January 24, 2024

Strategies studied for an ecofriendly management of Grapevine Trunk Diseases (GTDs).

Pr FONTAINE Florence

Management?

Prophylactic, **biocontrol**, no chemicals

Pathogens

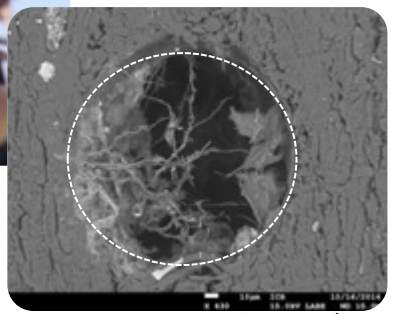
Complexe of fungi

Predisposing factors

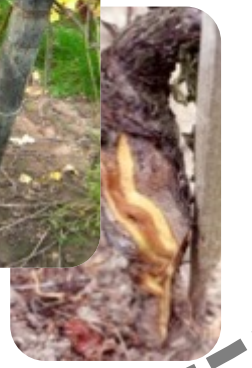
Saveguard of vineyard

Economic losses

chronic/apo forms



S. Trouvelot



Environment

Soil, climat, …

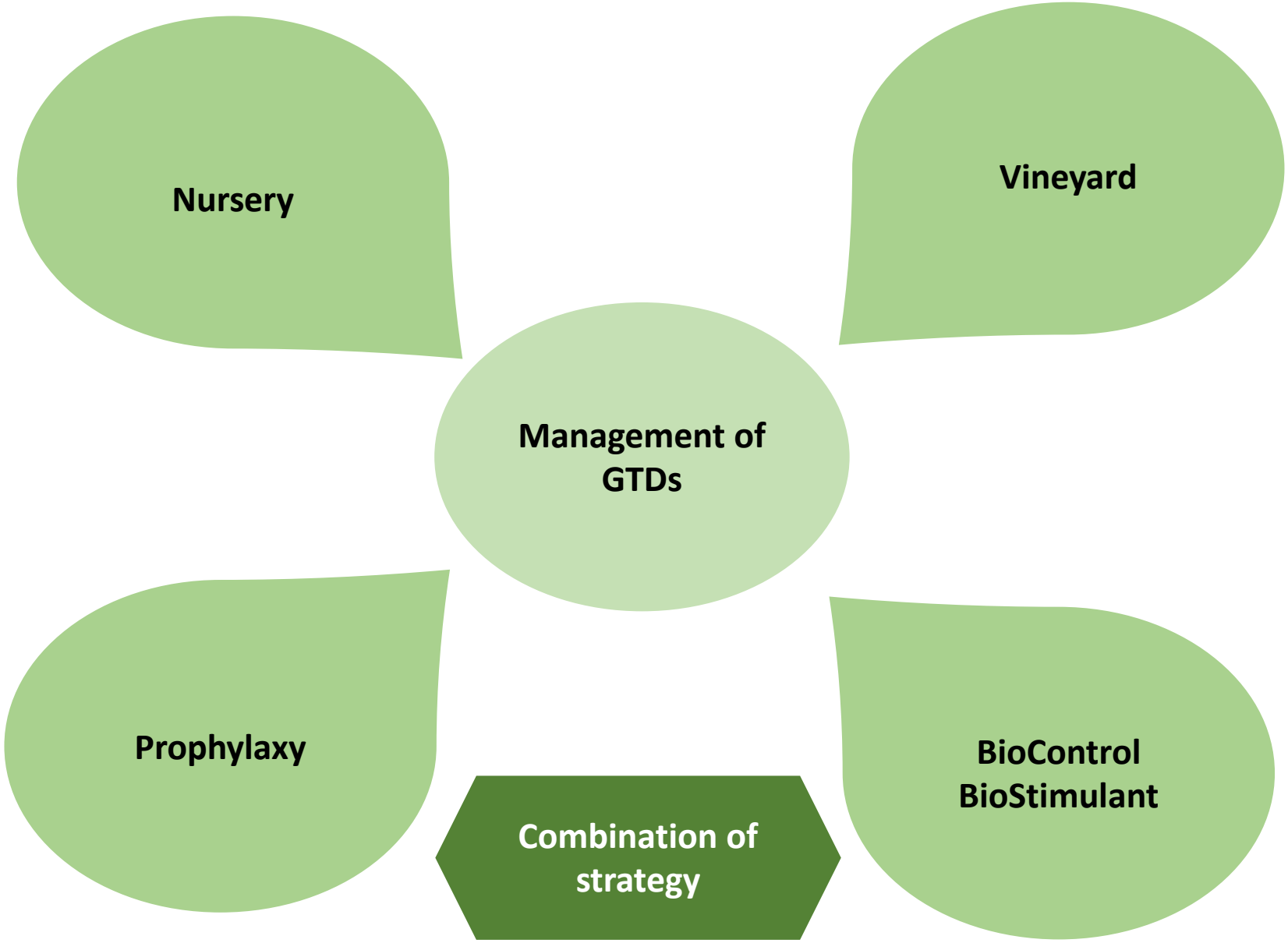
Aggravating factors

Plants

Cultivars, rootstock, age, cultural practices, vigor

Contributing factors

Herlemont, 1995, Mugnai *et al.* 1999, Bertsch *et al. 2012,* Mondello *et al.* 2018, 2019, Fischer & Peighami 2019


Nursery
Vineyard
Management of GTDs
Prophylaxy
BioControl
BioStimulant
Combination of strategy

Strategies at RIBP

Chaire MALDIVE — Maladie du bois de la vigne

RIBP — Résistance Induite et Bio-protection des Plantes

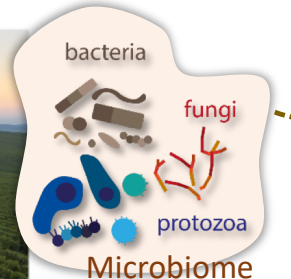
Natural product
LC2017

2

Hydroxyapatite
Bioactive molecule

GTDs vineyard

Healthy vineyard



Microbiome vineyard

Isolation of beneficial

1

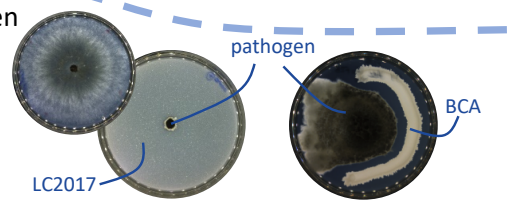
Biocontrol agents (BCA)

Bacillus subtilis PTA 271
Aureobasidium pullulans-Fito278

Fusarium proliferatum
Trichoderma atroviride SC1, I-1237

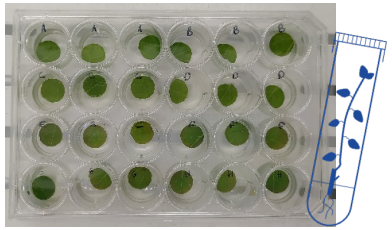
Evaluation of their potential under controlled conditions

In vitro test

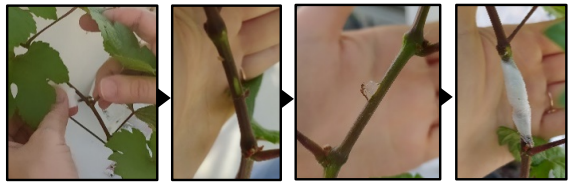


Antagonism test

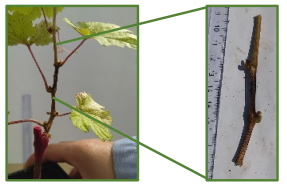
Phytotoxicity



Measure of protection



Artificial infection



In greenhouse

Some parameters analyzed

Pathogen growth — Colonization — Toxicity — Necrosis lenght — Plant growth — Plant defenses — Photosynthesis

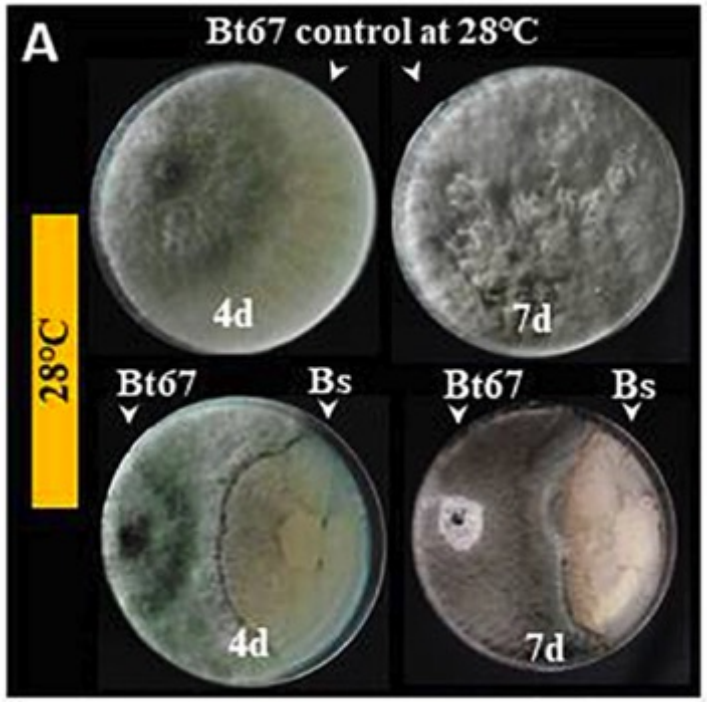
USE IN NURSERY AND VINEYARD

Leal & Mondello et al. 2023

BioControl Agents - Bacteria

Bacillus subtilis PTA-271 *Trotel-Aziz et al. 2019, Leal et al. 2021*

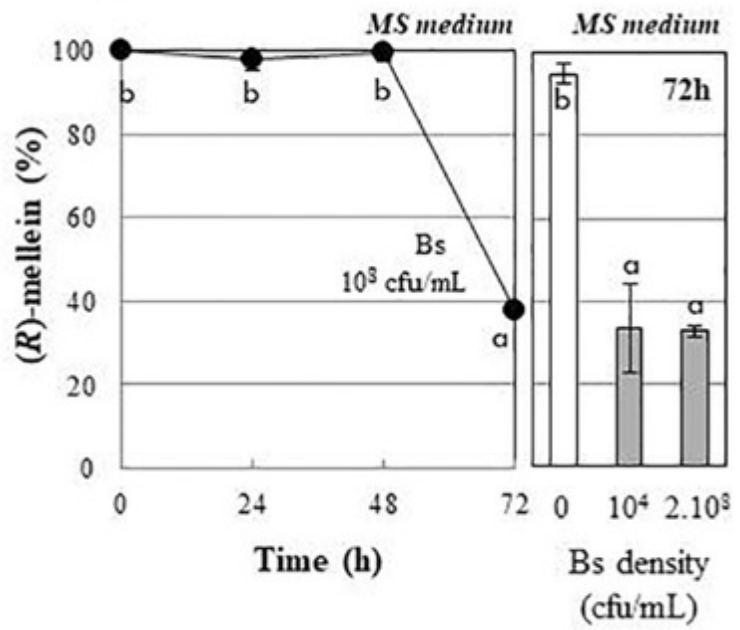
1- Antagonistic activity



Pathogen Bt67, Bs *Bacillus subtilis*

2- Detoxifying capacity

2 phytotoxins produced by GTD pathogens: terremutin, mellein



3- Prime some defense responses on leaves (PR2 gene)

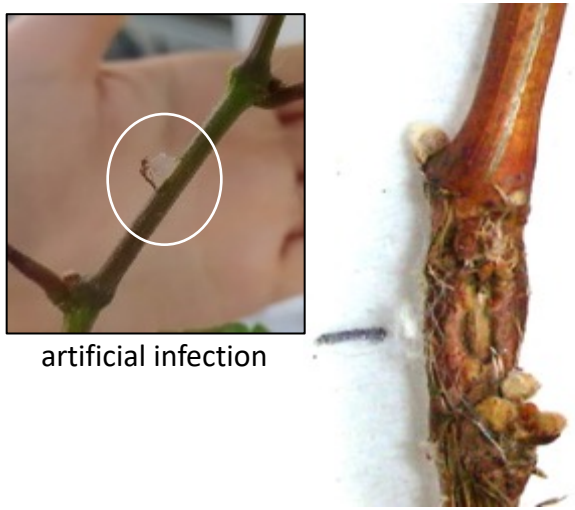
soil application

Bacillus subtilis PTA-271

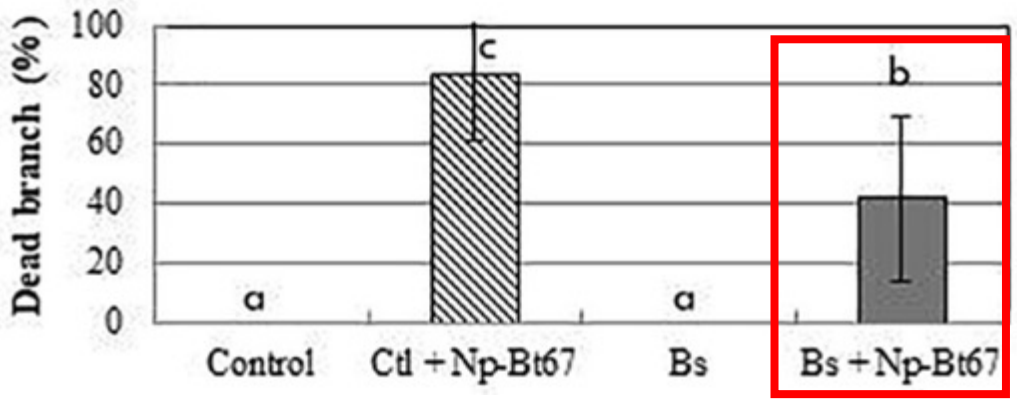
Trotel-Aziz et al. 2019, Leal et al. 2021

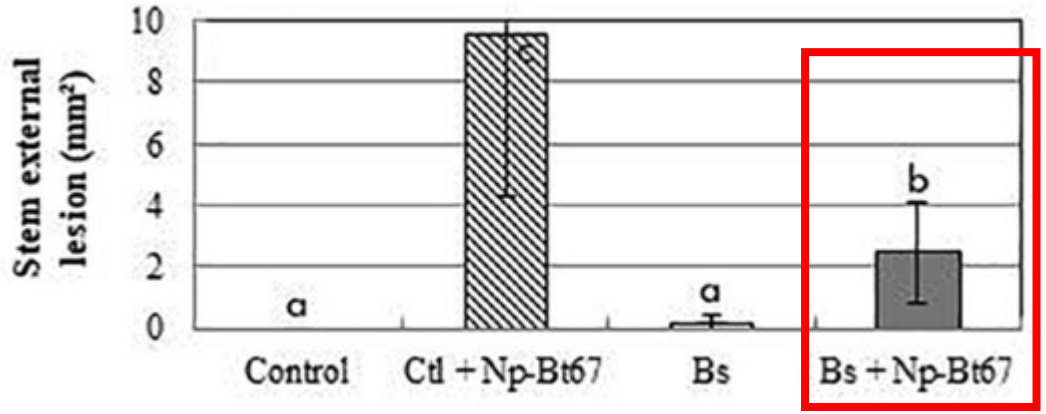
4- Significant decrease of symptom expression

Pathogen Np-Bt67
Bs *Bacillus subtilis*



artificial infection



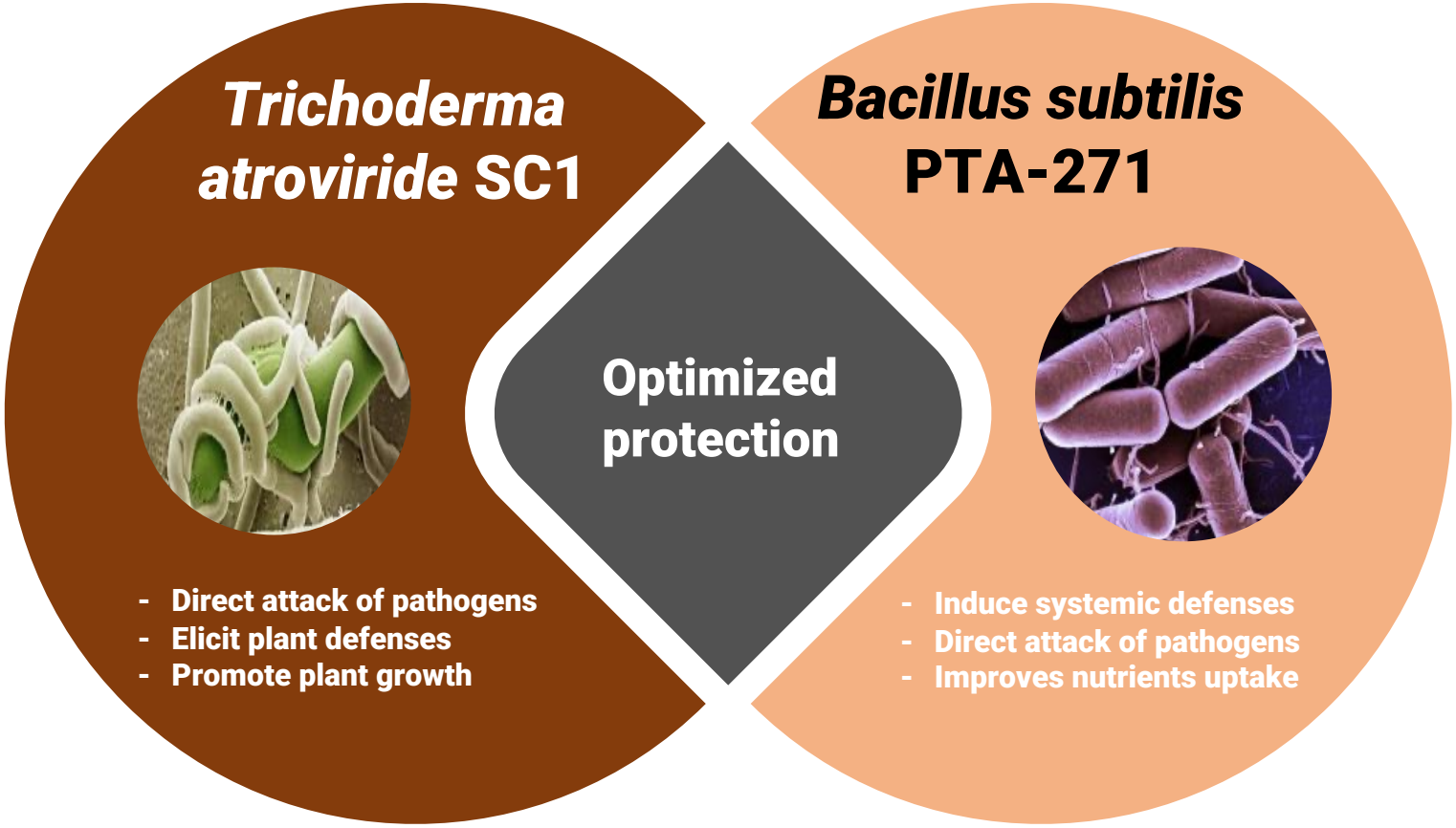


Bacillus subtilis PTA-271 — *Trotel-Aziz et al. 2019, Leal et al. 2021*

Trichoderma atroviride SC1 — *Leal et al. 2022*

Why *Trichoderma*?

One of the most BCA studied
&
The most marketed strain against GTDs



BELCHIM

RIBP Résistance Induite et Bio-protection des Plantes

BioControl Agents – Bacteria / Fungi

Bacillus subtilis PTA-271 — *Trotel-Aziz et al. 2019, Leal et al. 2021*

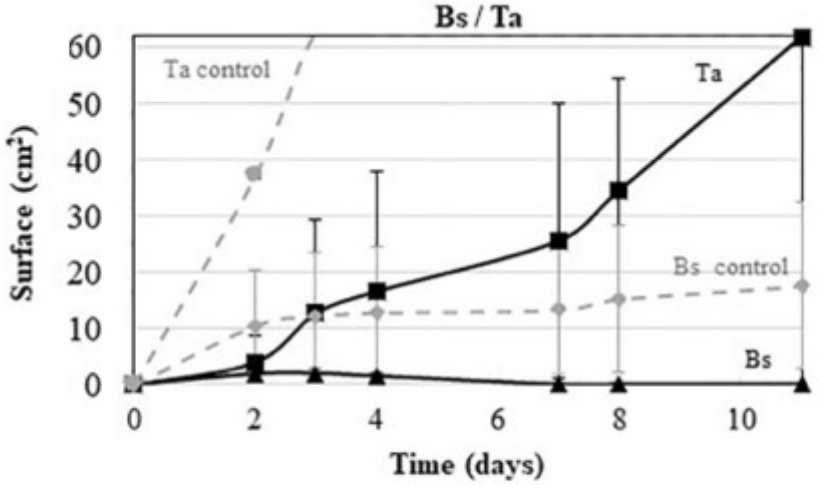
Trichoderma atroviride SC1 — *Leal et al. 2022*

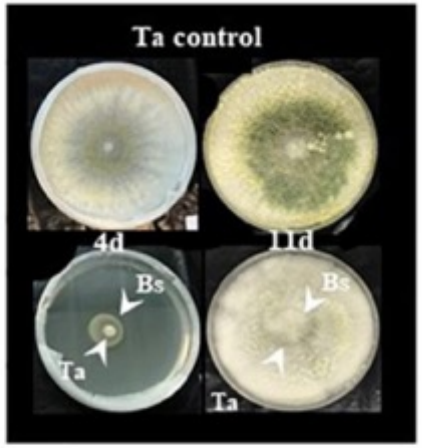
1- Antagonistic activity against GTD pathogens: Tricho. > Bacillus

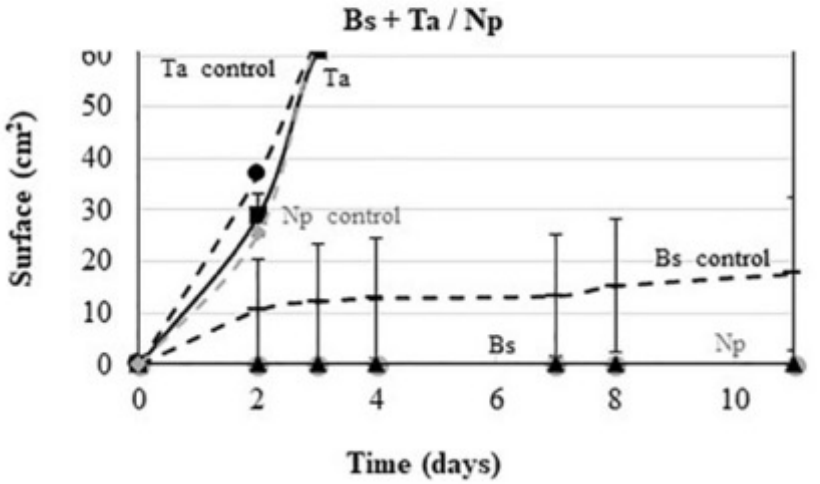
Dual confrontation Tricho. / Bacillus <u>without</u> pathogen: Bacillus reduce the growth of Tricho

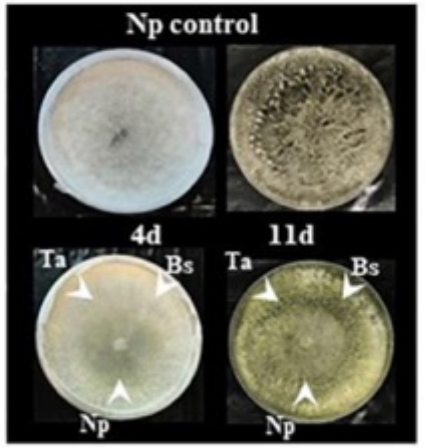
Dual confrontation Tricho. / Bacillus <u>with</u> pathogen: keep their full antagonistic potential

Treatment:
Bs in the soil / Ta as wound protectant









Bs, Bacillus; Ta, Trichoderma; Np, pathogen

BioControl Agents – Bacteria / Fungi

Bacillus subtilis PTA-271 — *Trotel-Aziz et al. 2019, Leal et al. 2021*

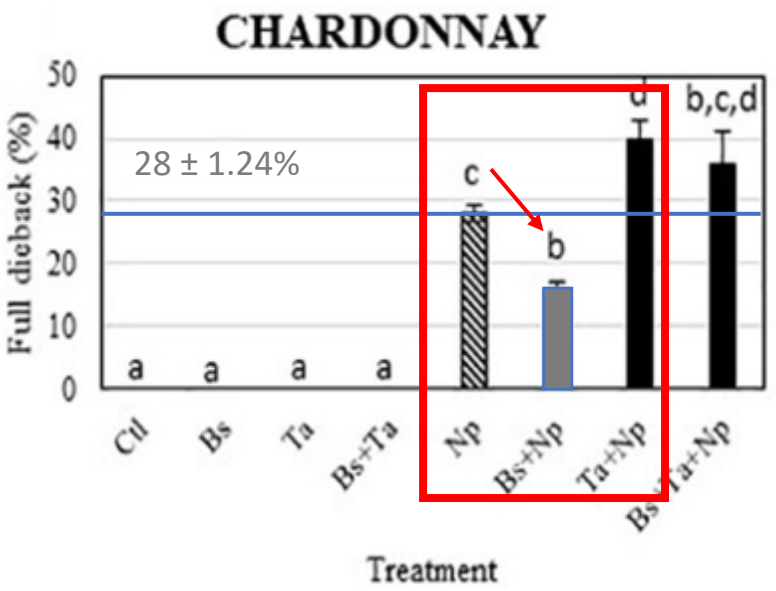
Trichoderma atroviride SC1 — *Leal et al. 2022*

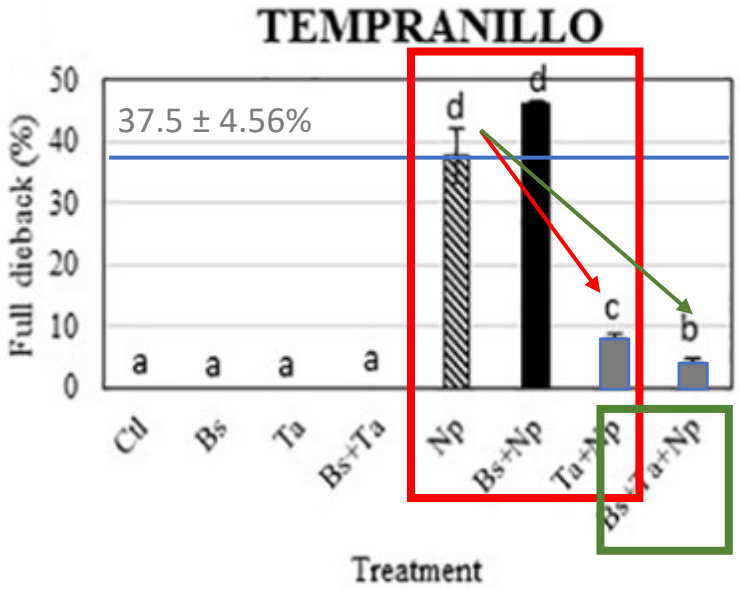
2- Significant decrease of symptom expression BUT strong relationship between cultivars & BCA effects

3- BCA combination
best protection for Tempranillo

Bs, Bacillus; Ta, Trichoderma; Np, pathogen

+ susceptible





4- Plant defense responses: both BCAs repress SA-dependent defenses to protect grapevine against pathogen

The cultivar basal metabolism could modulate the BCA effectiveness against GTD pathogen

BioControl Agents – Bacteria / Fungi

Bacillus subtilis PTA-271

Trichoderma atroviride SC1

(wileyonlinelibrary.com) DOI 10.1002/ps.7339

Evaluation of *Bacillus subtilis* PTA-271 and *Trichoderma atroviride* SC1 to control Botryosphaeria dieback and black-foot pathogens in grapevine propagation material

Catarina Leal,[a,b] David Gramaje,[c] Florence Fontaine,[b] Nicolas Richet,[b] Patricia Trotel-Aziz[b] and Josep Armengol[a*]

Nursery process

BCA suspension

Combination Trichoderma + Bacillus showed potential to reduce infections caused by GTD pathogens in the nursery propagation process

Strategies at RIBP

Chaire MALDIVE — Maladie du bois de la vigne

RIBP — Résistance Induite et Bio-protection des Plantes

2

Natural product

LC2017

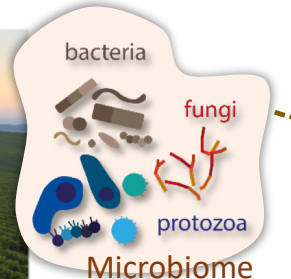
Hydroxyapatite

Bioactive molecule

Decline

GTDs vineyard

Healthy vineyard



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Bacillus subtilis PTA 271

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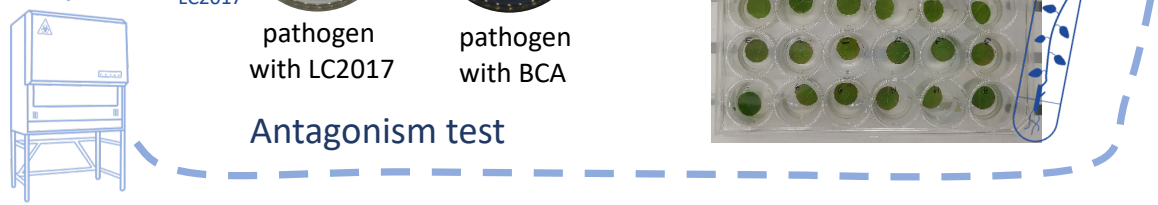
Evaluation of their potential under controlled conditions

In vitro test



Phytotoxicity

Measure of protection

In greenhouse

Some parameters analyzed

Pathogen growth | Colonization | Toxicity | Necrosis lenght | Plant growth | Plant defenses | Photosynthesis

USE IN NURSERY AND VINEYARD

Leal & Mondello et al. 2023

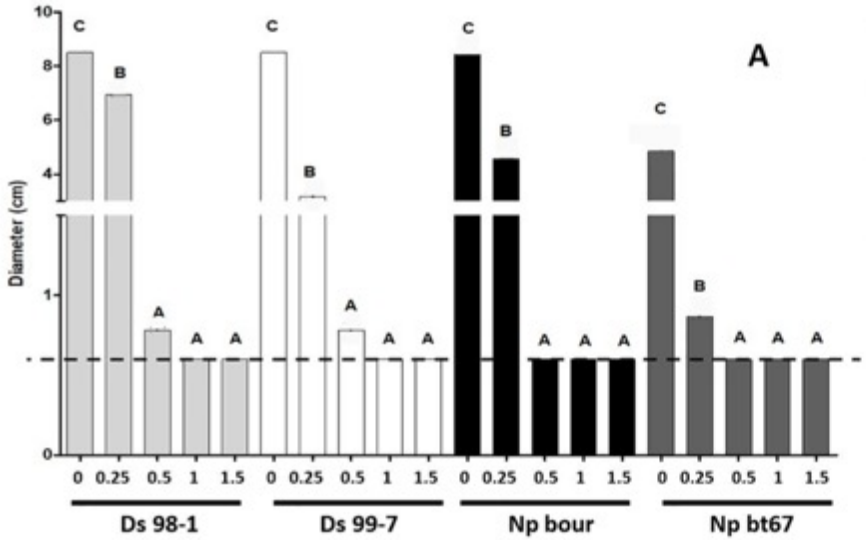
LC2017

HA **MicroSAP®** : Natural Development Group

Battiston et al. 2018, 2019, 2021
Mondello et al. 2021, 2022
Reis et al. 2022

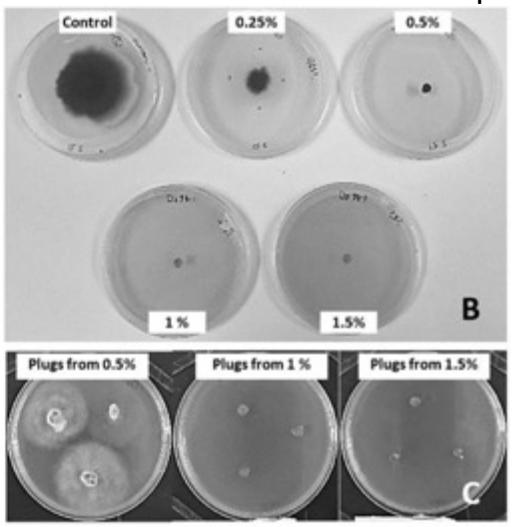
Composition:
HydroxyApatite: carrier of bioactive molecules
Copper, fungicide: low concentration 35 g/L (3.5%)
Plant extracts

1- Fungistatic effects on GTD pathogens at low concentrations



Pathogens / 9 dpi

4 dpi



3 dpi

fungistatic fungicide

2- No phytotoxic effect on plant physiology, a slight temporary increase of photosynthesis and an increase of plant growth

leaf spray

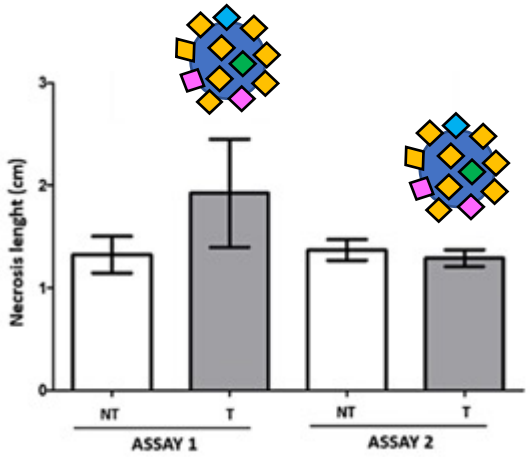
LC2017

HA **MicroSAP® :** Natural Development Group

Mondello et al. 2021, 2022

3- No significant effect on necrosis length (Chardonnay, Cabernet Sauvignon)

Leaf spray
Before / After infection



Chardonnay

2- Elicitor effect on leaves

Assay 2
Chardonnay 2B +8 h

	BTH	T
CHI4C	3,5	8,8
GLUC	10,1	18,6
GST1	15,2	7,8
PR1	1,7	1,8
PR10	1,9	1,9
STS	3,0	4,2
PAL	1,3	3,8
Pspb1	31,0	1,7
RbcL	24,0	26,6
PME25	1,0	0,9
MSR	1,2	1,6
WRKY	5,0	6,0
Hyd2	1,3	2,6

T

BTH: Bion ©

LC2017

HA **MicroSAP® :** Natural Development Group

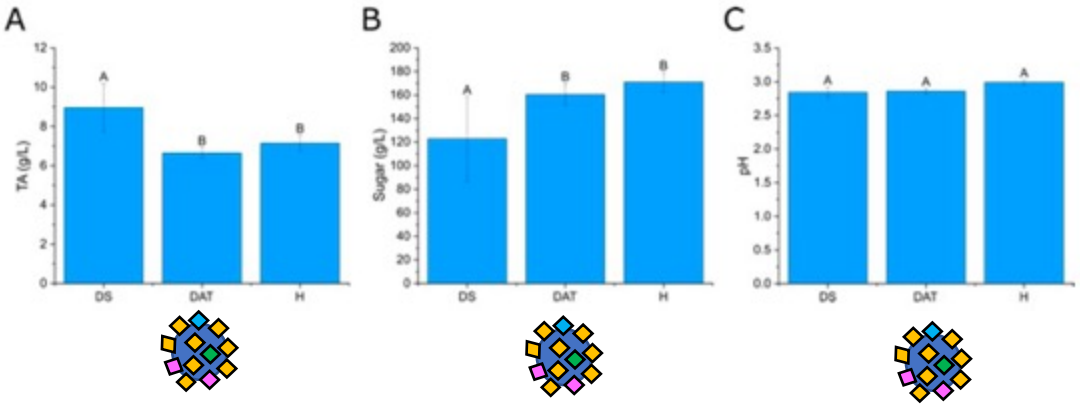
Mondello et al. 2021, 2022

In vineyard, what is the potential of LC2017?

Field trial from 2015 to 2017 to set-up the protocol and from 2018 to 2019, to evaluate the potential: 5 treatments per year

1- Trend to decrease foliar symptom expression: no significant differences between LC2017-treated and control BUT a trend to a decrease and less apoplectic form expression

2- No effect on vine's physiology: similar profile between LC2017-treated vines and asymptomatic vines (H) compared with symptomatic vines (DS) (leaf and woody tissues)



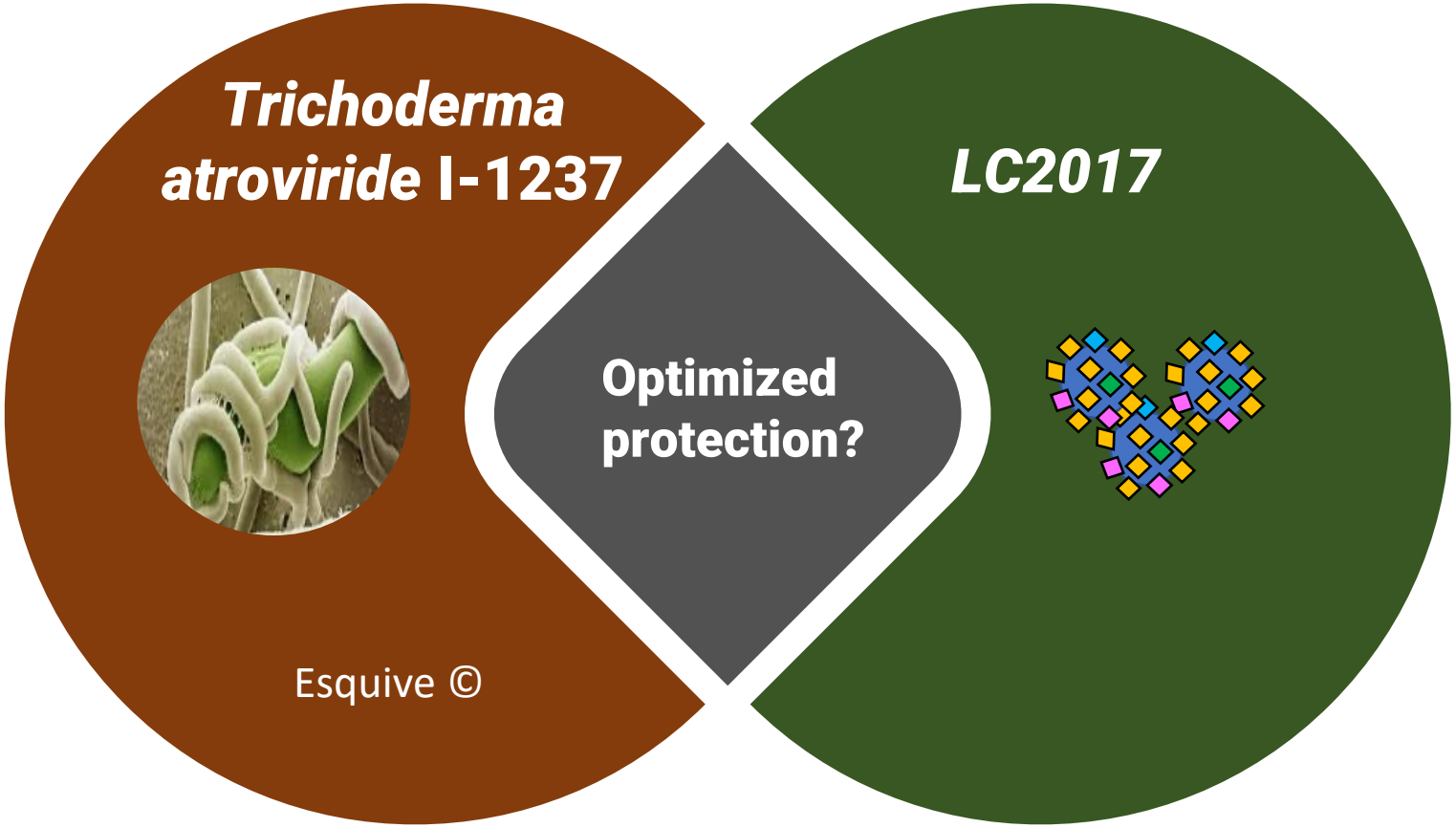
3- No effect on juice: the main oenological parameters (TA Total Acidity, Sugar, pH)

4- No changes on vine's microbiome in woody tissues (bacteria / fungi)

LC2017

HA **MicroSAP® :** Natural Development Group

Reis et al. 2020, 2022



1- *In vitro*, no effect of LC2017 on Tricho. growth at low concentrations (0.025 to 1.25 ml/L)

2- Validation of the elicitor effect of LC2017 on grapevine responses

3- In vineyard, no clear evidence of improving the pruning protection by this combination

Only 2 years of vineyard experiment, with a vintage effect… to continue

LC2017

HA **MicroSAP® :** Natural Development Group

2 new formulations

Project Coordinator
NDG NATURAL DEVELOPMENT GROUP S.R.L. (NDG)
Valerio Borzatta

Funded by the Life programme of the European Union

NATRUAL AGROchemical formulations to reduce the environmental impact of pest control in vineyards

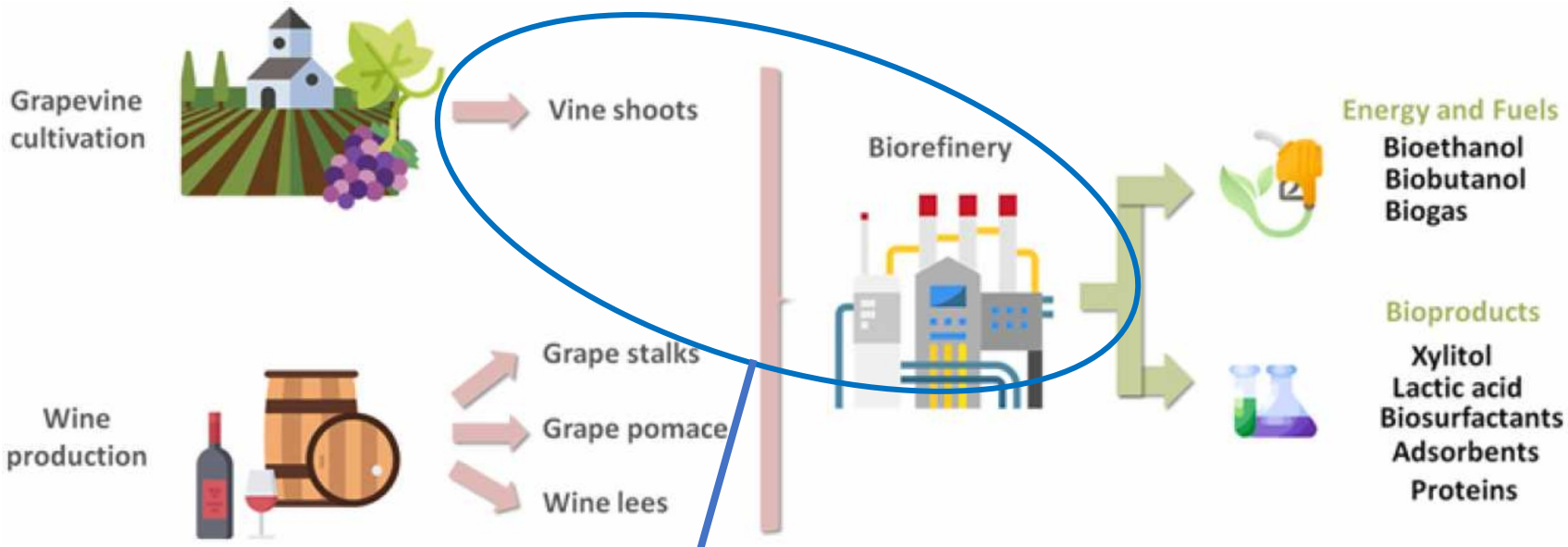
GTDs & Downy mildew

Italy, France, Portugal

2023-2028

« Natural Agro is financed by the CINEA LIFE 2022 Horizon 2020 Framework under the specific programme LIFE-2022-SAP-ENV-ENVIRONEMENT (GA No 101113781)

Grapevine waste & GTD pathogens & Circular economy



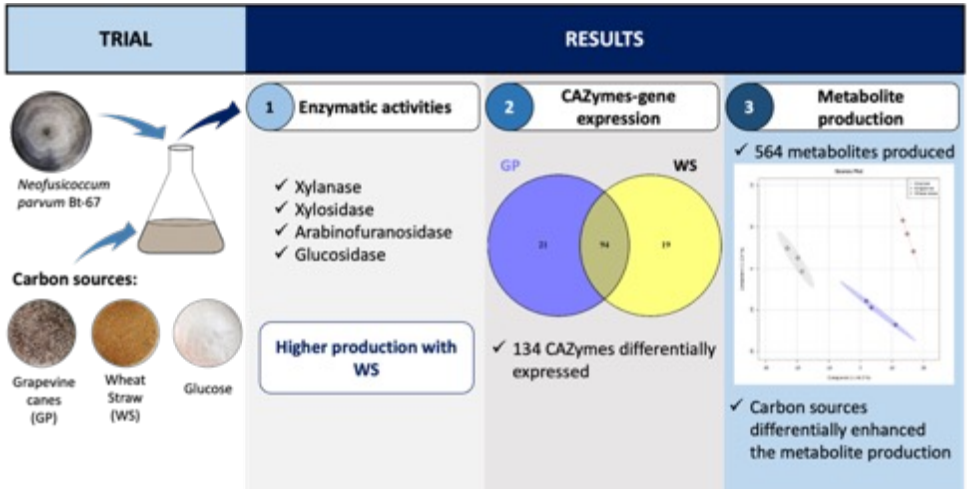
MYCOLOGIA
https://doi.org/10.1080/00275514.2023.2216122

Taylor & Francis
Taylor & Francis Group

OPEN ACCESS Check for updates

Differential carbohydrate-active enzymes and secondary metabolite production by the grapevine trunk pathogen *Neofusicoccum parvum* Bt-67 grown on host and non-host biomass

Julián D. Restrepo-Leal[a,b], Marie Belair[a], Jochen Fischer[c], Nicolas Richet[d], Florence Fontaine[b], Caroline Rémond[a], Olivier Fernandez[b], and Ludovic Besaury[a]



Mar Contreras et al. 2022; Restrepo-Leal et al. 2023

Acknowledgements

Chaire MALDIVE Maladie du bois de la vigne

Université de Reims Champagne-Ardenn

RIBP Résistance Induite et Bio-protection des Plantes

INRAE

Institut Georges Chappaz Vigne & Vin en Champagne Villas Douce & Bissinger

Partners

Universitat Politècnica de València

ICVV Instituto de Ciencias de la Vid y del Vino

Mendelova univerzita v Brně

Universitas Friburgensis

U Lisboa | Universidade de Lisboa

Instituto Superior de Agronomia

Louis Roederer Champagne

universidade de aveiro

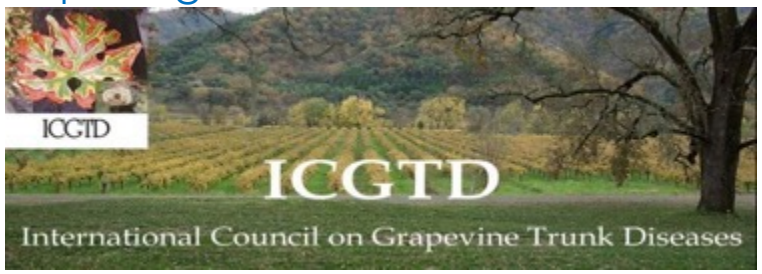
biocant

BIOME MAKERS

INRAE Agroécologie Dijon Unité de Recherche

International Workshop of Grapevine Trunk Diseases

http://icgtd.ucr.edu/



Financial support

BELCHIM Crop Protection

Natural Development Group

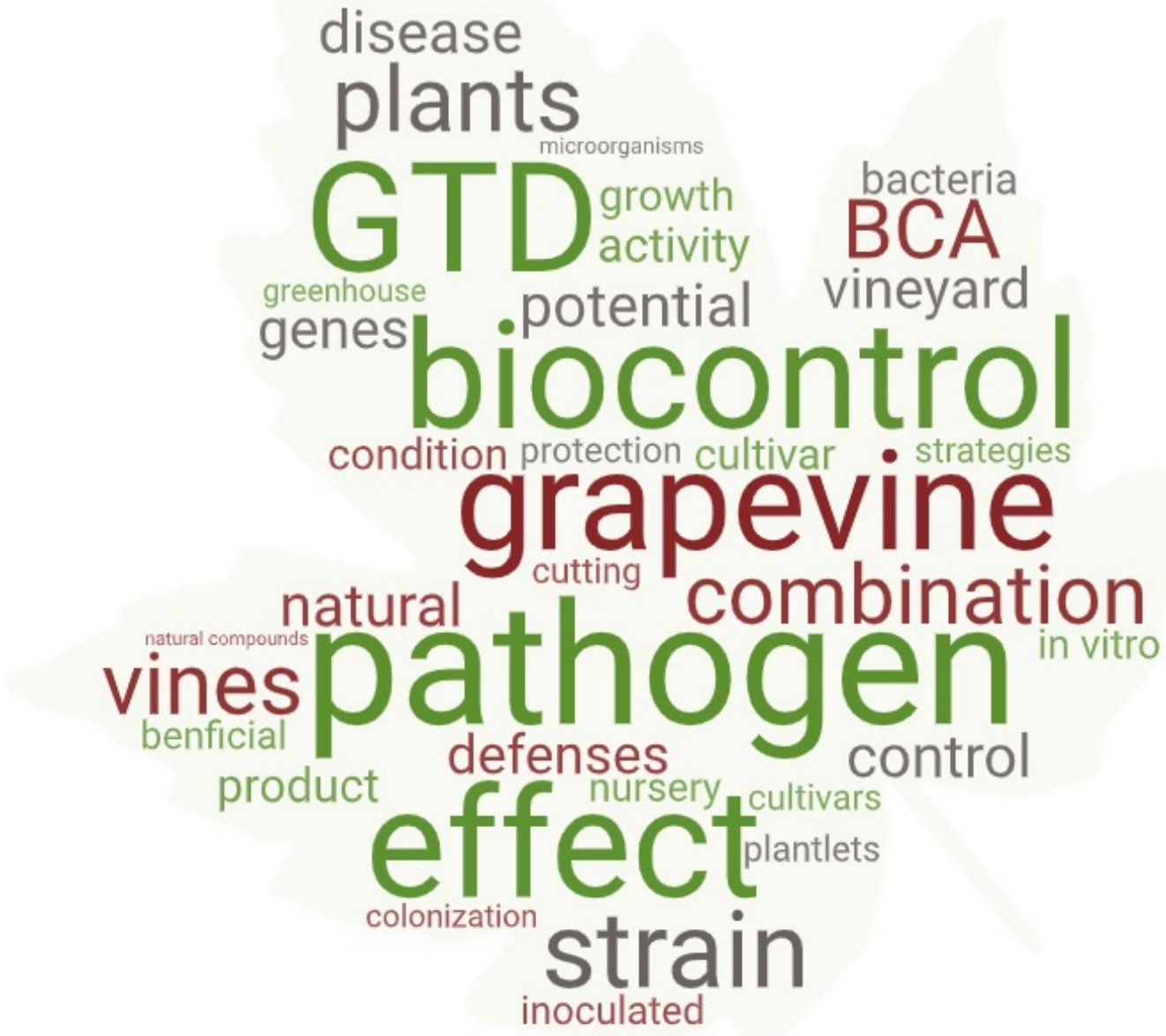
Grand Reims Communauté urbaine

Grand Est

Agrauxine Lesaffre Plant Care

Nufarm

FCT Fundação para a Ciência e a Tecnologia Ministério da Educação e Ciência



V. Mondello
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O. Fernandez
L. Gérard
P. Reis
C. Rego
C. Pinto
P. Trotel-Aziz

Merci à tous
Any questions.....

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