boost your potential of innovation!

SFR 4207 Angers Qualité et Santé du Végétal Quasav

n°8

Biocontrol strategies
What's new in research in Pays de la Loire?



Last update: november 2017

Companies talk about it

Charlotte CENIER,
Biodiversity and Biosolutions Consultant
Agrosolutions

Society's expectations for change in agriculture are high. Consumer demands and regulatory obligations are driving the farming industry to find **new production methods** that are more respectful of the environment and biodiversity. **Biocontrol** represents a new method of crop protection but, like any new method, it **requires a great deal of development and support**. The solutions are multiple: the use of macro-organisms, micro-organisms, natural substances or chemical mediators, but many of them are not yet operational. In addition, the use of these solutions involves more complex mechanisms of action and efficacy conditions than conventional active ingredients.

These products raise many questions:

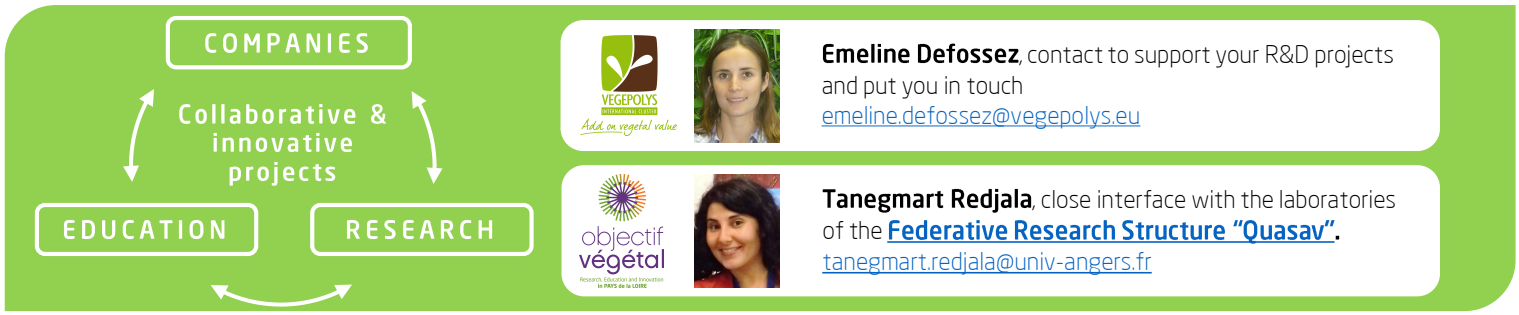
- How do they work?
- Which indicators should be monitored and which ratings should be carried out to assess their effectiveness?
- What biotic and abiotic factors will determine their effectiveness?
- What is their real impact on the environment, user and consumer health, biodiversity?

Apart from the use of products, **the use of natural mechanisms** such as allelopathic activity of certain plants, interspecific competition or natural regulation by crop auxiliaries **are all biocontrol methods to be developed and better understood.** The expectations of farmers are therefore very high with regard to research, suppliers, technical institutes and distributors, on the one hand to **broaden the range of solutions available**, which are still too few at the moment, and on the other hand to **support them in the use of these new practices and solutions**.

In this context, the work of SFR Quasav (Federative Research Structure "Plant Health and Quality) finds its full meaning. In order to meet field expectations and accelerate the availability of these new practices and solutions, **it is essential that research and companies cooperate.**

Looking for partners?

Two contacts to help you build your projects and support them:



This issue has been produced with the contribution of an editorial board: M.-N. Brisset (INRA), M. Marchi (INRA) E. Belmas (GEVES), D. Longevialle (IBMA), C. Profizi (Agrauxine-Lesaffre Plant Care), C. Cenier (Agrosolutions), L. Emile (VEGEPOLYS), T. Redjala (RFI Objectif Végétal).

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Biocontrol products: definitions and work in progress

1. Auxiliary macro-organisms

Invertebrates, insects, mites or nematodes. **Modes of action**: parasitoids, predators or entomopathogenic nematodes.

The **EGI (Ecology and Genetics of Insects)** team of **IGEPP**[1], in collaboration with **LARIS**[2], **Plante & Cité**, **FREDON PACA**, **KOPPERT** and **IF TECH**, has developed an **integrated biological protection strategy** with the use of a nematode and an auxiliary insect, which has led to commercial products (Tigranem, Tigrador). A **tool has also been created** to **quantify leaf discolouration and evaluate the effectiveness of biocontrol products** - **PETAAL project** (2009 - 2012) – *FUI funds.*

bruno.jaloux@agrocampus-ouest.fr

2. Chemical mediators

Insect pheromones and kairomones. **Modes of action**: sexual confusion, mass entrapment.

The EGI team of **IGEPP**[1] has shown that low doses of neonicotinoids promote the reproduction of pests by stimulating their sense of smell - **PHEROTOX project** (2012-2016) - *ANR funds*
→The **potential interactions between low doses of insecticides and chemical mediators** must be taken into account when using them for biocontrol.

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3. Natural substances

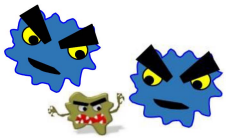
Substances of plant, animal, microbial and mineral origin. **Modes of action**: direct effect on the pest or stimulation of the defenses of the plant.

S. Tourneur

During her **PhD thesis** at **LBPV**[3], **Sabine Tourneur** evaluates the role of miPEPs (new class of regulatory peptides) in **controlling the interaction between sunflower and the parasitic plant orobanche** - miPEPITO project (2017-2020) in collaboration with **MicroPEP Technologies** - *ANR funds.*

philippe.delavault@univ-nantes.fr

IRHS[4] is studying the ability of secondary metabolites extracted from microorganisms to induce plant defenses (qPFD® test) or inhibit the growth of phytopathogenic fungi - **NABUCO project** (2015-2018) in collaboration with **Agrauxine - Lesaffre Plant Care** - *Ministry of Agriculture funds.*



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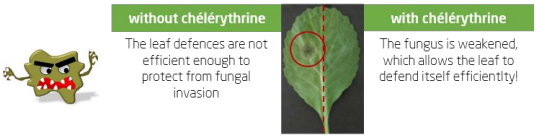
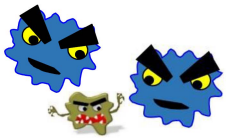


IRHS[4] and **SONAS**[5] have **patented natural substances capable of making pests more sensitive to plant defenses.**
→ These **"sensitines"** could act in synergy with **PRIs** (Plant Resistance Inducers).

4. Living microorganisms

Fungi, bacteria, viruses. **Modes of action**: direct effect on the pest, nutritional or spatial competition, stimulation of the defenses of the plant.



IRHS[4] identifies **microorganisms that are aggressive to phytopathogenic fungi** - **NABUCO project** (2015-2018) in collaboration with **Agrauxine - Lesaffre Plant Care** - *Ministry of Agriculture funds.*

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S. Rezki

Samir Rezki's thesis (2014-2017) at **IRHS**[4] studied the behaviour of **microbiota associated with seeds** during the transmission of phytopathogenic agents - **MetaSEED project** (2014-2016) in collaboration with **HM Clause** and **Vilmorin** – *funded by Région Pays de la Loire*
→ microbial populations could thus be identified as **potential biocontrol agents** capable of **competing with plant pathogens transmitted by/to seeds**.

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[1]UMR IGEPP site of Angers: Institute for Genetics, Environment and Plant Protection (joint research unit Inra, Agrocampus-Ouest, Université Rennes 1)
[2]LARIS: Angevin Laboratory for Research in Systems Engineering (Université d'Angers)
[3]LBPV: Laboratory of vegetal biology and pathology (Université de Nantes)
[4]UMR IRHS: Research Institute in Horticulture and Seeds (joint research unit Inra, Agrocampus-Ouest, Université d'Angers)
[5]SONAS: Laboratory of Natural Origin Substances and Structural Analogues (Université d'Angers)

FOCUS on PRIs

Plant Resistance Inducers (PRIs): **any substance or any non-pathogenic micro-organism capable of promoting resistance in plants to biotic stress**.
http://elicitra.org/

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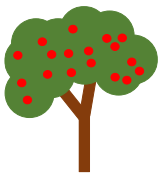

IRHS[4] and **UEH**[7] are working on the **integration of SDPs in the management of apple orchards** under production conditions (**PEPS project** - 2014-2018 – *Casdar funds* and **Tavinnov project** -2017-2020- *SMaCH INRA meta-programme funds*): are particularly studied i) **factors influencing the effectiveness of PRIs** (environment, inputs, others), ii) the **sustainability** of this protection strategy.

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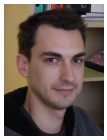

R. Warneys

M. Skopikova

Romain Warneys' PhD thesis, carried out at **IRHS**[4] as part of the **Pomme d' épi project** (2016-2019 - *funded by RFI Objectif Végétal*) and **Michaela Skopikova's PhD thesis** at **SONAS**[5] (2017-2020), aim to **explore the mode of action of PRIs at different levels** (**epigenetic, transcriptomic, protein and metabolic**) in apple trees.

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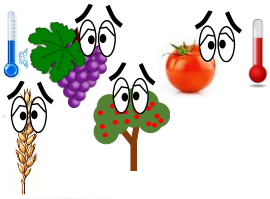

The **effectiveness of PRIs** depends on the **physiological state of the plant**, which is **partly conditioned by abiotic stress**. **IRHS**[4] is developing tools for **evaluating** this physiological state, based on (i) **expression of stress marker genes and imaging techniques** (**ESTIM project**: joint laboratory with **SAS Arexhor Pays de la Loire** - *ANR LabCom funds*) and (ii) **activation of transposable elements.**

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J. Bénéjam

IRHS[4] seeks to **combine constituent defenses, QTLs of partial genetic resistance and PRIs** to control **apple scab**. This is the subject of **Juliette Bénéjam's PhD thesis** (2017-2020), associated with the **PREDIRE project** (2016-2019 - *funded by RFI Objectif Végétal*) and **QTLstim project** (2017-2020 – *INRA funds*).

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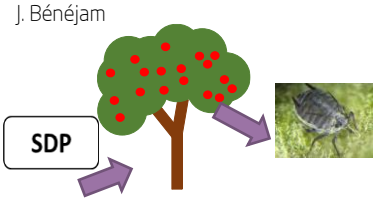

Among the defense genes induced by **PRIs**, some are involved in the production of **volatile organic compounds**. **IRHS**[4] and EGI team of **IGEPP**[1] are studying SDP's ability to modify the **behaviour of the aphid** by olfactometry and ElectroPenetroGraphy.

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Biocontrol through plant diversity

A. Pollier

Agricultural practices, the flora of the field and its border, agricultural landscape are major determinants of biological control. A conceptual model integrating them is being developed at EGI team of **IGEPP**[1] - **PEERLESS project** (2013-2017) – *funded by ANR Agrobiosphère and Chaire AEI*. **Anna Pollier's thesis** improved **flower strips for the biological control of insect pests of rapeseed and wheat.**

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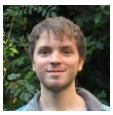

N. Carton

Nicolas Carton's PhD thesis at **LEVA**[6] made it possible to propose **combinations of lupine and cereals to control weeds** while ensuring the productivity of both crops.

ghellou@groupe-esa.fr

M. Luquet

Associated crops can also provide food resources for auxiliaries; **Martin Luquet's PhD thesis** at EGI team of **IGEPP**[1] (2016-2019) focuses on **parasitoids of aphids in cereal-protein associations.**

bruno.jaloux@agrocampus-ouest.fr

LBPV[3] seeks to identify **legume species with negative allelopathic activity in relation to the rowing orobanch**, with a view to **associating** them with **rapeseed crops** – **PHERAFAB project** (2014-2017) - *CASDAR funds*.

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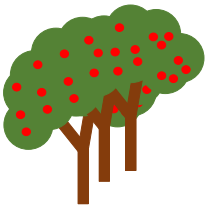

Mixing varieties or species of different resistances helps to **limit the spread of pests and slow down resistance circumvention**. A **mathematical model** has been developed at the **IRHS**[4] to **design** these mixtures according to the constraints of the plot, and successfully used in the projects **Vergers cidricoles de demain** (2012-2014 then 2015-2018) - *CASDAR funds*.
Model usable on all crops, at **plot, farm or landscape scale.**

natalia.sapoukhina@inra.fr

[6]LEVA: Leguminosae, Plant Ecophysiology, Agro-ecology Research Unit (Ecole Supérieure d'Agricultures d'Angers - Inra)
[7]UEH: Experimental Horticultural Unit (Inra)

OFFERS TO COMPANIES

Examples of possible areas of collaboration

- **Develop the molecular test for the screening of PRIs** (qPFD®) for **new crop species.**
- Optimize the use of **PRIs under production conditions**
- Evaluate "sensitines[MD]" on new pathosystems; test their **synergy with PRIs**
- Formulate "sensitines[MD]" for seed encapsulation
- Develop screening methods for biocontrol products on **seeds** (antagonistic fungi…)
- **Identify active molecules** in an extract of **natural origin**
- **Choose the species/varieties** to be associated and the **way to associate them** according to the objectives

SUCCESS STORY - Choose the right legume varieties!

Annick Basset
Jouffray-Drillaud

« The success of crop associations depends not only on the species but also on the varieties chosen. At **Jouffray-Drillaud** company, we create varieties for targeted uses. **Joining our forces with academic research** is strategic to the development of our R&D sector. **Our collaboration with the partners** of **Alliance project** (CASDAR funds) has allowed us to **consolidate and quantify the ecosystem services of several legume varieties** that we thought interesting **to accompany rapeseed or wheat**. In particular, **this partnership has made it possible to prove scientifically** (**UMR Agronomy**, **UMR AGIR**, **USC LEVA[6] (ESA-Inra)** that certain varieties of legumes are useful in controlling weeds, while preserving crop yields."

associated rape **rape alone**

(a purple vetch Titanium variety with a clover of Alexandria monocup Eclair variety monocup)

Strenghten your R&D team by recruiting a (CIFRE) **PhD student** (financial support by **ANRT** and **CIR**), a **PhD graduate** (financial support by CIR) or a **working students** (in contract of professionalisation or apprenticeship).

Training for enterprises

Biocontrol of microbial and metabolic origin: Use of microorganisms and defense stimulators for plant protection. *Under construction*
Contact : thomas.heitz@agrocampus-ouest.fr

Tailor-made training courses **on request**:
Contacts : thomas.heitz@agrocampus-ouest.fr
sonia.boucheron@univ-angers.fr
j.fustec@groupe-esa.fr

Patents

qPFD® Device for determining or studying the state of stimulation of the natural defenses of plants or plant parts. WO/2011/161388 claire.lemontey@paris.inra.fr

"sensitines[MD]" Inhibiting agents of the adaptive response of fungi for the protection of plants against fungal infections. WO/2014/012766A1 herve.le-deit@ouest-valorisation.fr

Services (in Région Pays de la Loire)

Test the effectiveness of a PRIs using the qPFD® molecular tool on **apple**, **vine**, **tomato**, **potato**, **wheat**.
innovation@vegepolys.eu

Assess the **biocidal effect** of a product by nephelometry and spectrophotometry

Practical value testing of SDPs on apple orchards (dedicated plots to **UEH**[7])
arnaud.lemarquand@inra.fr

Identify a seed bio-aggressor and evaluate biocontrol solutions
joel.lechappe@geves.fr

Design optimal mixtures of species or varieties on a plot, farm or production basin scale
natalia.sapoukhina@inra.fr

Assess the **antagonistic power of a fungus** against a phytopathogenic fungus
joel.lechappe@geves.fr

Know the aggressiveness of a microorganism, Assess the impact of a bio-aggressor on germination and emergence
phenotic@listes.univ-angers.fr

Obtain **strains of bacteria** (phytopathogenic or not)
cfbp@inra.fr

Getting **Insects/Aphids**
Bioinsecte@listes.inra.fr
biopuceron@listes.inra.fr

Objectif Végétal, Research, Education & Innovation in Pays de la Loire is a regional program (2014-2019) established by the Pays de la Loire Regional Council and that involves the teaching and research institutions (Université d'Angers, leader of the program, Agrocampus Ouest, ESA, Inra, Université de Nantes) as well as the international French cluster Végépolys.
Objectif Végétal program mainly aims to reinforce the visibility of the regional centre for education and basic research, to boost translational research and reinforce the processes of economic valorization of research findings, and to develop international partnerships.

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