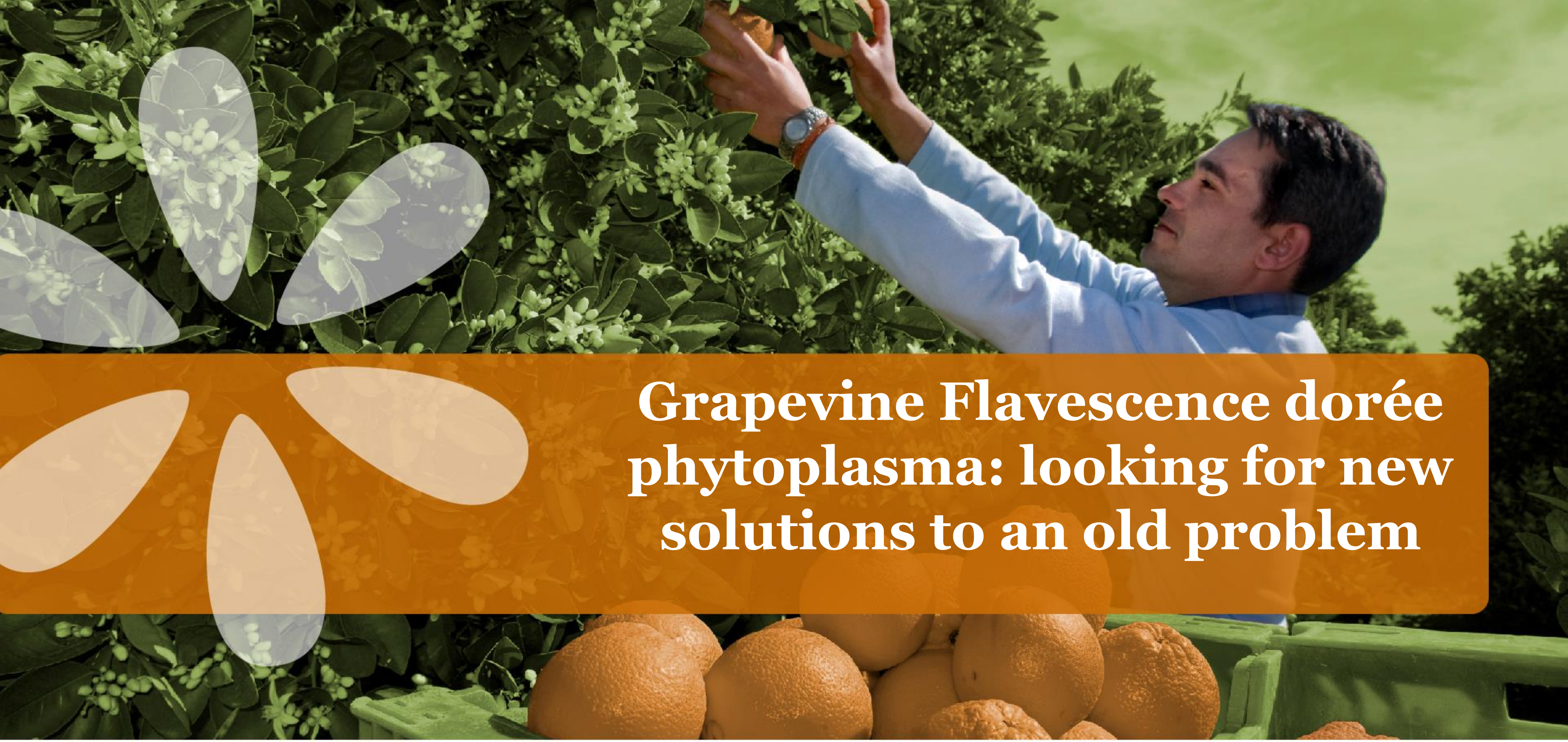

Grapevine Flavescence dorée phytoplasma: looking for new solutions to an old problem

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Position: *CREA Viticulture and Oenology, IT*
Name of the event: *28th StaDG-ER meeting*

10/11/2022

Mission

To ensure a viable, innovative, competitive EU agriculture and agri-food sector guaranteeing food security to half a billion people throughout Europe.

Objective

Promoting European farmers and agri-cooperatives views to **influence** EU decision-making process and public opinion.

copa
european farmers

- Created in **1958**
- **22** million European farmers and family members
- **60** full members from the EU Member States and 36 partner organisations

cogeca
european agri-cooperatives

- Created in **1959**
- **22,000** European agricultural cooperatives
- **35** full members from the EU Member States, 4 affiliated members and 36 partner organisations

In **1962**, a joint Secretariat was created, making it one of the largest and most active organisations in Brussels for the past **60** years.

Emerging risk

"Emerging risk" to human, animal and/or plant health and the environment is understood as a risk resulting from a newly identified hazard to which a significant exposure may occur or from an unexpected new or increased significant exposure and/or susceptibility to a known hazard (EFSA 2019).

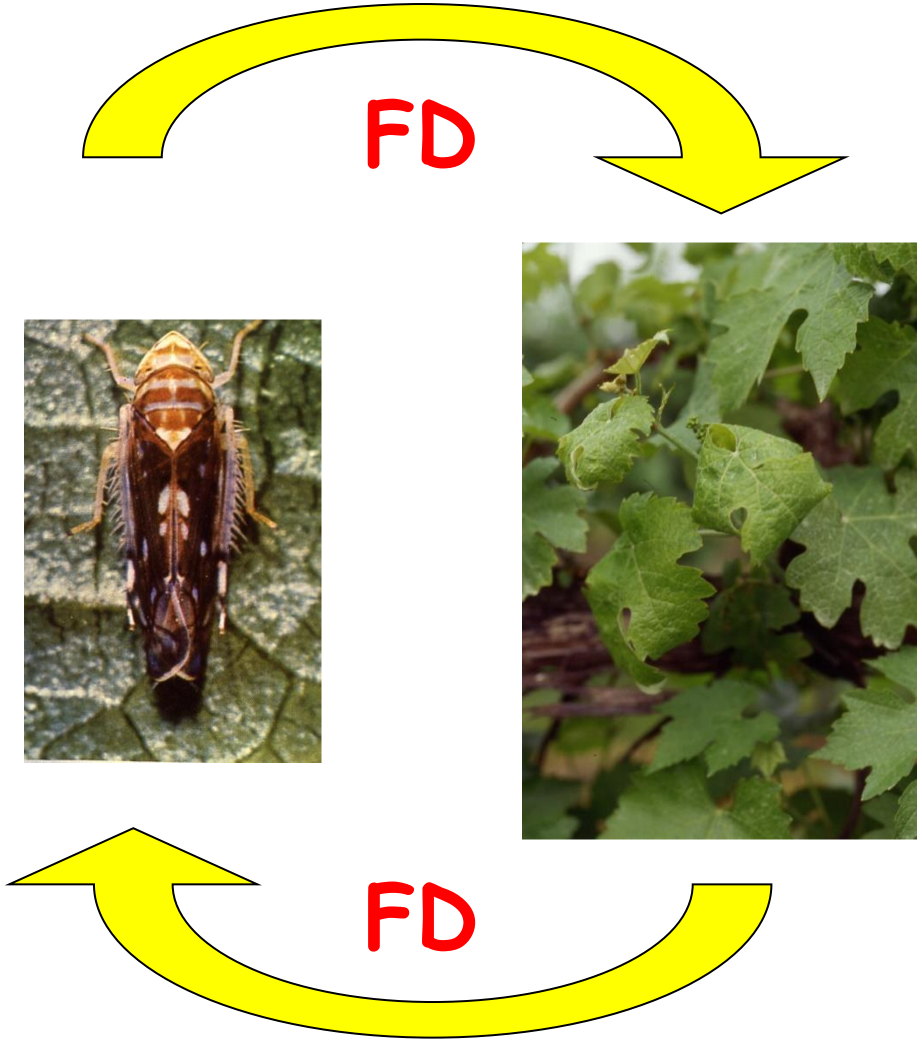
Flavescence dorée (FD) and its vector *Scaphoideus titanus*

FD caused by specific phytoplasmas (wall-less bacteria parasites of plants and insects)

Transmitted from grapevine to grapevine by the American leafhopper *Scaphoideus titanus*

Strongly epidemic

***S. titanus* introduced in Europe probably in the 1920s** (Chuche and Thiery 2014). **FD first identified in Europe (France) in the 1950 years** (Caudwell 1959)



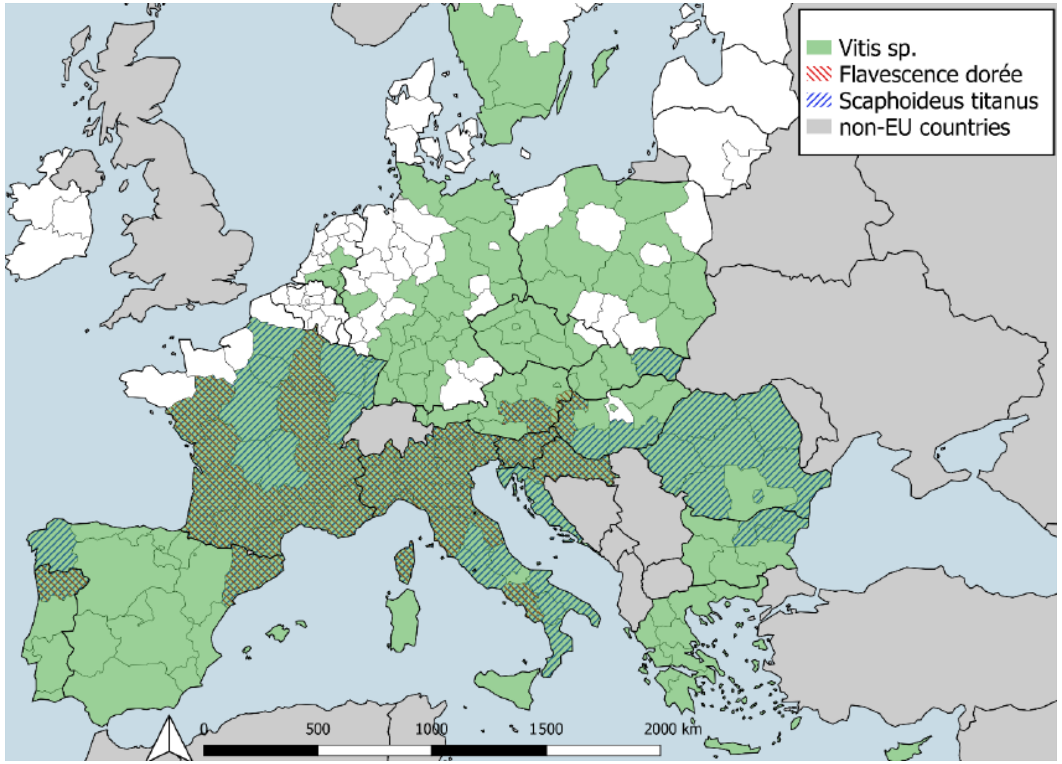
Impact on the grapevines

- Drop in yields
- Death of the vine

- EFSA 2019: *"Based on the general and specific scenarios (...), proportion (in %) of yield losses is estimated to be 4,3% (range 0,8-21,9%)."*

Disease propagation in EU

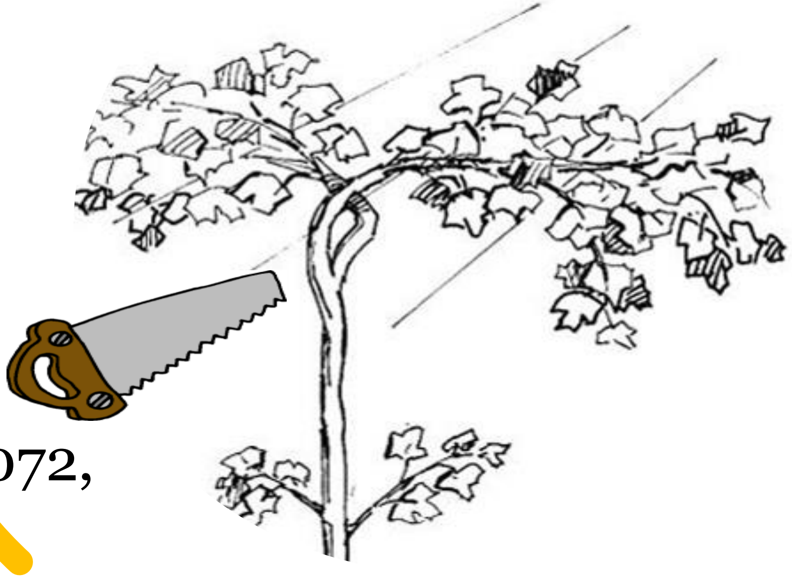
2020



1950

(EFSA, 2020)

European Legislation



- Council Directive 2000/29/EC
- EC Regulations 2016/2031, 2017/625, 2019/2072, 2021/2285, 2022/1630

- Quarantine disease of the grapevine
- Mandatory controls in vineyards and nurseries by:
  - **monitoring** the disease and the vector
  - mandatory **insecticide** treatments against the vector
  - **uprooting** of infected grapevine plants
  - **hot water** treatments in nurseries, if located in FD-infected areas
- Control measures differ across demarcated areas

New drivers altering the risk: insecticide panel in the EU

1. **Systemic insecticides:**

- Generally persistent, **from 7 to up to 30 days** post treatments
- On-field effectiveness: **80-100%** and **45-90%**

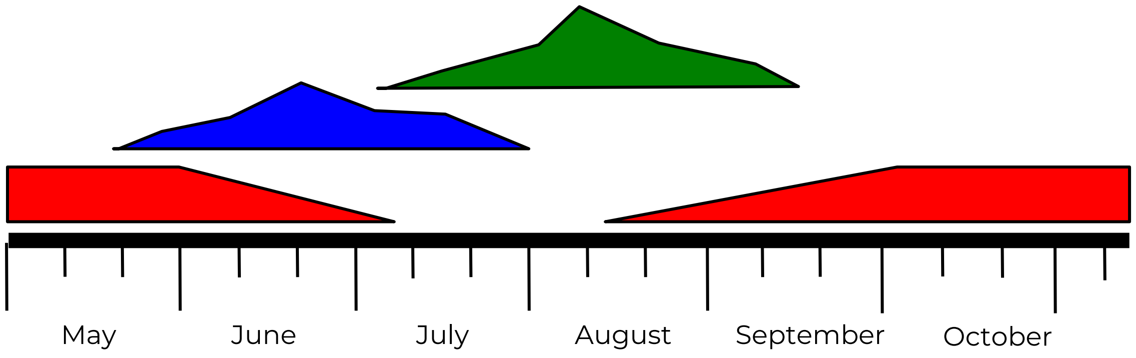
2. **Pyrethroids (contact products)**

- Not persistent (few hours or days)
- On-field effectiveness: **70-97%**
- Wide-spectrum action, also non-target insects

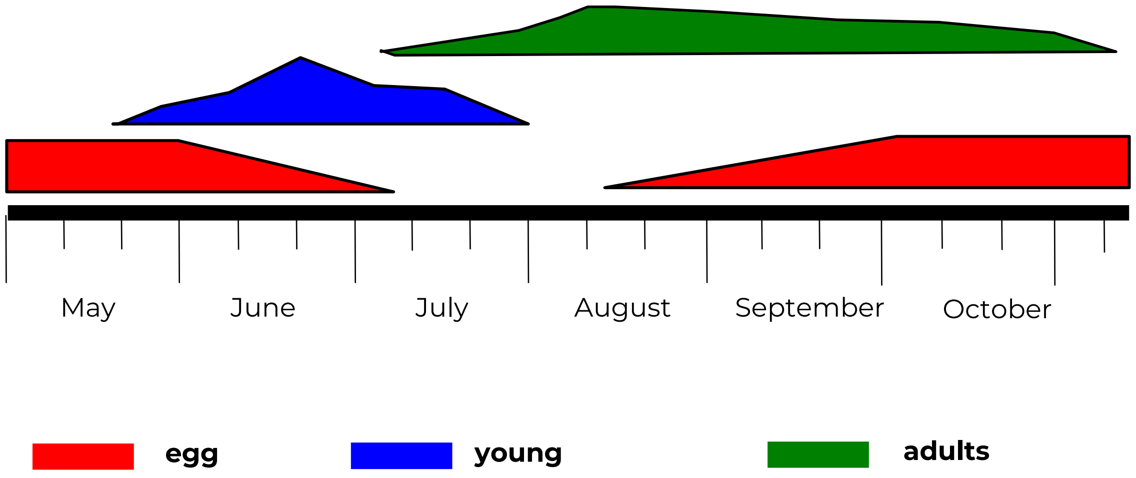
2011	2020
thiamethoxam	
chlorpyriphos metil	
chlorpyriphos etil	
flufenoxuron	
	flupyradifurone
acetamiprid	acetamiprid
etonfenprox	etonfenprox
deltamethrin	deltamethrin
acrinathrin	acrinathrin
taufluvalinate	taufluvalinate
lambda chyalothrin	lambda chyalothrin
cypermethrin	cypermethrin
esfenvalarate	esfenvalarate

New drivers altering the risk: vector and climate change

1. **<u>Vector longevity:</u>**
   - Adult longevity: **30-40 days** (Vidano 1966, Chuche and Thiery 2014)
   - 2020 adult longevity: **50-70 days** (Bocca et al 2020)



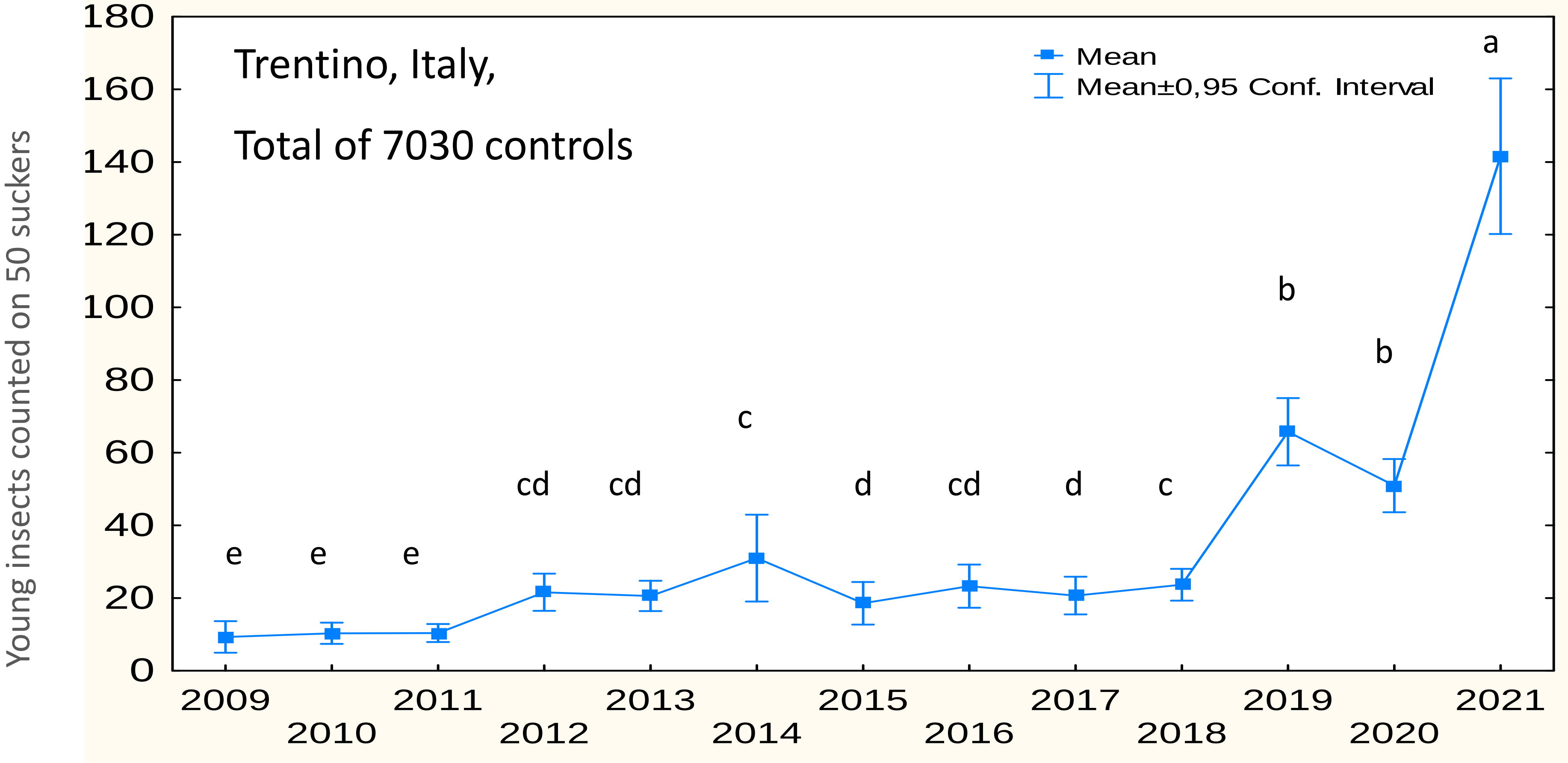
2. **<u>Fecundity</u>** (no. of eggs per female)
   - **8-24 eggs** (Vidano 1966; Alma et al 1988; Cravedi et al 1993; Bosio and Rossi 2001; Bressan et al 2005; Linder and Jermini 2007; Eriksson et al 2012)
   - 2020: **60 eggs** (Bocca et al 2020)



(credits to N. Mori, Italy)

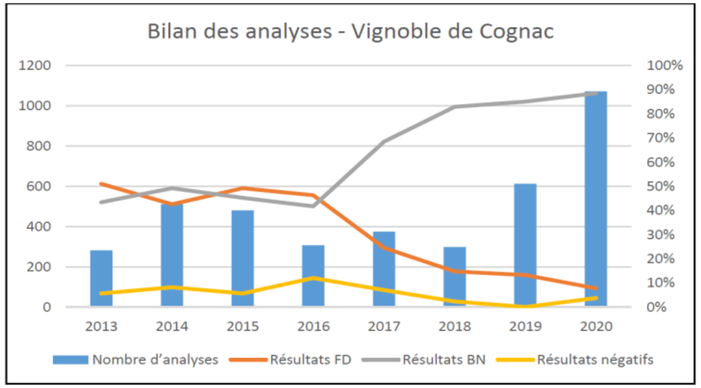
Vector population increasing on the field: an example in Northern Italy

Credits to M. Bottura, Italy

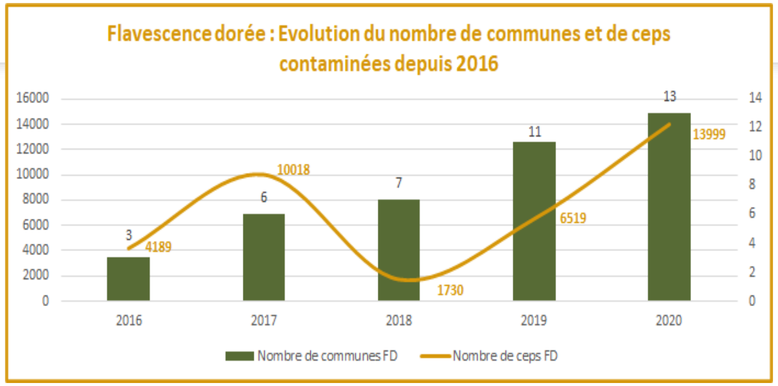


FD prevalence increasing on the field: examples in France

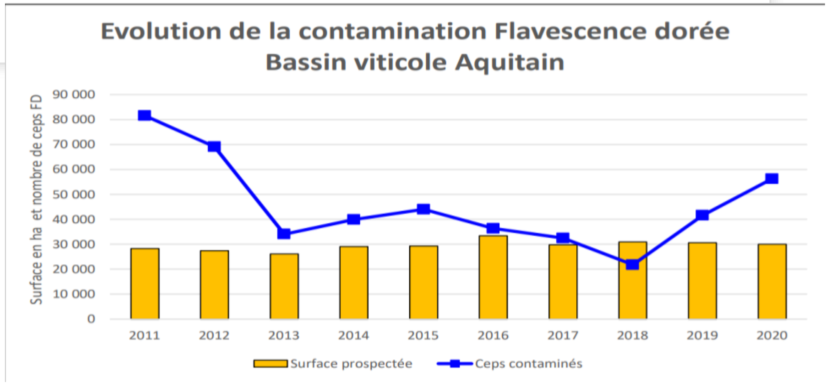
Cognac



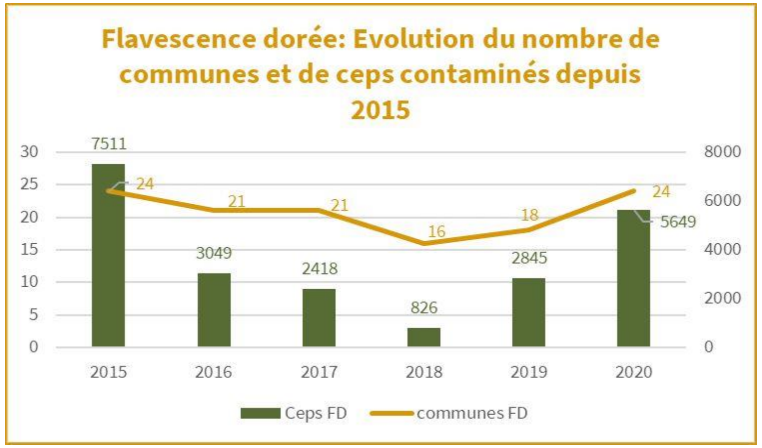
Ardèche



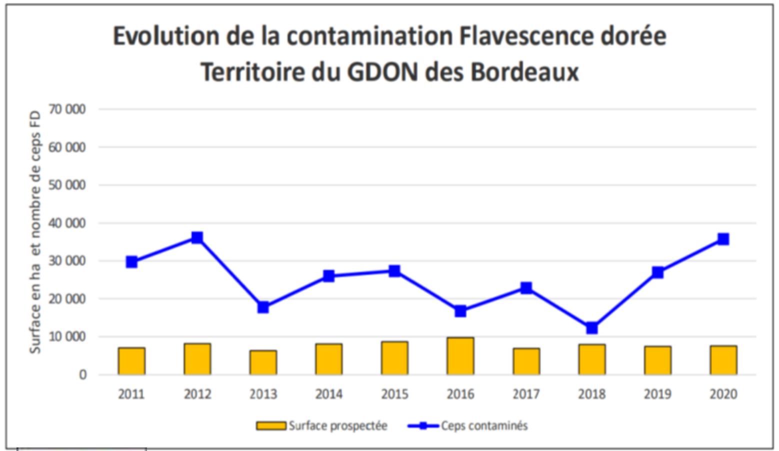
Aquitain



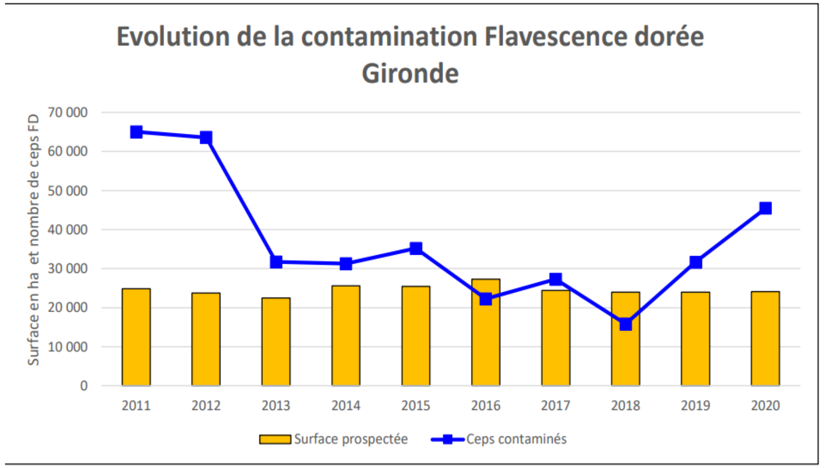
Drôme - secteur sud Drôme



Bordeaux



Gironde



Source: https://www.stop-flavescence-bourgogne.fr/la-flavescence-doree-en-france.html

Credits to:

Control measures in the EU

Despite mandatory controls and treatments, *S. titanus* and FD are slowly "**conquering" new areas**

In already infected areas, situation **was under control** until a few years ago.

More treatments needed in **organic vineyards** because of **lower effectiveness of the allowed active substance**.

Surfaces of organic vineyards are increasing.

Thus, the overall **number of insecticide treatments is increasing**. In parallel, the prevalence of **infected plants is increasing** in the vineyards (Forte et al 2023).

New environmental problems:
The increased use of pyrethrum (organic) and pyrethroids (integrated) is altering the delicate equilibrium reached in the last 20 years in vineyard.

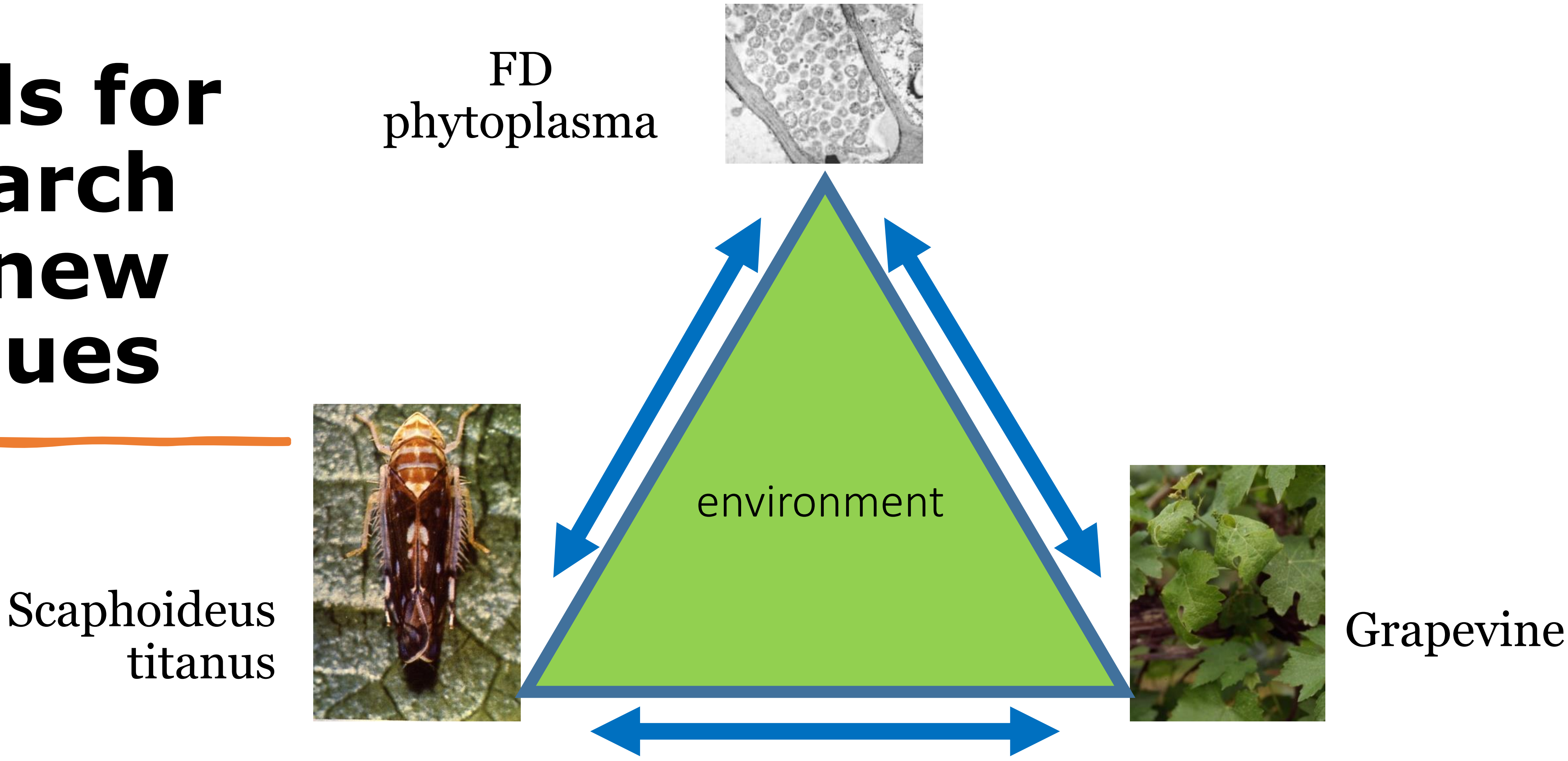
e.g., red (*Panonychus ulmi*) and yellow (*Eotetranychus carpini*) mites are destined to increase in vineyard (due to the damages to their natural predators, phytoseiids), and in some areas are **already a re-emerging pest**.

Shall we now define FD as a new emergent risk ?

"unexpected new or increased significant exposure and/or susceptibility to a known hazard"

(EFSA 2019)

Needs for research and new avenues



Natural antagonists to the vector S.t.

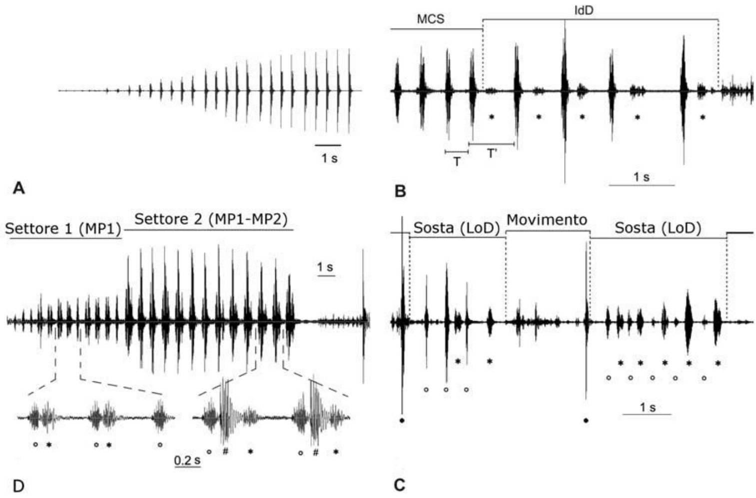
1. Endosymbionts:

- Natural endosymbiont *Asaia* sp., **already present** in European *S. titanus* populations (Gonella et al 2012)
- In model leafhopper *Euscelidius variegatus*, experimental vector of FD phytoplasma, insects colonised by *Asaia* strains exhibited **significantly reduced phytoplasma acquisition** (**5–28% *versus* 25–77%** in control insects) (Gonella et al 2018)

2. Parasitoids and predators

- **European** parasitoids and predators are **not specific and/or not effective**, with 0,2-1,3% of parasitisation (Alma and Arzone 1994; Belgeri et al 2021)
- Vector origin: **USA**. **First trials** in 2000s performed in France to use imported specific American parasitoids **failed** (Malausa et al 2003a; Malausa et al 2003b; Nusillard et al 2003; Malausa 2004). No other attempts since - is it time to **try again?** (see for example successful control of *Metcalfa pruinosa* and *Halyomorpha halys*)

Vibrational mating disruption of vector



S. titanus males and females **communicate and mate** via **vibrations** ("calling songs"), not via chemical signals as pheromones (Mazzoni et al 2009a)

Exact length waves were identified, and **vibrational mating disruption** demonstrated to be **effective in laboratory conditions** (Mazzoni et al 2009b)

Trials in the field are **ongoing** (Mazzoni et al 2019)

Need for more efforts and research on several points to optimise the method

(credits to V. Mazzoni and A. Lucchi, Italy)

Stimulation of plant natural defences

Some active substances can stimulate the natural defence pathways of the plants

e.g., acibenzolar-S-methyl may prevent vector-mediated FD phytoplasma transmission (Miliordos et al 2017)

Also, **other products or microorganisms** can stimulate the natural defences of the plants

Could they help to control FD in the field?

More research is needed!

FD-resistant grapevines

- Different species and varieties of grapevine are **more or less susceptible to FD.**

(Schvester et al 1967; Boudon-Padieu 1996; Borgo and Angelini 2002; Pavan et al 2012; Eveillard et al 2016; Ripamonti et al 2021), and these features are genetically heritable (Jollard et al 2019).

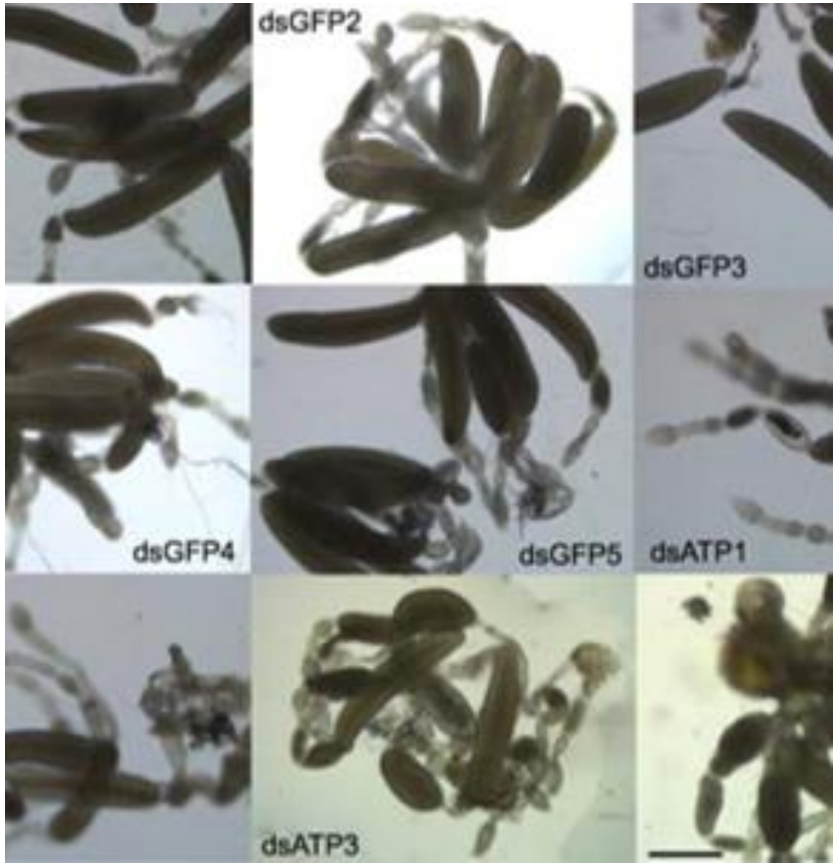
- Resistance to downy and powdery mildew is well reported. Many **responsible genes and QTLs** (Quantitative Traits *Loci*) were identified (Vezzulli et al 2022), and several **resistant grapevine varieties** were obtained by traditional breeding.

- **Genetic traits responsible for susceptibility and resistance to FD are not yet known!** Only a few researches studies are ongoing, due to the complexity of the pathogen, which is not cultivable *in vitro*.

(Bertazzon et al 2018; Angelini and Crespan 2020; Casarin et al 2020, 2022)

Gene silencing

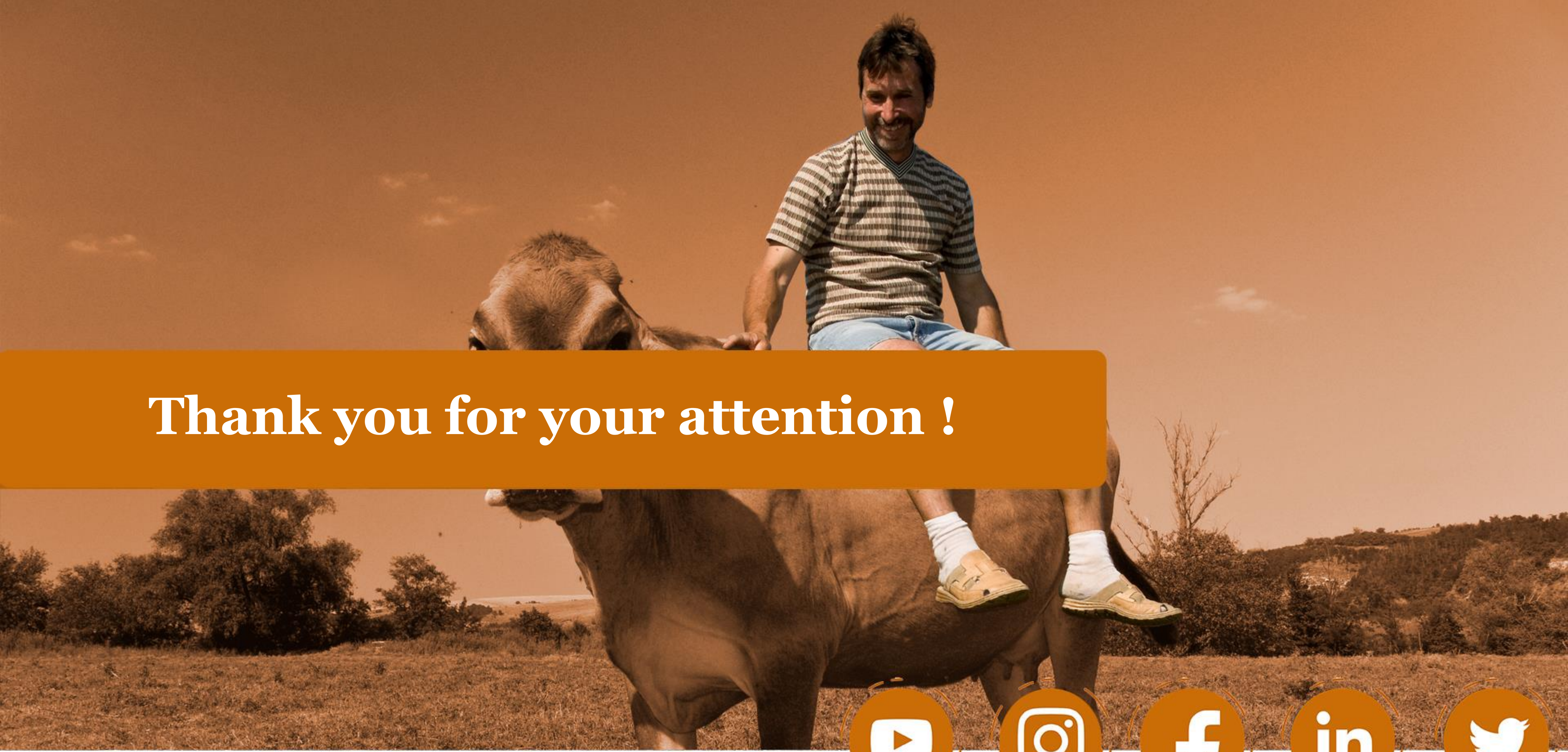
- Gene silencing, based on RNA interference, can be used **for controlling pest-vector-plant interactions.**
- **Experiments with FD phytoplasma** have been carried out:
  - in the experimental FD vector *Euscelidius variegatus*, **increased mortality**, **lack of egg development**, and **female sterility** were obtained (Abbà et al 2019; Ripamonti et al 2020).
  - in *S. titanus*, silencing of ATP synthase β **impairs egg development** (Ripamonti et al 2020).
- The major problem to be solved: the **delivery of the RNA to the vector**



(Ripamonti et al 2020)

But… attention!

- **All these methods can help** in decreasing the vector population, the disease prevalence in the field and the epidemics.
- Indeed, there is **no threshold tolerance for disease vectors**, as one single vector can cause the disease, if the pathogen is present.
- → ***Innovative biological control measures should be employed together with classical control measures.***
- **The advantages will be:**
  - decrease of insecticide use, and
  - increase of environmental & social sustainability



Thank you for your attention !

Name/Surname

Twitter Handle @

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