Does biostimulation of grapevine impact elicitor-induced resistance against downy mildew ? A methodological framework

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Context

Biostimulants (BS) are applied to crops in order to improve [1] :

- the yield and quality of harvested organs
- the uptake of nutrients
- tolerance to abiotic stresses

BUT ...*How do they act and how to assess it ?*

We aim at deepening the knowledge of their **mode of action on grapevine** (*Vitis vinifera, L.), a* perennial crop of economic and cultural value.

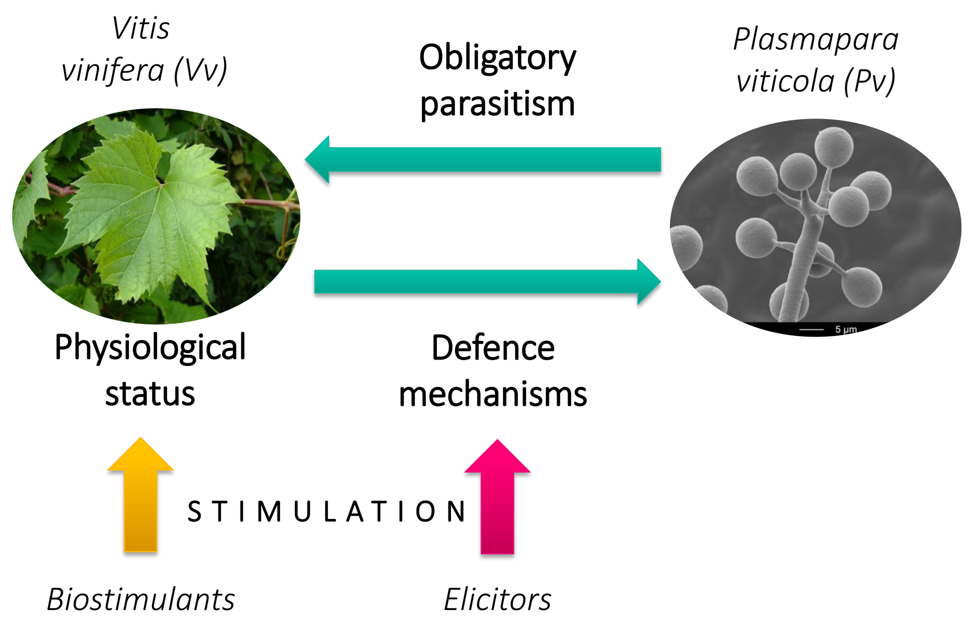
MOREOVER...

Grapevine is susceptible to cryptogamic diseases such as **downy mildew** caused by *Plasmopara viticola.*

Protection strategies using **resistance inducers** (RIs) on those crops are well documented and validated in controlled conditions[2]. However, the efficacy of RIs is **variable** in field conditions, and may **depend on the physiological status** of the plant [3, 4, 5].

HYPOTHESIS

An improvement of the plants' physiological status by biostimulation is expected to increase their responsiveness to RI application.



Aims and global approach of the IRIS+ project

1 **To define and develop a panel of tools and methods** to study the impact of biostimulants on the development and the physiology of grapevine in greenhouse conditions.

2 **To test whether biostimulation can increase** grapevine responsiveness to RI application, *via* an improvement of its physiological status.

BS application(s) → Analysis of the effects on plants → RI application → Inoculation with the pathogen → Increased protection rate compared to RI only ?

Foliar and/or root applications of BS (or water for control) on potted grapevine herbaceous cuttings (cv Marselan) in greenhouse conditions.

Measurement the impacts of BS on grapevine development and physiology, compared to water-treated control.

Foliar application of RI (or water), 2 days before inoculation with Plasmopara viticola.

Assessment of the efficacy of RI by measuring the sporulating leaf area.

Development of tools and methodology

A Definition of culture systems and growth conditions

Pot system

Rhizotron system

B Evaluation of the effects of biostimulation

PLANT – ORGAN scale

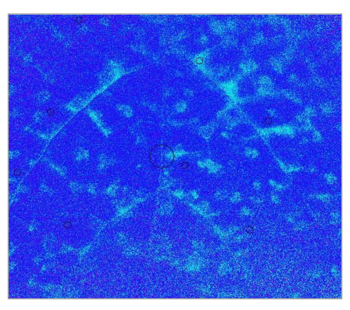
Aerial and root phenotyping

Ex: Non destructive growth and development tracking devices.

Photosynthetic activity

Ex: Photosynthesis analysis by gas exchange measurements (CO_2, H_2O).

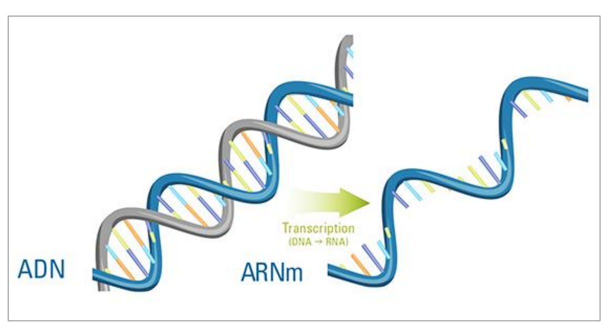
TISSUE – CELLULAR scale



Chlorophyll fluorescence

Ex: Imaging-PAM. Image capture and analysis for quantifying chlorophyll fluorescence of leaves.

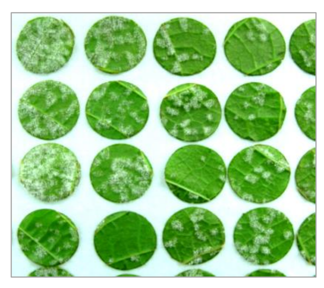
MOLECULAR scale



Gene expression and related enzymatic activity

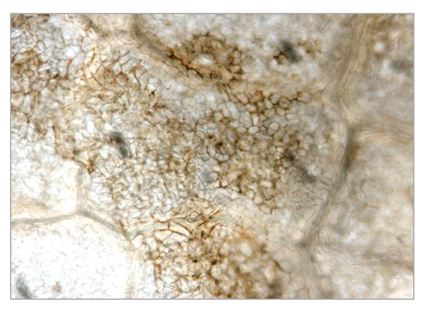
Ex: Targeted analysis of the expression level of genes involved in physiology/defence (encoding for invertases, PR-proteins, amongst others).

C Evaluation of elicitor-induced resistance



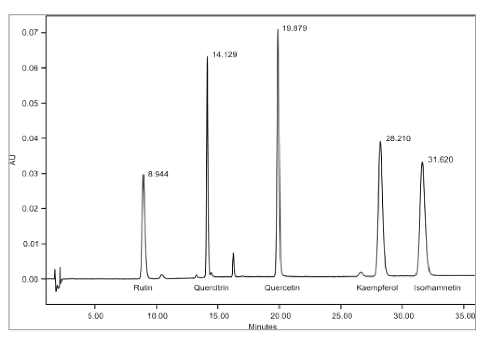
Protection rate

Ex: Image analysis of sporulating area of leaf disks infected by *P. viticola*.



Defence events

Ex: Vizualisation of H_2O_2 production sites (diaminobenzidine staining).



Metabolic profiles

Ex: Analysis of primary and secondary metabolites in response to treatments (carbohydrates, phytoalexins, phytohormones).

[1] European Biostimulants Industry Consortium, EBIC (2012) The 1st World Congress on the use of Biostimulants in Agriculture- Strasbourg Congress Center, France
[2] Delaunois *et al*. (2014). Elicitors as alternative strategy to pesticides in grapevine? Current knowledge on their mode of action from controlled conditions to vineyard. *Environ Sci Pollut Res* (2014) 21:4837–4846
[3] Bolton MD.(2009.) Primary metabolism and plant defense-fuel for the fire. *Mol Plant Microbe Interac,* 22: 487–497
[4] Dietrich *et al*. (2005). Growth responses and fitness costs after induction of pathogen resistance depend on environmental conditions. *Plant, Cell and Environment* 28: 211–222
[5] Maymoune A. *et al*. (2015). Impact of abiotic stresses on the protection efficacy of defence elicitors and on metabolic regulation in tomato leaves infected by *Botrytis cinerea*. *Eur J Plant Pathol*, 142: 223-237