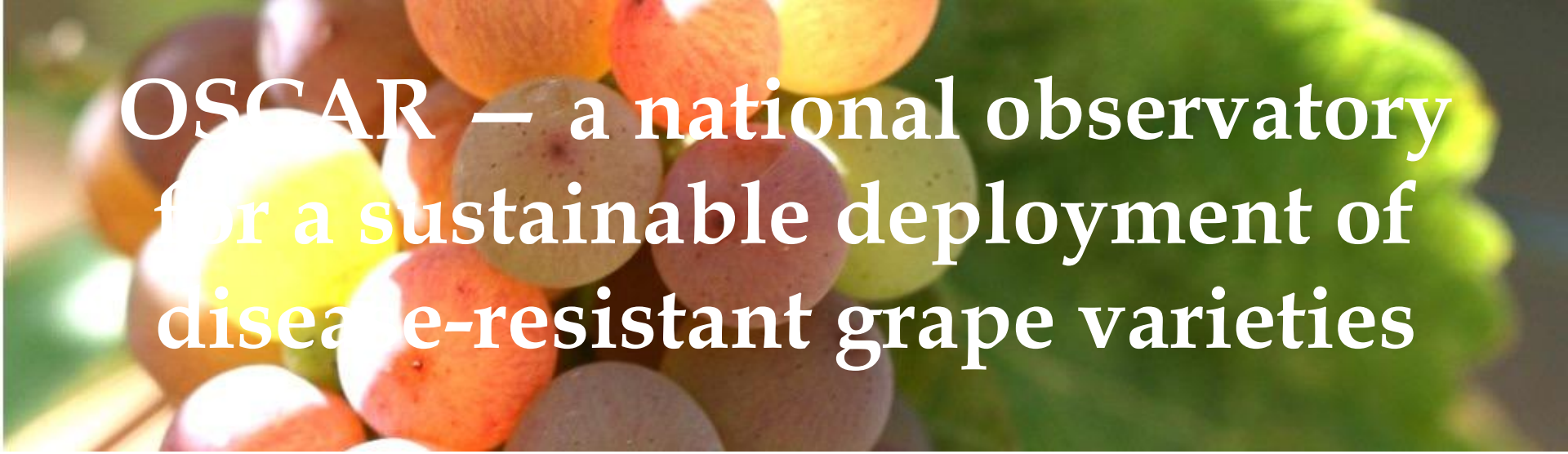


# OSCAR – a national observatory for a sustainable deployment of disease-resistant grape varieties

**F. Delmotte**, S. Guimier,
I. Demeaux, F. Fabre,
L. Audeguin, L. Delière

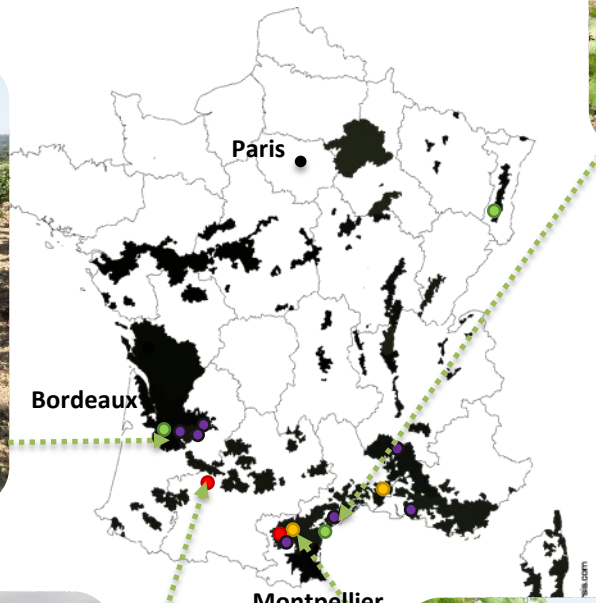
INRA Bordeaux
France

Bordeaux, ICGBG, 15-20 July 2018

In Europe, conventional breeding programmes has led to the creation of a new generation of disease resistant varieties with excellent agronomic and organoleptic characteristics.

# In France, an underlying trend for the use of disease-resistant varieties







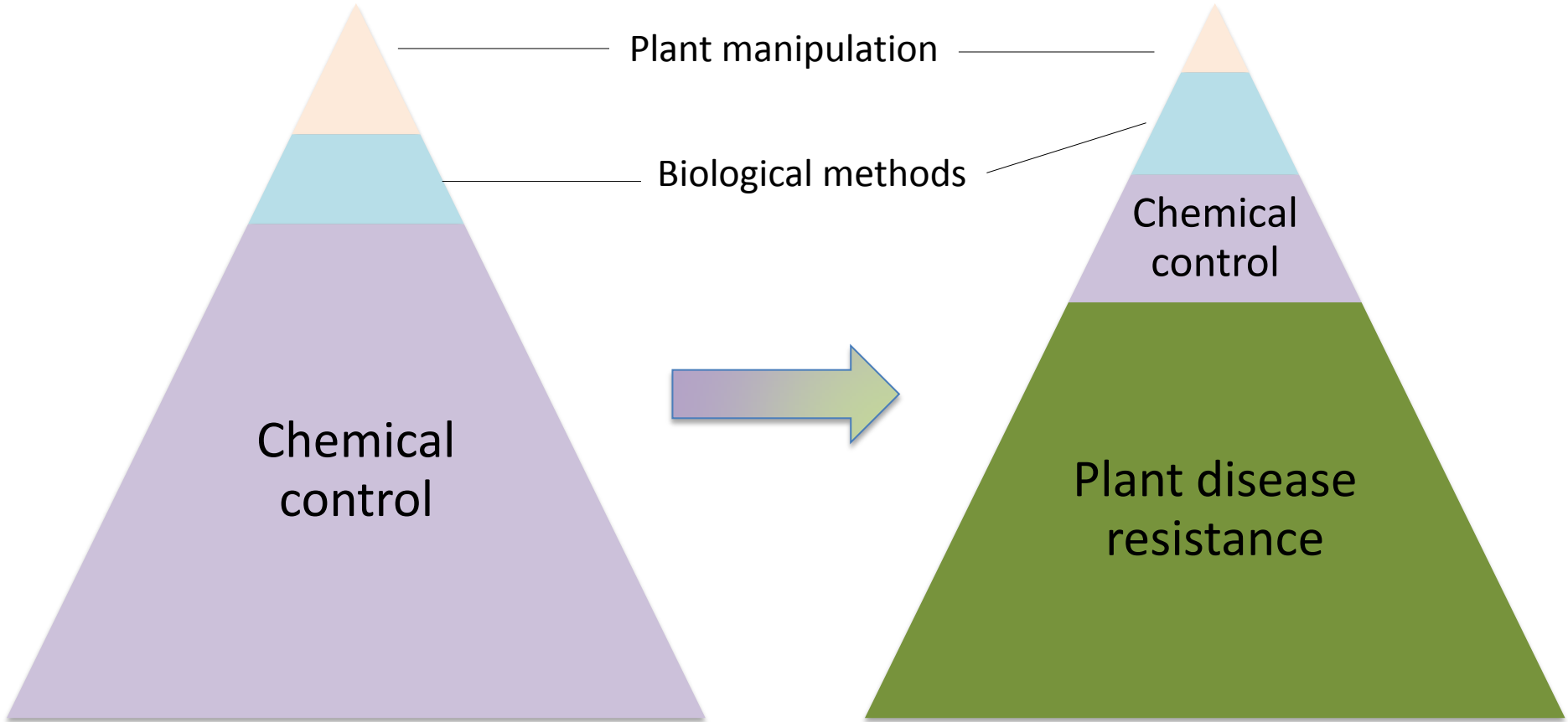

# Challenges

1. **Valorisation potential**
   - Quality, organoleptic characteristics, wine-making process
   - Market ‘environmental quality’
   - Regulation (Varieties deriving from interspecific crosses are prohibited in AOC - European regulations EU1308/2013)

# Challenges

## 2. Cropping systems

- Management of varieties with new « disease profiles »
- Modification of the cropping system and of the objectives of grapevine protection



# Challenges

## 3. Durability of resistances

- Perenial plant, limited number of genes
- Adaptation of the pathogens to plant resistance
- Increase of agressivess, erosion of quantitative resistance

Peressotti *et al. BMC Plant Biology* 2010, **10**:147
http://www.biomedcentral.com/1471-2229/10/147

BMC Plant Biology

RESEARCH ARTICLE Open Access

Breakdown of resistance to grapevine downy mildew upon limited deployment of a resistant variety

Elisa Peressotti[1,4], Sabine Wiedemann-Merdinoglu[1,2], François Delmotte[3], Diana Bellin[4,6], Gabriele Di Gaspero[4,5], Raffaele Testolin[4,5], Didier Merdinoglu[1,2], Pere Mestre[1,2*]

Evolutionary Applications

Open Access

Evolutionary Applications ISSN 1752-4571

ORIGINAL ARTICLE

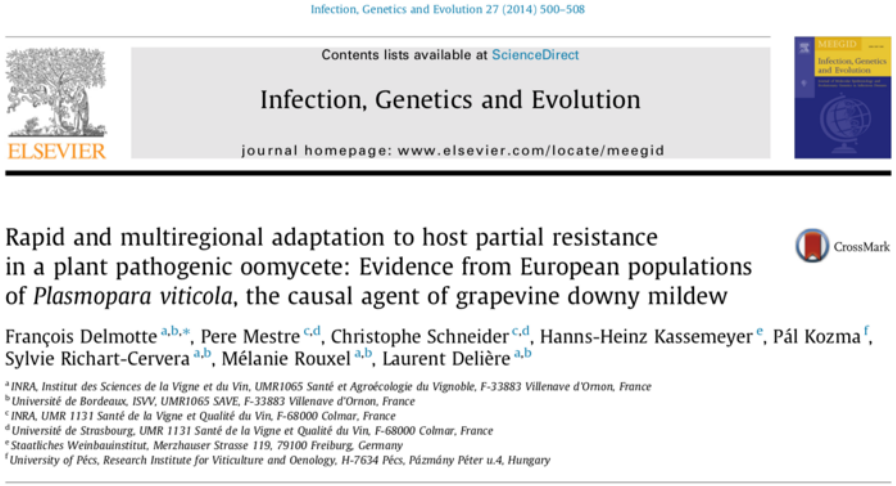
**Adaptation of a plant pathogen to partial host resistance: selection for greater aggressiveness in grapevine downy mildew**

Chloé E. L. Delmas,[1,2] Frédéric Fabre,[1,2] Jérôme Jolivet,[1,2] Isabelle D. Mazet,[1,2] Sylvie Richart Cervera,[1,2] Laurent Delière[1,2] and François Delmotte[1,2]

1 UMR 1065 Santé et Agroécologie du Vignoble, INRA, Villenave d'Ornon, France
2 Bordeaux Science Agro, UMR 1065 SAVE, ISVV, Université de Bordeaux, Villenave d'Ornon, France

**Keywords**
erosion, evolvability, fitness cost, host

**Abstract**



Infection, Genetics and Evolution 27 (2014) 500–508

Contents lists available at ScienceDirect

Infection, Genetics and Evolution

journal homepage: www.elsevier.com/locate/meegid

ELSEVIER

Rapid and multiregional adaptation to host partial resistance in a plant pathogenic oomycete: Evidence from European populations of *Plasmopara viticola*, the causal agent of grapevine downy mildew

CrossMark

François Delmotte[a,b,*], Pere Mestre[c,d], Christophe Schneider[c,d], Hanns-Heinz Kassemeyer[e], Pál Kozma[f], Sylvie Richart-Cervera[a,b], Mélanie Rouxel[a,b], Laurent Delière[a,b]

[a] INRA, Institut des Sciences de la Vigne et du Vin, UMR1065 Santé et Agroécologie du Vignoble, F-33883 Villenave d'Ornon, France
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[c] INRA, UMR 1131 Santé de la Vigne et Qualité du Vin, F-68000 Colmar, France
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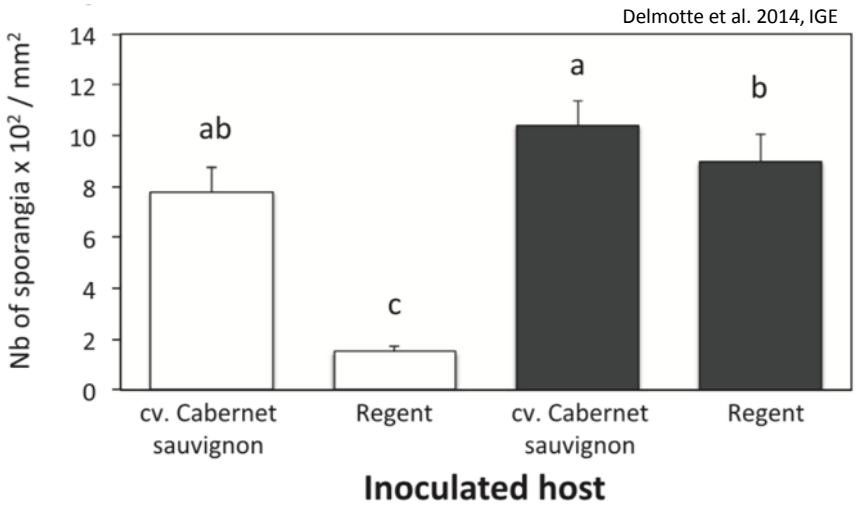
[f] University of Pécs, Research Institute for Viticulture and Oenology, H-7634 Pécs, Pázmány Péter u.4, Hungary

# Challenges

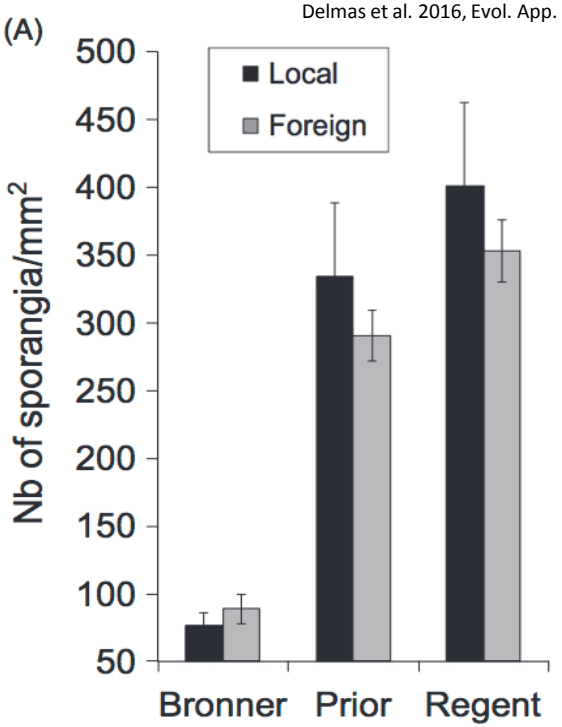
## 3. Durability of resistances

- Perenial plant, limited number of genes
- Adaptation of the pathogens to plant resistance
- Increase of agressivess, erosion of quantitative resistance

Delmotte et al. 2014, IGE




Delmas et al. 2016, Evol. App.

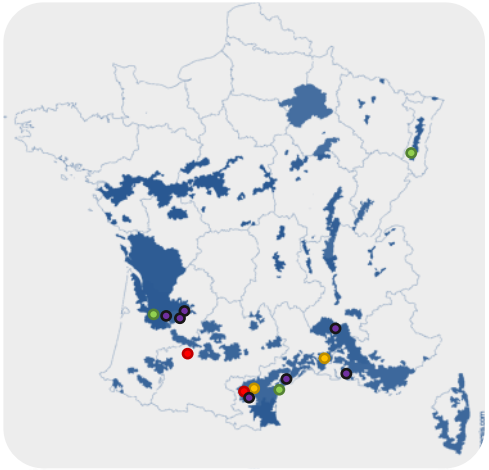



□ *P. viticola* isolates collected on cabernet sauvignon

■ *P. viticola* isolates collected on Regent

# Observatoire national du déploiement des cépages résistants

- A national network launched in 2017
- Based on wine growers willigness to contribute
- Research and action is being done 'with' people and not 'for' people



**To organise the collective monitoring of long-term resistance efficacy**


**To collect data, share results and experiences**

**To initiate a participatory action research**

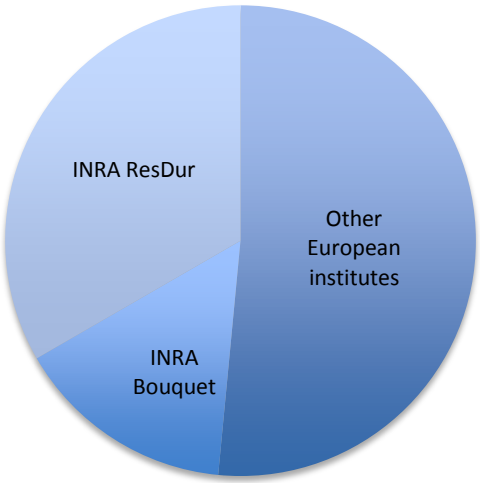


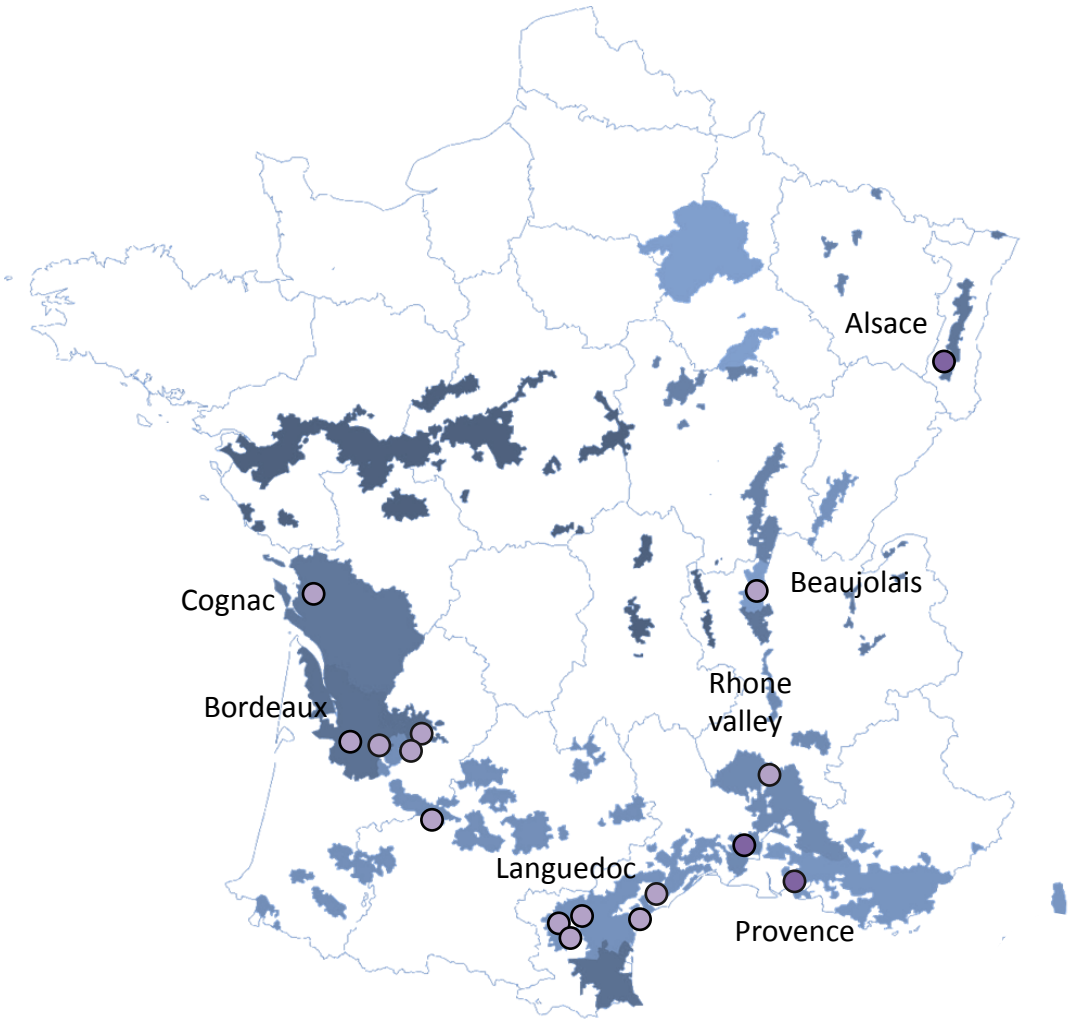


- Plot in production (> 0.5 ha)
- Diversity of agro-climatic conditions
- Diversity of cropping systems
- OSCAR includes all resistant varieties registrated in France
  - INRA-Bouquet (Rpv1, Run1)
  - INRA- Floreal, Voltis, Artaban, Vidoc (Rpv1/Rpv3; Run1/Ren3)
  - Cabernet cortis, Souvignier gris, Soreli, Monarch, Muscaris

- 2017 — #34 plots
  (Bordeaux, Rhone valley, Provence, Languedoc)
- 2018 — #65 plots
  (+ Cognac, Alsace, Beaujolais)
- ≈ 300 ha

- 20 varieties



# Implementation

- A shared protocol

**Mars - Avril**
**Débourrement**

**Mai**
**Préfloraison**
> Evaluation bioagresseurs:

**Juin**
**Floraison / Nouaison**
> Evaluation bioagresseurs:

**Juillet**
**Fermeture**
> Evaluation bioagresseurs:

**Août**
**Véraison**
> Evaluation bioagresseurs:

**Septembre**
**Récolte**
> Evaluation bioagresseurs

**Octobre**
> Bilan de campagne
> Estimation de la pression parasitaire locale


1. Description of the plot
2. Socio-economical caracteristics of the farm
3. Phenological stages
4. Diseases dynamics
5. Local disease pressure
6. Phytosanitory protection
7. Harvest

# Implementation

- Survey of practices, feedback
  - *Agronomical behaviour (plant growth, fragility, productivity, quality)*
  - *Mecanisation (pruning, yield)*
  - *Protection (Strategy and Decision rules)*

# Implementation

- Assessing diseases at the vineyards

*Epidemiology of pathogens (targeted or not by grape resistance)*

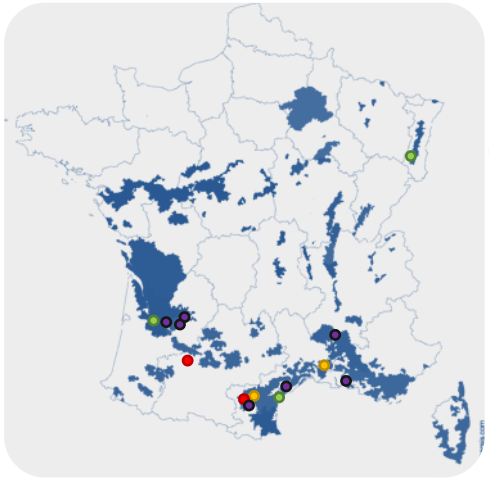






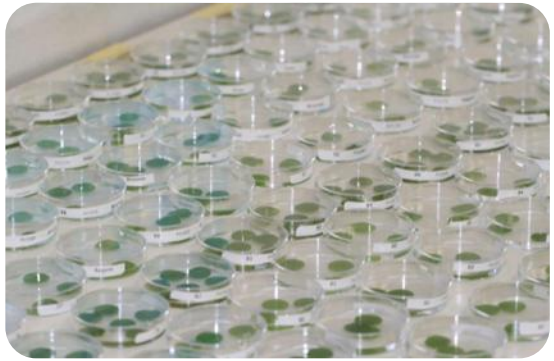

# Implementation

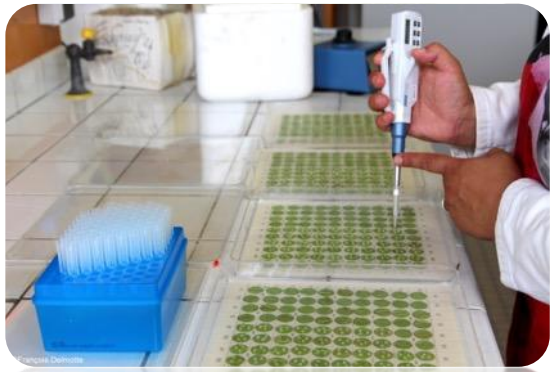
- **Monitoring** pathogens targerted by R genes
- Long-term preservation of isolates
- Bioessays to assess agressivenes/virulence evolution



Annual large-scale sampling

Multiplication, preservation





Monitoring of agressiveness

# POSTER n°100

## Disease-resistant grapevine cultivars drastically reduce fungicides use: results of a five years multi-criteria evaluation of two low-fungicide input cropping systems

SOIZIC GUIMIER[(1)], FREDERIC FABRE[(1)], ISABELLE DEMEAUX[(1)], JEAN-PASCAL GOUTOULY [(2,3)], DOMINIQUE FORGET [(4)], FRANÇOIS DELMOTTE[(1)], LAURENT DELIÈRE [(1,2)]

(1) INRA, UMR 1065 SAVE, F-33883 Villenave d'Ornon, France, (2) INRA UE 1442 Vigne Bordeaux, F-33883 Villenave d'Ornon
(3) INRA, UMR 1287 EGFV, F-33883 Villenave d'Ornon, France, (4) INRA, Château Couhins SAS, F-33140 Villenave d'Ornon

### Objectives

The RESINTBIO project aims to design and evaluate low input cropping systems. We compare a system using disease resistant grape variety with a system using susceptible variety. The systems combine different strategies of diseases, pests and weed control (Table). For the system based on the resistant variety Artaban, we also evaluate the durability of the resistance genes Rpv1 and Rpv3.

### Method

Two systems, planted in 2011, are experimented at a large scale (3 repetitions of 0,2 ha) for a multi-criteria evaluation.

#### In the field : Multi-criteria evaluation

RES : fungus resistant variety system  INT : low-pesticide input system

| Strategies | | RES | INT |
|---|---|---|---|
| Efficience of chemical treatments | Decision rules Doses reduction | | |
| Cultural control | Mechanical weed control | | |
| Biocontrole | Natural substances use | | |
| Prophylaxis | Leaf removal Inoculum suppression | | |
| Varietal resistance | Variety Artaban, resistant to downy and powdery mildew | | |

Not used  Low  Moderate  High

Levels of utilisation of the strategies in the 2 systems

Criteria used to evaluate the systems :
- Production (yields, quality, residues)
- Pests and diseases
- Environmental impact
- Costs of production, working time

#### In the lab : Durability assessment of the resistance

- Cross-inoculation of pathogens on plants in controlled conditions
- 4 hosts*85 isolates*4 replicates = 1360 interactions (leaf discs)
- Aggressiveness assessed at 6 days after inoculation by image analysis

- *Origin of downy mildew isolates*

res. var : Isolates collected on Artaban (system RES). ***44 isolates***
sus. var. : Isolates collected on *V. vinifera* in Bordeaux region. ***41 isolates***
Isolated were collected from 2011 to 2015

| • *Inoculated hosts* | Resistance genes |
|---|---|
| Cabernet sauvignon | - |
| Artaban | Rpv1,Rpv3 |
| IJ85 | Rpv1 |
| Regent | Rpv3 |

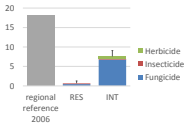
- *Data analysis*: one way ANOVA and Tukey test

### Results

#### In the field

**Environment**

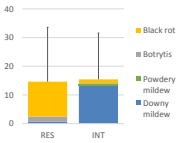
*TFI : Treatment frequency index**




**-50% IFT reduction for INT** compared to regional references ; **90% of IFT reduction** between RES and INT.
-The quantity of fungicide residues measured in the wine is low : 3 molecules in INT, and none in RES.

**Agronomy**

*Diseases severity on clusters before the harvest (%)*

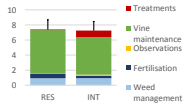



-Diseases severity on clusters are principally caused by **downy mildew in INT, and black rot in RES.**
Diseases **severity in RES less than 5% since 2015**, with decision rules for 1 or 2 treatments against black rot

-**Yields objectives** reached almost every year in INT and always higher than 78%. Since 2015 yields objectives reached in RES.

**Socio-economics**

*Costs in k€/ha*



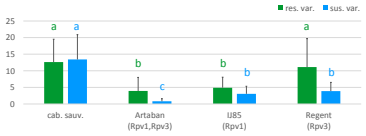

**-No difference of costs** between the 2 systems. The savings made thanks to the economy of treatments in RES are balanced with prophylaxis measures. Costs close to the references.

*Mean and standard deviation on 2012-2016*

**sum, for the various applications, of the ratio of the applied pesticide dose to the national recommended dose*

#### In the lab

*Sporulation leaf disc area (%)*




**Resistance efficiency depends on isolate's origin**

**For isolates collected on *V. vinifera*,** resistant varieties are more efficient with 2 resistance genes. **For isolates collected on Artaban,** we found resistance breakdown for Rpv3 but a high resistance level for Rpv1 alone and for Rpv1 pyramided with Rpv3

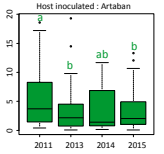
**Evidence for adaptation to resistance genes**

Isolates collected on Artaban are more aggressive on Artaban and Regent than isolates collected on *V. vinifera*
However, resistant varieties do not select for additional aggressiveness on susceptible variety

**Resistance erosion with time ?**

*Sporulation leaf disc area (%) of isolates collected on resistant variety Artaban*

No evidence for a greater aggressiveness of the downy mildew with time




*Conclusion* : Resistances remain overall efficient. Pathogen adaptation results from the selection by resistant genes of preexisting aggressive isolates.

INRA SCIENCE & IMPACT  AGENCE FRANÇAISE POUR LA BIODIVERSITÉ ÉTABLISSEMENT PUBLIC DE L'ÉTAT  ÉCOPHYTO RÉDUIRE ET AMÉLIORER L'UTILISATION DES PHYTOS

# Oral presentation (O29)

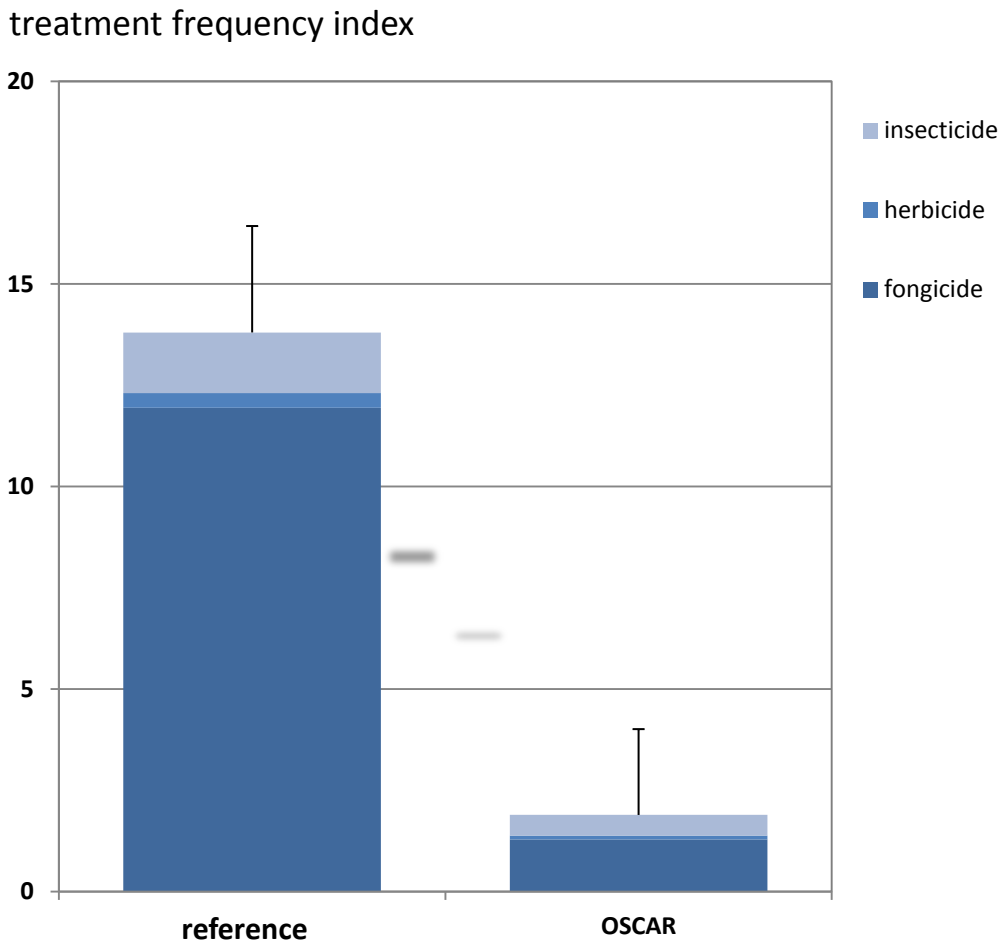
Session 'Genomics and data handling' – Mario Pezzotti

Tuesday 15h40

Yann Dussert et al.

*"Plasmopara viticola population genomics : adaptation of downy mildew to grapevine partial*

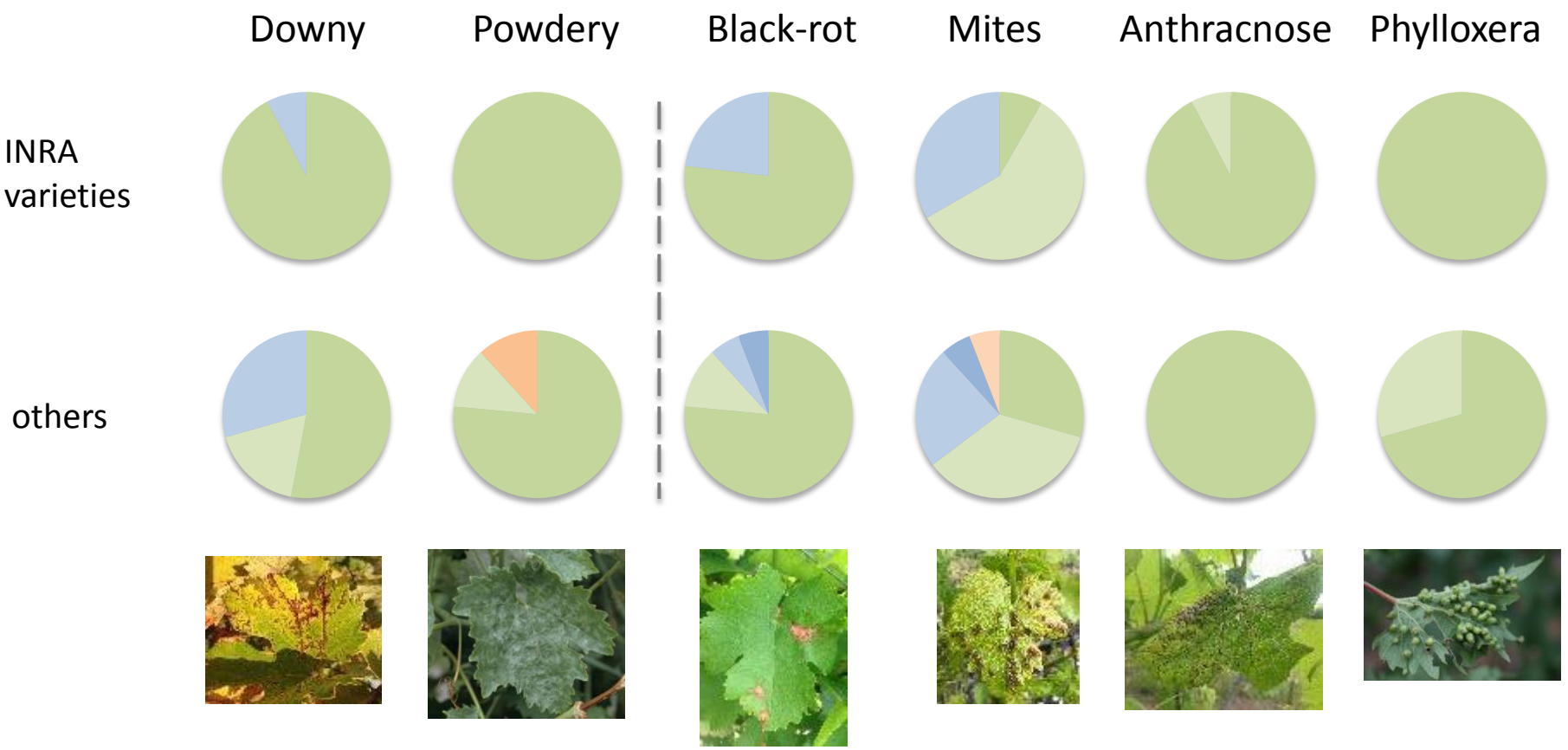
# Overall, a reduction of 86% of fongicide use



# 2017 - Pests & diseases prevalence

Maximal **frequency** of vines presenting disease symptoms on **leaves**

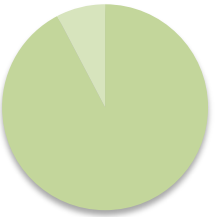
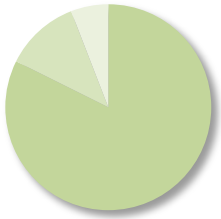
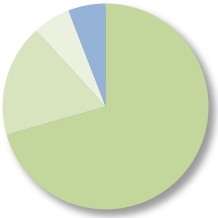
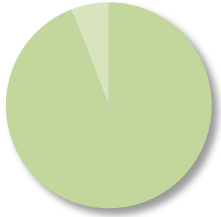
0 | 0 - 5% | 5% - 25% | 25% - 50% | 50% - 80% | > 80 %



# 2017 - Pests & diseases prevalence

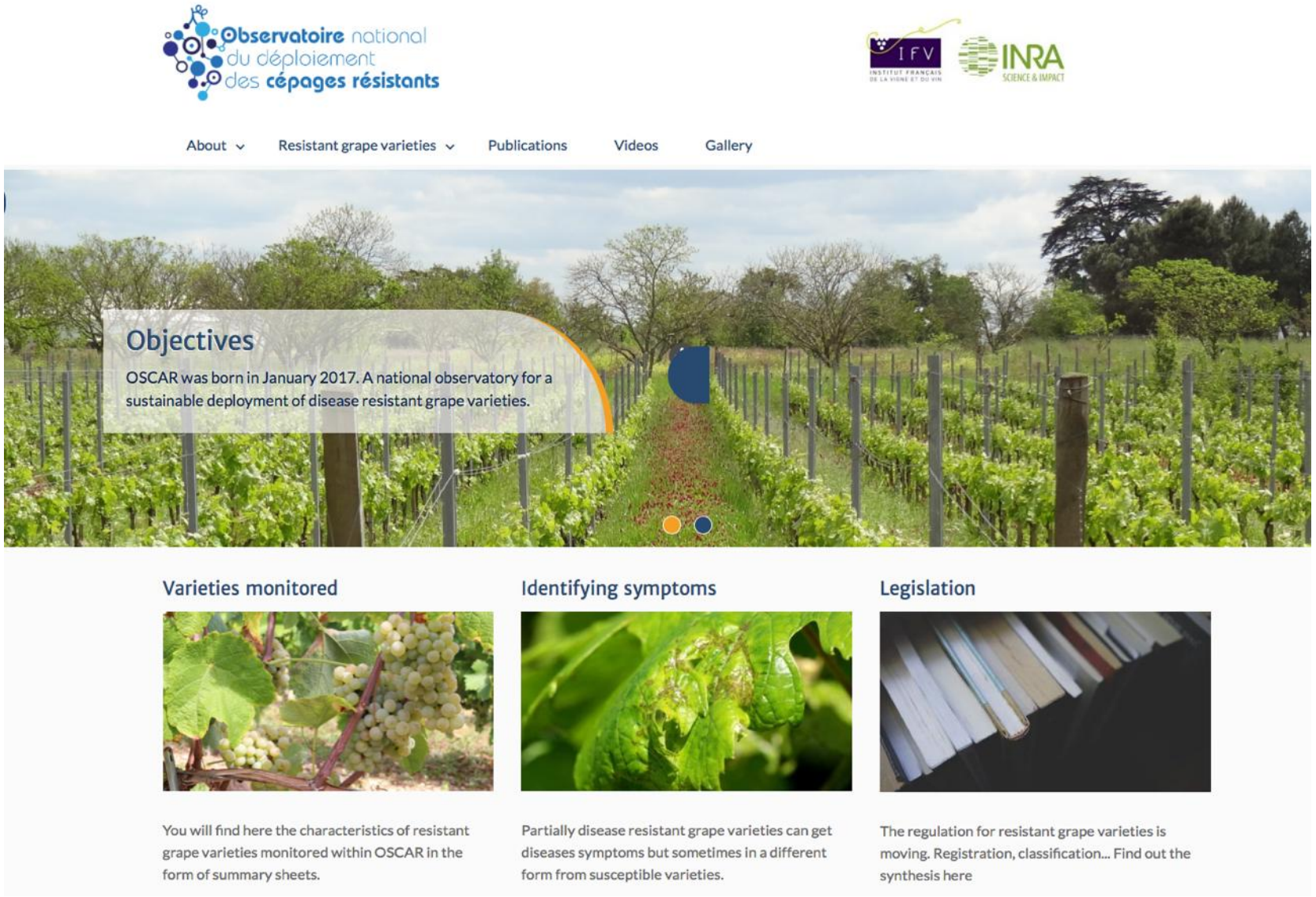
**Maximal severity** of symptoms **on clusters**

0 | 0 - 1% | 1% - 5% | 5% - 10% | 10% - 50% | > 50 %

| | Downy | Powdery | Black-rot | Mites | Anthracnose |
|---|---|---|---|---|---|
| INRA varieties |  |  |  |  |  |
| others |  |  |  |  |  |
| |  |  |  |  |  |

http://observatoire-cepages-resistants.fr/en

@oscar_vigne



# Summary sheets by variety

3159-2-12 B »

3160-11-3 N »

3176-21-11 N »

3184-1-9 N »

3197-81 B »

Artaban »

Cabernet cortis »


Floreal »

Monarch »

Muscaris »

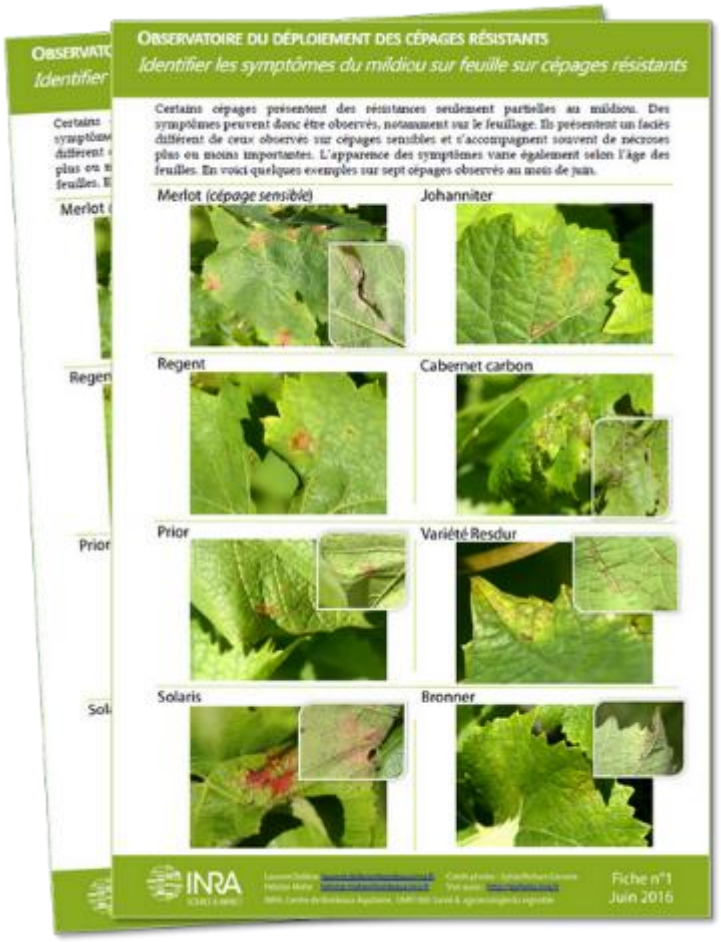
Soreli »

Souvignier gris »

Vidoc »

Voltis »

# « Learning tools » for disease symptoms recognition




# Update on legislation

Observatoire national du déploiement des cépages résistants

IFV INSTITUT FRANÇAIS DE LA VIGNE ET DU VIN — INRA SCIENCE & IMPACT

About | Resistant grape varieties | Publications | Videos | Gallery

## Legislation

In France, any grape variety intended for use in producing and marketing wine must meet two cumulative conditions: **be registered in the official listing** and **be classified** as a wine-grape vine variety. Although the very first definitive classifications for resistant grape varieties were awarded at the beginning of 2017, some grape varieties have a **temporary classification**, even if they are sometimes registered in the official listing in the country in which they were bred. Limited areas of **trial plots can then be planted.** The modalities are defined by the Ministerial Order of 9 May 2016 under the new planting licensing regime.

+ Temporary classification, definitive classification, registration in the EU common catalogue of plant varieties - what is the difference?
+ What are the approaches for experimental planting?
+ How to find planting material ?
+ Can AOC (protected designation of origin) be made with these new grape varieties?

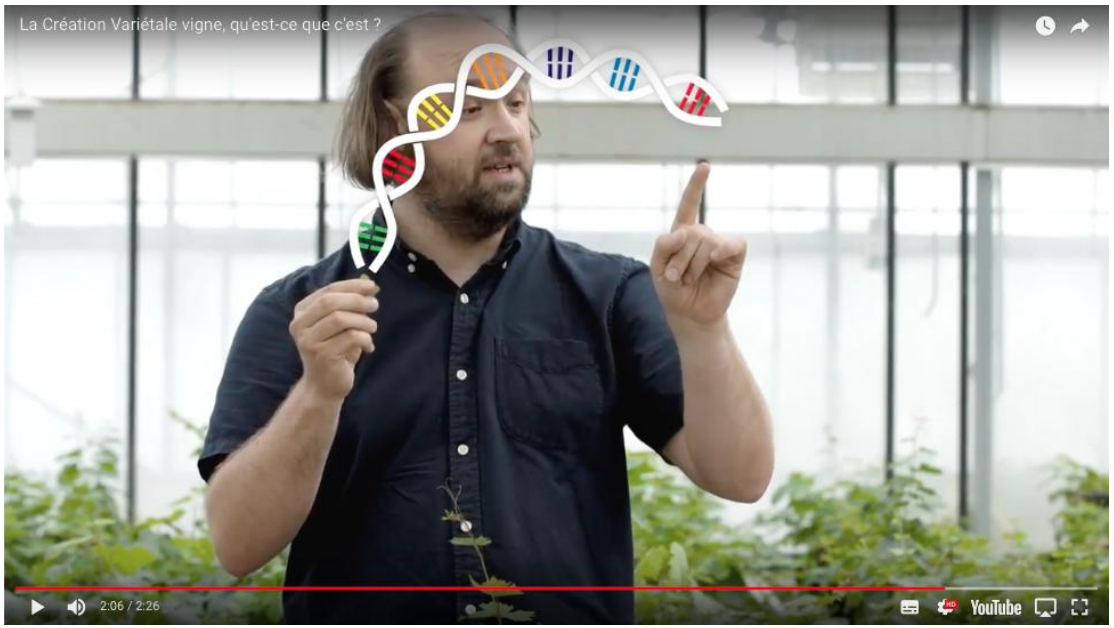
Tweets by @oscar_vigne

OSCAR
@oscar_vigne

Lancement d'une thèse en septembre qui s'appuiera sur le réseau OSCAR ! #cépagesrésistants observatoire-cepages-resistants.fr/2018/07/05/une…

**Une collecte nationale de mildiou da...**
OSCAR, en structurant les initiatives d...
observatoire-cepages-resistants.fr

# Bibliographic ressources





- Videos
- Reports, press kits
- Technical articles
- Scientific papers

## Expected results of OSCAR

- Data on the « behaviour » of the interaction [Variety] x [Cropping system] x [Agroclimatic cond.]
- Data on the valorization of wines poduced for R-var.
- Durable managment of resistance
  - Long term monitoring of resistance efficacy
  - Epidemiological data to calibrate mathematical models
- Surveillance of emergences (new diseases, etc.)
- Enlarge OSCAR to Switzerland, Germany, Italy, etc.?

# Authors



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**Soizic Guimier, INRA**
Frédéric Fabre, INRA
Isabelle Demeaux, INRA
Carole Couture, INRA
Laurent Audeguin, IFV





# Fundings

ÉCOPHYTO
PIC | RÉDUIRE ET AMÉLIORER L'UTILISATION DES PHYTOS

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
Ministère de l'Environnement, de l'Énergie et de la Mer

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTÈRE DE L'AGRICULTURE ET DE L'ALIMENTATION

AGENCE FRANÇAISE POUR LA BIODIVERSITÉ
Établissement public du ministère de l'Environnement

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IFV

Plant breeding

Rémy Cailliatte

INRA

Plant breeding

François Delmotte

INRA

Phytopathology

Frédéric Fabre

INRA

Epidemiology

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INRA

Sociology

Lionel Ley

INRA

Viticulture

Hernan Ojeda

INRA

Viticulture

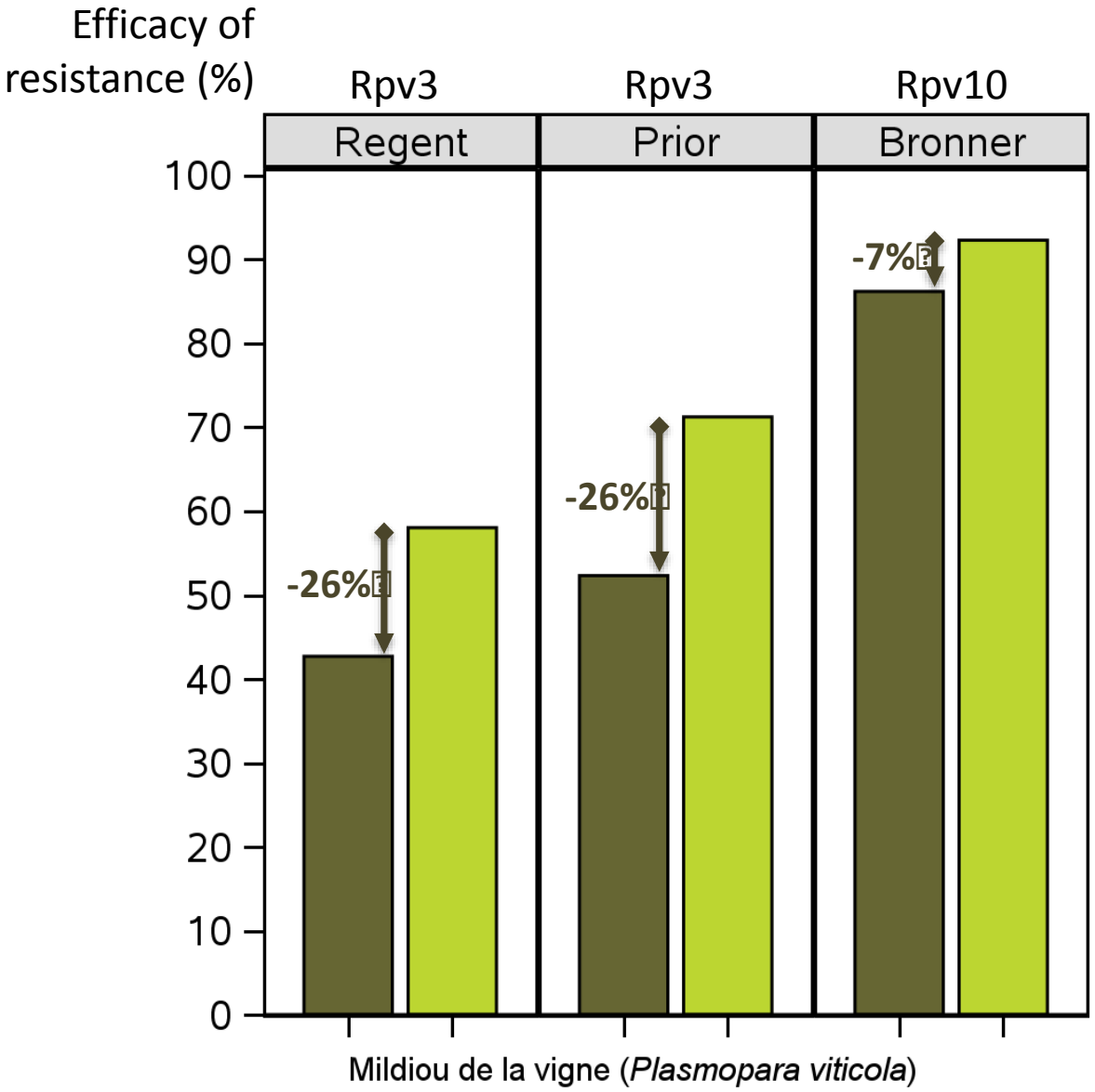
Marc Raynal

IFV

Christophe Schneider

INRA

# An undergoing erosion of grapevine partial resistance




***Naïve* population**
49 isolates from *V. vinifera*

***Adapted population***
54 isolates from resistant varieties


ORIGINAL ARTICLE

**Adaptation of a plant pathogen to partial host resistance: selection for greater aggressiveness in grapevine downy mildew**

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# Cultivar specificity ?
# A general increase of aggressiveness