Instituto de Ciencias de la Vid y del Vino

Gobierno de La Rioja

CSIC

UNIVERSIDAD DE LA RIOJA

cost

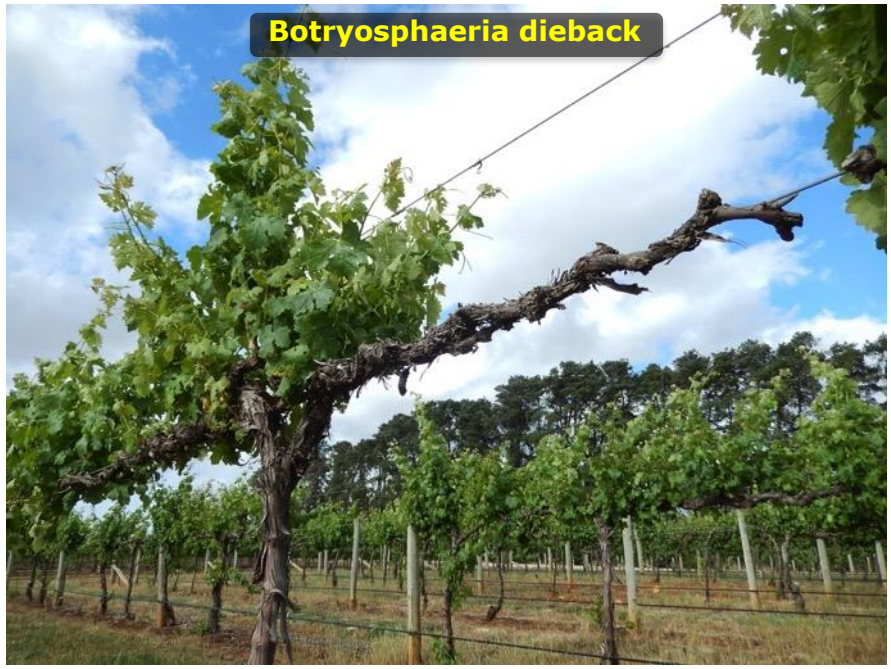
FoodWaStop

Fungal trunk diseases: a global threat to grapevine health

David Gramaje

FoodWaStop COST Action Meeting, Ancona 24-25 February 2024

Fungal grapevine trunk diseases: external symptoms



Fungal grapevine trunk diseases: internal symptoms

Economic impact

Australia: losses of 1,500 kg/ha in 47% Syrah due to Eutypa dieback (**AU$ 2,800/ha**) (Wicks and Davies, 1999)

California: Botryosphaeria and Eutypa diebacks (**$USD 260 M/year**) (Siebert, 2001)

France: 12% of affected vineyards (**1 billion €/year**) (Lorch, 2014)

Replant: Tempranillo in La Rioja

Plant cost: 1.5 €
Annual maintenance: 0.3 €
Cost of plantation: 2.8 €

→ PLANT DENSITY: 3,000 plants/ha

1% (GTD)

Total cost per plant: 4.6 €

Total cost of replant: 138 € / ha

51,896 ha

7.16 M € /year

+ losses in wine production until full yield

Martínez-Diz et al. (2019) Sci. Hortic. 246:104-109

GRAPEVINE TRUNK DISEASES (GTD)

Ravaz 1901

Ravaz 1909

Viala 1926

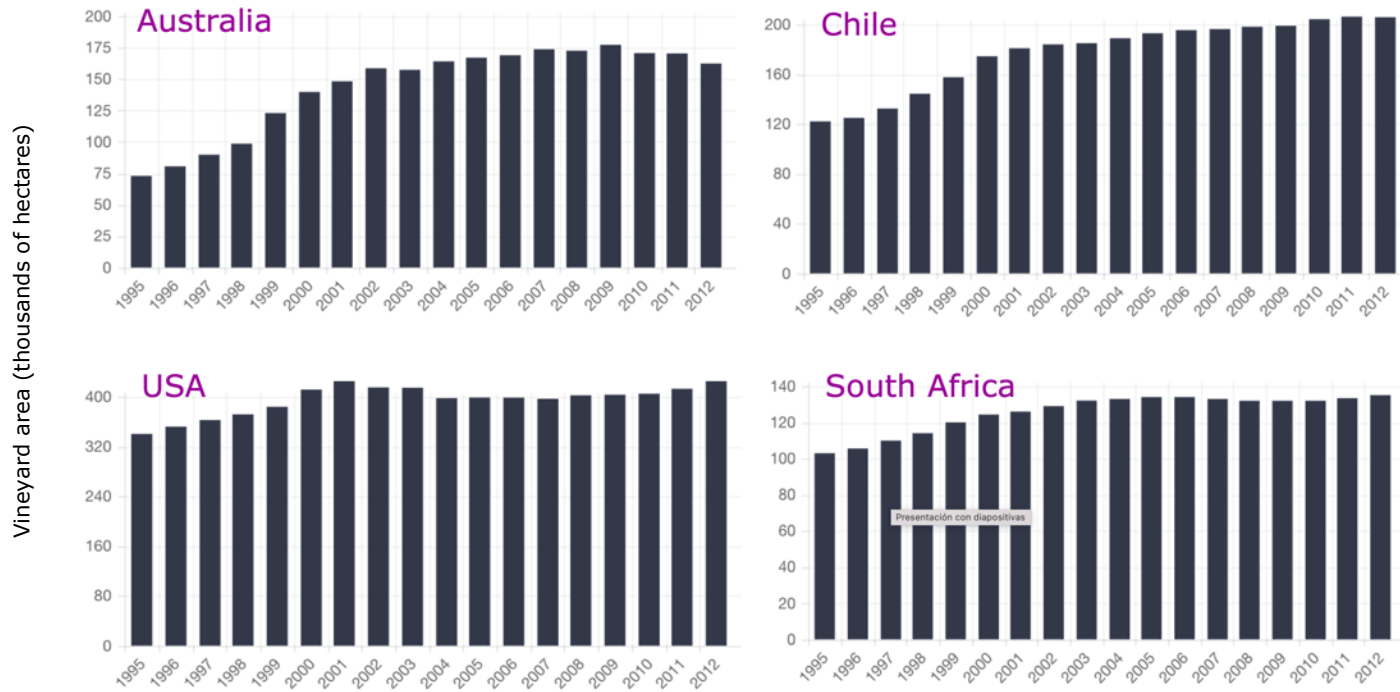
The disease currently known as esca may be as old as vine cultivation (Mugnai et al. 1999)

GRAPEVINE TRUNK DISEASES (GTD)

Increase of GTDs incidence worldwide

1. **Grapevine planting 'boom'** experienced during the 1990s:

- ✓ Increasing movement of potentially contaminated propagated material
- ✓ Increasing area of vineyard reaching an age where symptoms are expressed and therefore becoming more visually prevalent



Gramaje et al. 2018 Plant Dis. 102

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2. Drastic **changes in production methods** that have favoured fungal infection.

Traditional low-density head trained (bush vines)

High-density spur pruned trellis vineyards

Gramaje et al. 2018 Plant Dis. 102

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2. Drastic **changes in production methods** that have favoured fungal infection.

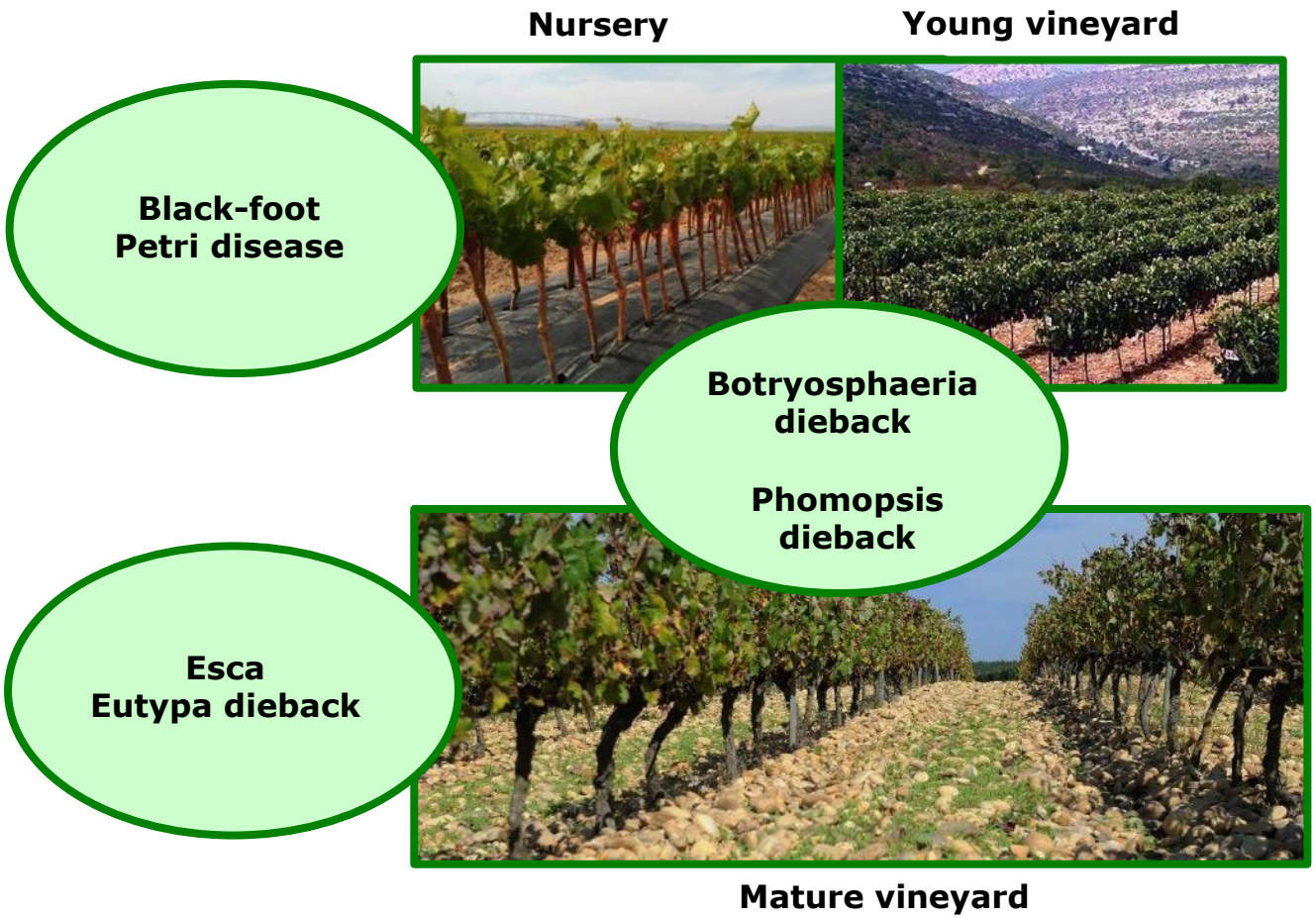
3. The **phasing out in some countries of sodium arsenite, benzimidazole fungicides, and methyl bromide** in the early 2000s due to environmental and public health concerns (EPA 1997; Decoin 2001)

Gramaje et al. 2018 Plant Dis. 102

GRAPEVINE TRUNK DISEASES (GTD)

Complexity of this pathosystem

1. **Many fungal species associated with GTDs symptoms**
   135 species – 35 genera



GRAPEVINE TRUNK DISEASES (GTD)

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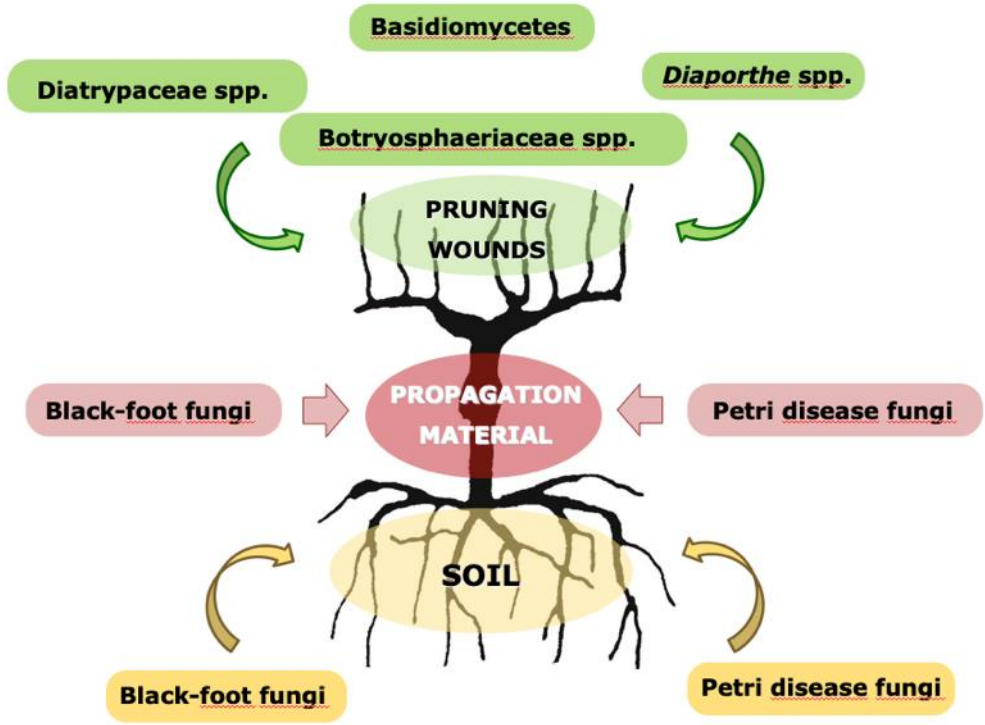


GRAPEVINE TRUNK DISEASES (GTD)

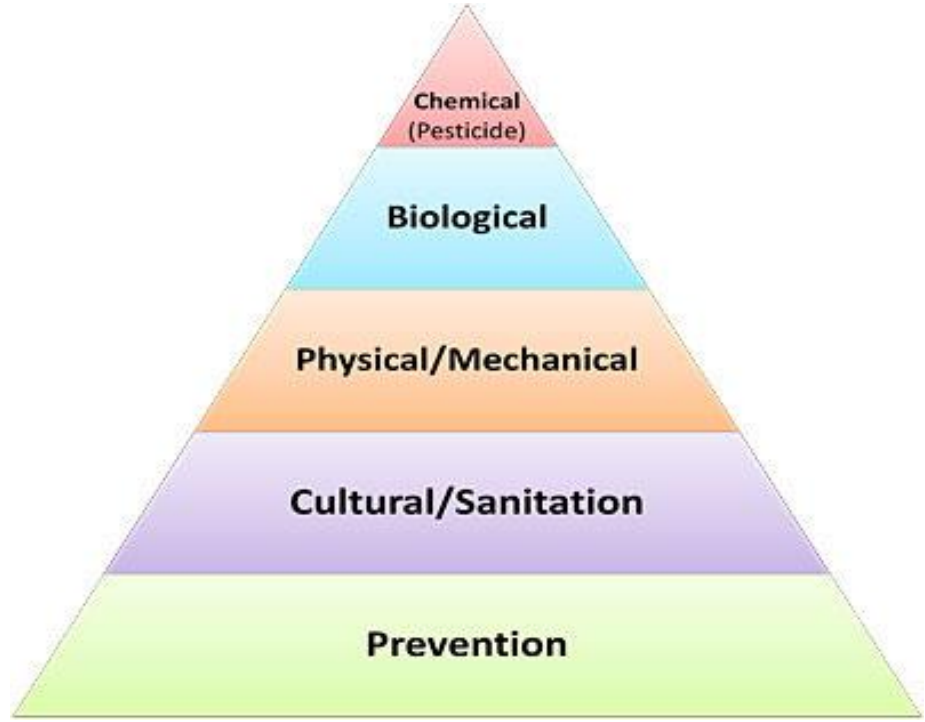
Complexity of this pathosystem

1. **Many fungal species associated with GTDs symptoms**
   135 species – 35 genera

2. **Fungi with different biology and epidemiology**

3. **No curative measures are known for control of GTD**

INTEGRATED DISEASE MANAGEMENT STRATEGY



Integrated management strategy

Nursery mother blocks

Propagation processes

Nursery field

Newly established vineyards

Mature vineyards

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NURSERIES ARE SOURCES OF DISEASED MATERIAL

1 Nurseries are favorable for fungal trunk pathogens

- ✓ Wet and humid conditions
- ✓ High root density
- ✓ Close spacing of plants

au
wi
sp
su
au
wi
sp

NURSERY PROCESS

Grapevine rootstock mother fields
Grapevine scion mother fields
Rootstock cuttings
Scion cuttings
Hydration
Cold storage
Disbudding
Hydration
Cold storage
Hydration
Grafting
Callusing and rooting
Nursery field
Potted plants
Distribution and sale
Uprooting and pruning
Distribution and sale

Hydration tanks

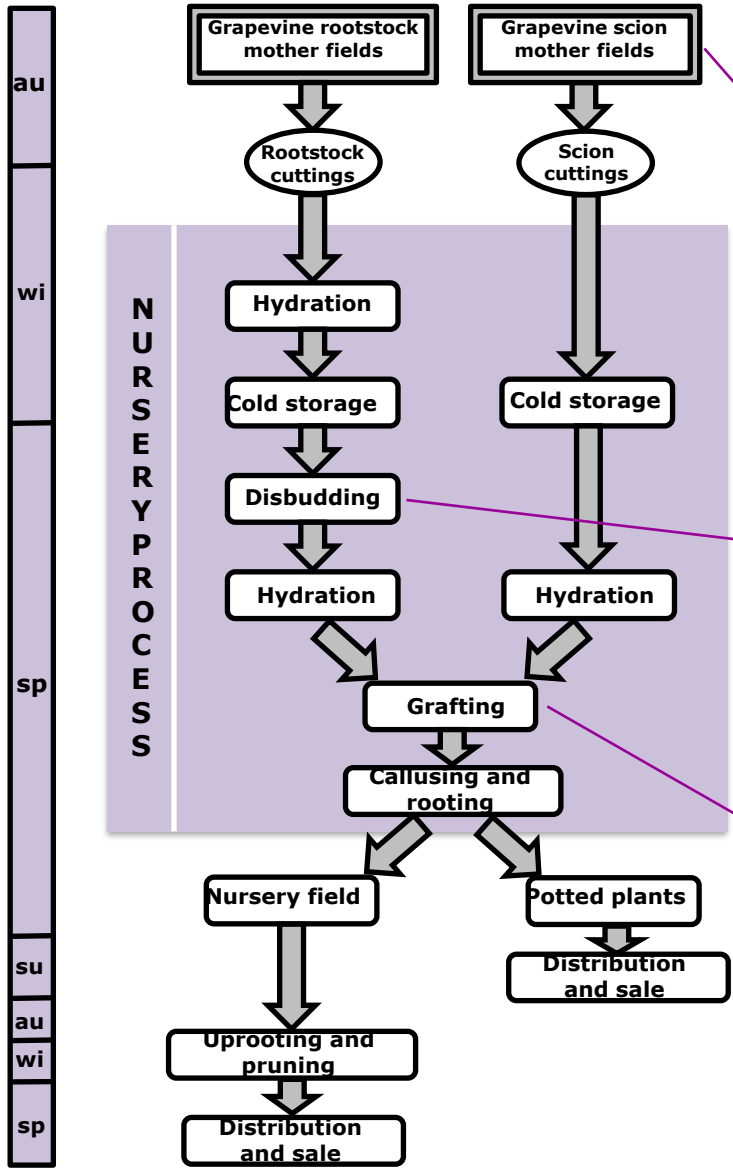
Callusing

Rooting

Gramaje and Armengol 2011. Plant Disease 95

NURSERIES ARE SOURCES OF DISEASED MATERIAL

2 Practices increase infection risk



Pruning wounds

Disbudding

Grafting

Gramaje and Armengol 2011. Plant Disease 95

NURSERIES ARE SOURCES OF DISEASED MATERIAL

3 Diseased plants are difficult to detect

External symptomless plants

Latent pathogens: asymptomatic tissues

Pathogenic: biotic and/or abiotic stress factors

Destructive sampling

Hrycan et al. 2020 Phytopath. Mediterr. 59

Propagation processes in the nursery

CHEMICAL CONTROL

BIOLOGICAL CONTROL

***Trichoderma atroviride* SC1 (Vintec®)**

Pertot et al. 2016. BioControl 61
Berbegal et al. 2019. Pest Manag. Sci.

***Bacillus subtilis* PTA-271**

Leal et al. 2023. Pest Manag. Sci. 79

HOT-WATER TREATMENT (HWT)

Standard treatment: 50ºC – 30 min.
Several pests and diseases: Phytoplasma organisms.

1. **Some *Vitis vinifera* varieties are more sensitive to HWT than others** (Waite et al. 2001)
2. **Tolerance of plants to HWT is affected by the climate in which the cuttings are grown**
3. **HWT is not completely effective in eliminating fungal trunk disease pathogens growth**

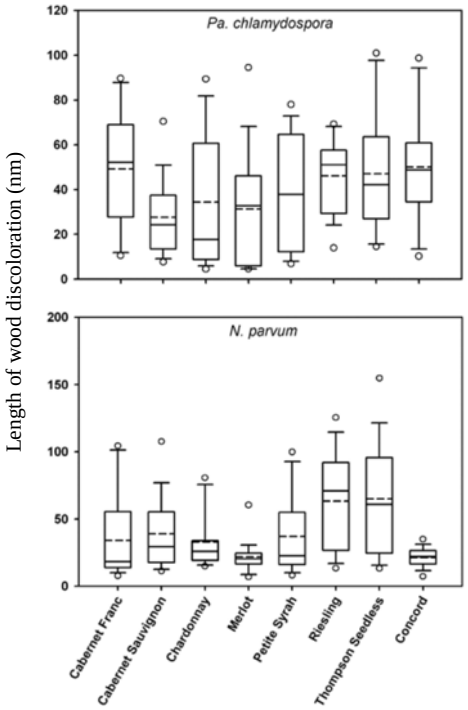
Disease resistance

ROOTSTOCKS

New Zealand
Jaspers et al. 2007; Billones-Baaijens et al. 2014
Spain
Alaniz et al. 2010; Gramaje et al. 2010
U.S.A
Eskalen et al. 2001; Gubler et al. 2004

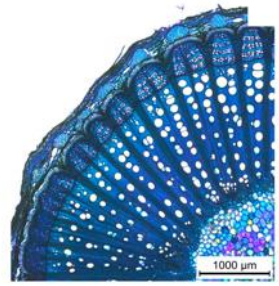
None of the rootstocks tested have shown complete resistance to black-foot and Petri disease pathogens

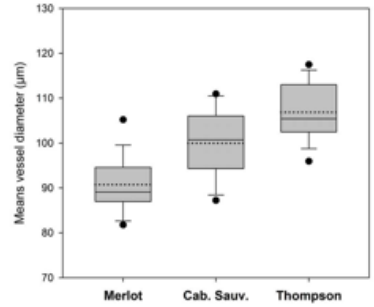
CULTIVARS



Travadon et al. 2013 Plant Dis. 97

There is a relationship between the mean diameter of the xylem and susceptibility to infection





Pouzoulet et al. 2014 Frontiers Plant Sci. 5

Table 1 | Mean of equivalent vessel diameter measured in 1 years old stems of *V. vinifera* cvs. Merlot, Cabernet Sauvignon, and Thompson Seedless.

Vitis vinifera cvs.	Merlot	Cabernet Sauvignon	Thompson Seedless
Level of susceptibility to fungal vascular diseases	Low	Medium	High
Mean vessel diameter	90.7 ± 5.8 a	99.9 ± 7.1 b	106.9 ± 6.3 c

Integrated management strategy

Nursery mother blocks

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Nursery field

Newly established vineyards

Mature vineyards

Commercial production settings

PREPLANTING TREATMENTS: Biological control agents (BCA)

Pest Management Science

Investigation of *Trichoderma* species colonization of nursery grapevines for improved management of black foot disease

Wynand J van Jaarsveld,[a,b] Francois Halleen,[a,b] Michael C Bester,[a] Romain JG Pierron,[c] Elodie Stempien[a] and Lizel Mostert[a*]

Pest Management Science

Field evaluation of biocontrol agents against black-foot and Petri diseases of grapevine

María del Pilar Martínez-Diz,[a,b] Emilia Díaz-Losada,[a] Marcos Andrés-Sodupe,[c] Rebeca Bujanda,[c] María M Maldonado-González,[c] Sonia Ojeda,[c] Amira Yacoub,[d] Patrice Rey[d] and David Gramaje[c*]

horticulturae

Does Inoculation with Arbuscular Mycorrhizal Fungi Reduce Trunk Disease in Grapevine Rootstocks?

Taylor Holland [1], Patricia Bowen [2], Vasilis Kokkoris [1], Jose Ramon Urbez-Torres [2] and Miranda Hart [1,*]

PeerJ

Commercial arbuscular mycorrhizal fungal inoculant failed to establish in a vineyard despite priority advantage

Corrina Thomsen[1], Laura Loverock[1], Vasilis Kokkoris[2,4], Taylor Holland[1], Patricia A. Bowen[3] and Miranda Hart[1]

agriculture

Performance and Establishment of a Commercial Mycorrhizal Inoculant in Viticulture

Daniel Rosa [1,*], Antreas Pogiatzis [1], Pat Bowen [2], Vasilis Kokkoris [3], Andrew Richards [1,*], Taylor Holland [1] and Miranda Hart [1]

Low level of BCA establishment in the vineyard

Inefficacy to prevent fungal trunk disease infection

Integrated management strategy

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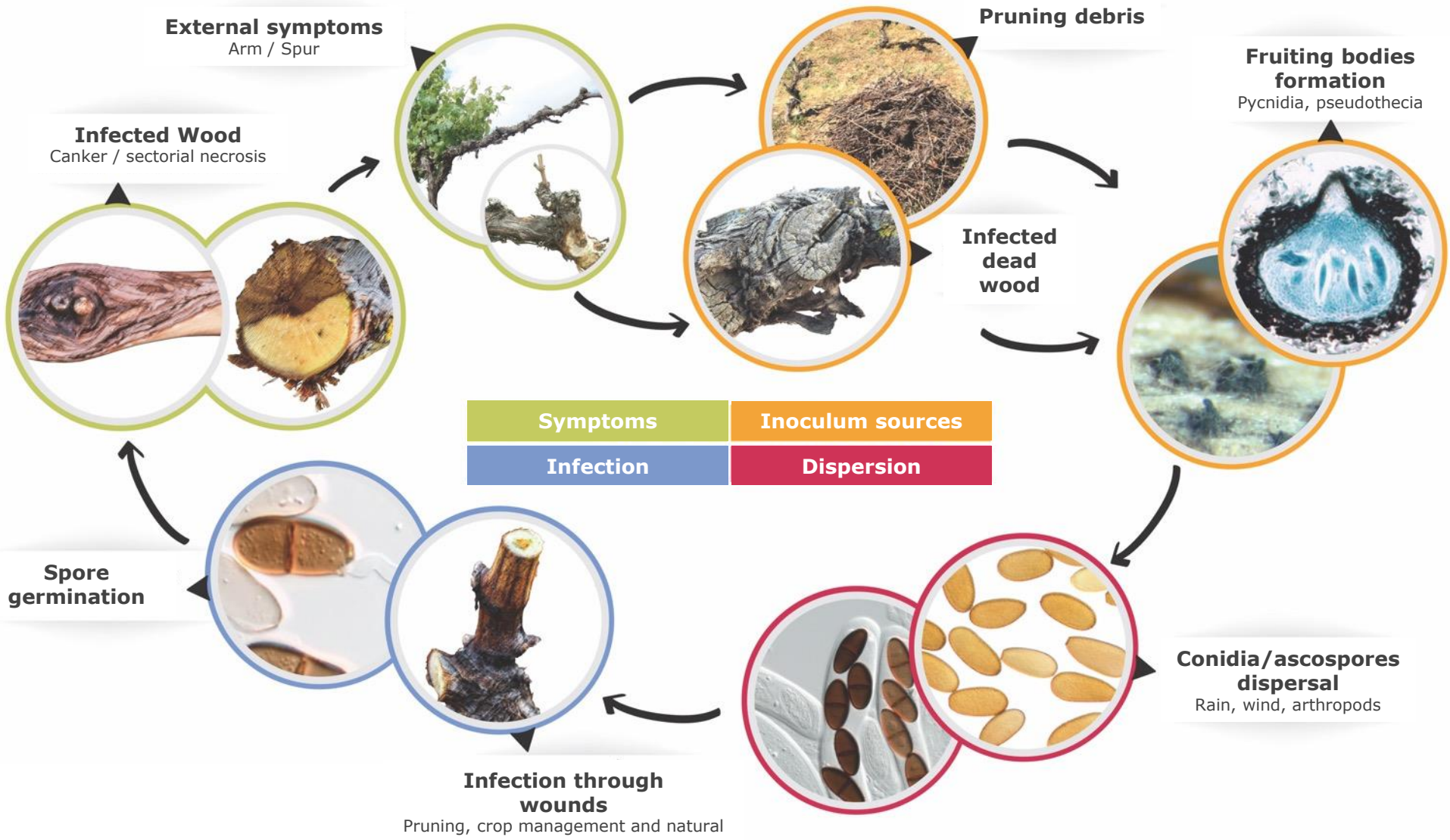
Epidemiology. Disease cycle

Botryosphaeria dieback



Mother plants & mature vineyards

Cultural practices and sanitation: removal of dead wood or pruning debris

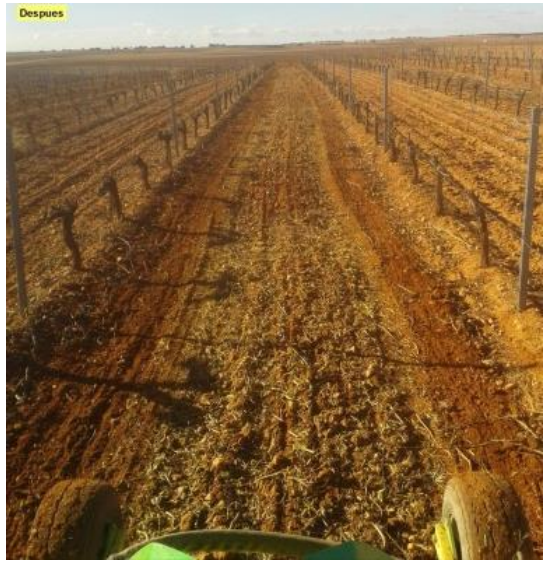
BURNING

GRIND AND COVER

500 µm

10 µm

MULCHING



COMPOSTING

140 m³ of plant material (pruning debris)
+
125 m³ of sheep manure
60 m³ of garden residues

Year 2

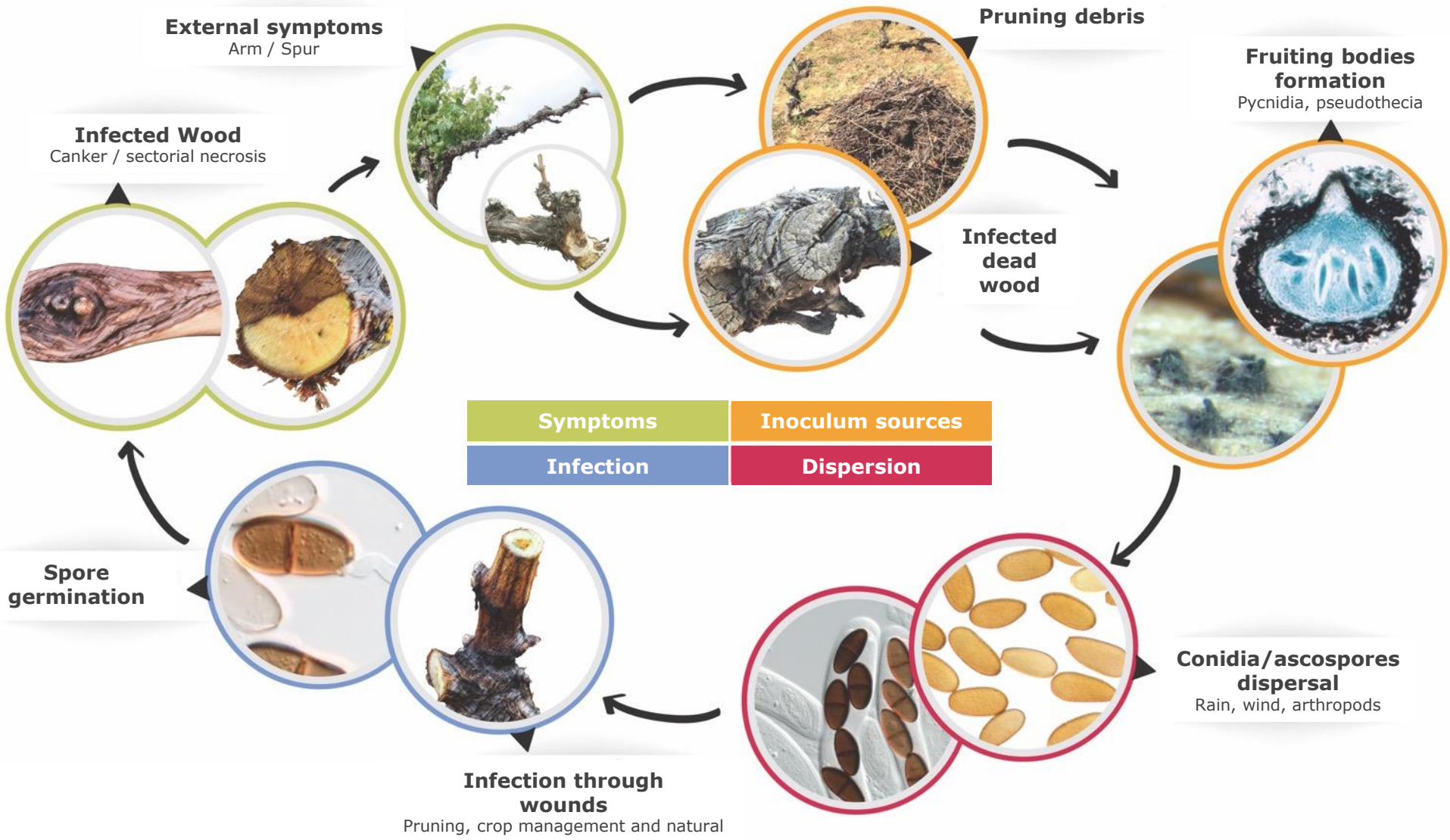
40-50 ºC (75ºC)

Botryosphaeriaceae spp. (60 % - 0%)
***P. chlamydospora* (93% - 0%)**
***P. minimum* (50% - 0%)**

Lecomte et al. 2006 Phytopathol. Mediterr 45

Epidemiology. Disease cycle

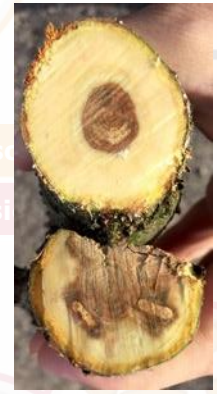
Botryosphaeria dieback



Epidemiology. Disease cycle

Almond

Pear



Walnut

Fruiting bodies formation

Pycnidia, pseudothecia

Fungal Ecology

Diatrypaceae species overlap between vineyards and natural ecosystems in South Africa

P. Moyo [a], L. Mostert [a], F. Halleen [a, b, *]

2019

Plant Pathology

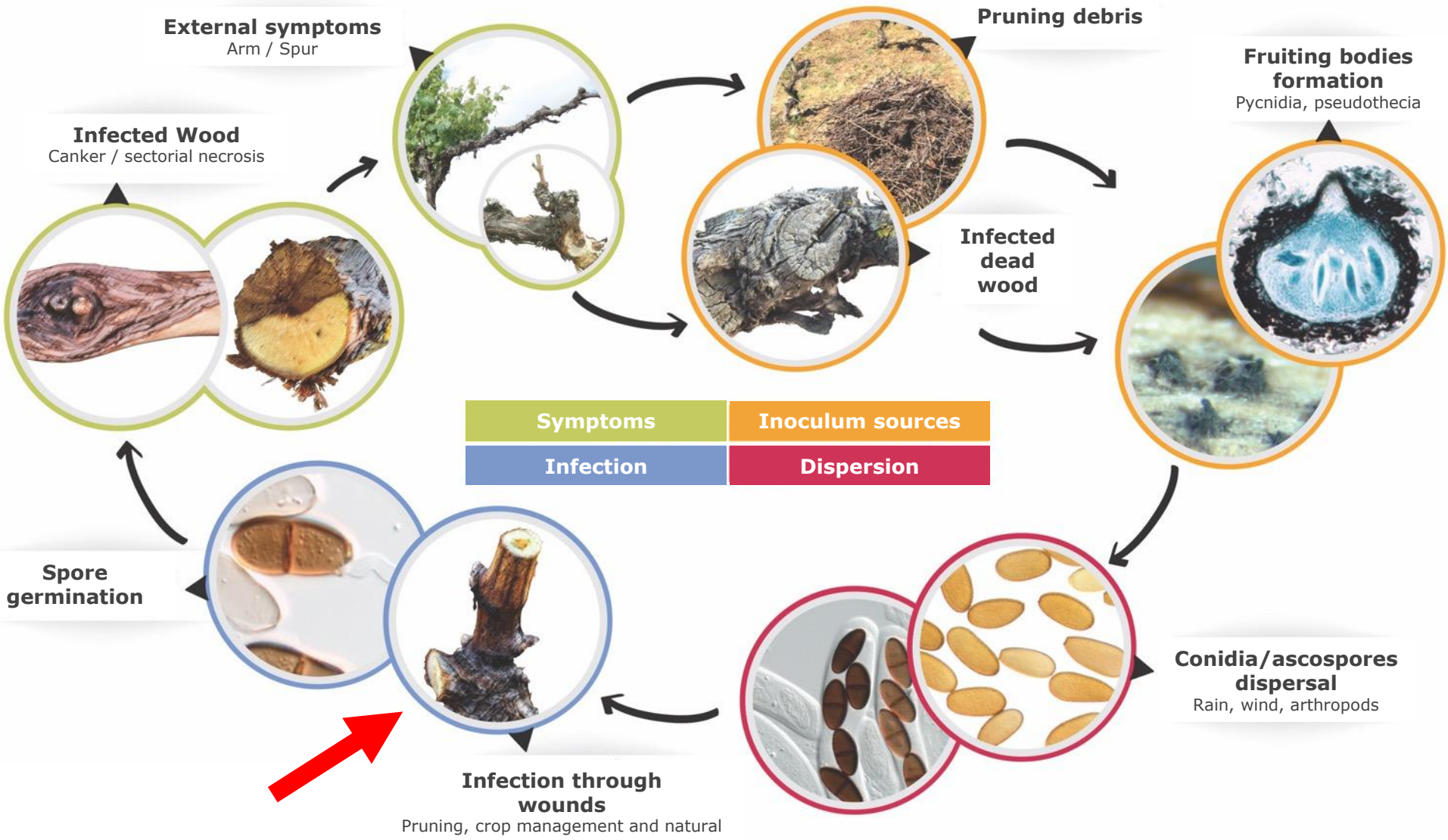
Fungal trunk diseases: a problem beyond grapevines?

D. Gramaje[a*], K. Baumgartner[b], F. Halleen[cd], L. Mostert[d], M. R. Sosnowski[e], J. R. Úrbez-Torres[f] and J. Armengol[g]

2016

Epidemiology. Disease cycle

Botryosphaeria dieback



Winter pruning

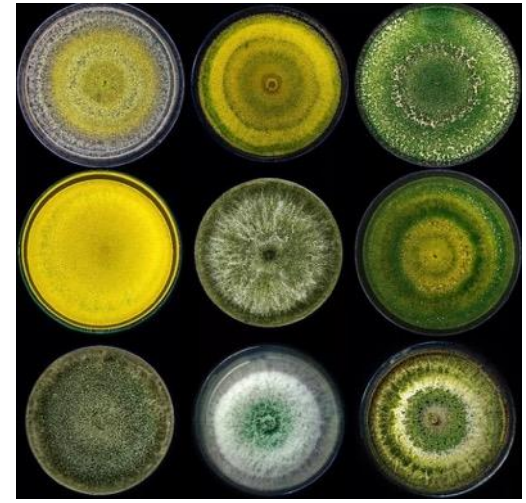
Diatrypaceae spp.
Botryosphaeriaceae spp.
Basidiomycetes
Phaeomoniella chlamydospora
***Phaeoacremonium* spp.**

Most effective:
Mastic/paste + fungicides

CHEMICAL CONTROL

Alternative

***Trichoderma* spp.**



In general, BCA have shown variable results for preventing infection by GTD pathogens

New perspectives for disease management

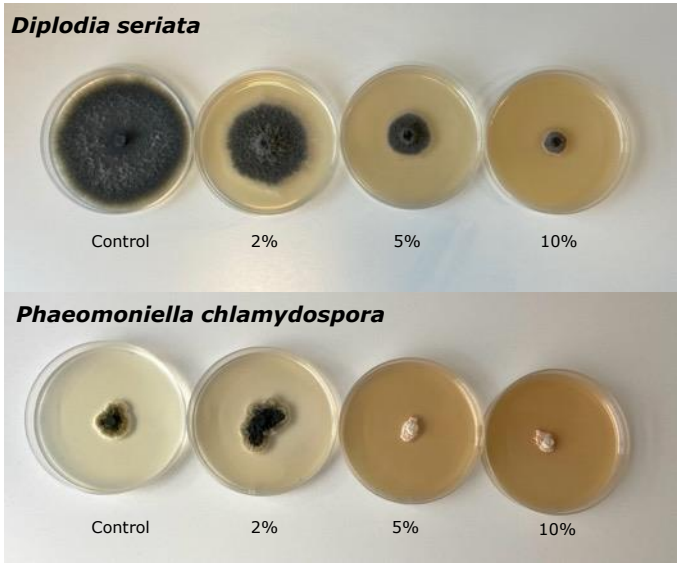
- Cultural practices
- Biological Control (fungi, bacteria, yeasts and oomycetes)
- Biostimulants
- Resistance inducers (elicitors)
- Biofumigation
- Nanomaterials
- Ozonated water
- Electrolyzed acid water
- Natural compounds (plant extracts)

New perspectives for disease management

GREENVITISV: NATURAL BIOACTIVE EXTRACTS FROM AGRIFOOD BYPRODUCTS AS CIRCULAR GREEN SOLUTIONS FOR A ZERO WASTE APPROACH IN THE AGRICULTURAL SECTOR

D. Gramaje, C. Leal, R. Bujanda, R. Facorro, L. Rubio, A. Castillo, M. Lores, E. Díaz-Losada, E.P. Pérez-Álvarez, T. Garde-Cerdán

The GREENVITISV project aims to produce eco-friendly products from grape pomace, such as phytosanitary pesticides to combat the primary fungal and oomycete diseases affecting grapevines. Additionally, it seeks to develop antioxidant-preservative alternatives to SO2 in winemaking, thereby promoting a sustainable circular economy.



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Thanks for your attention!

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