Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Grapevine Trunk Diseases

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Pacific Agriculture Research Centre, Summerland BC

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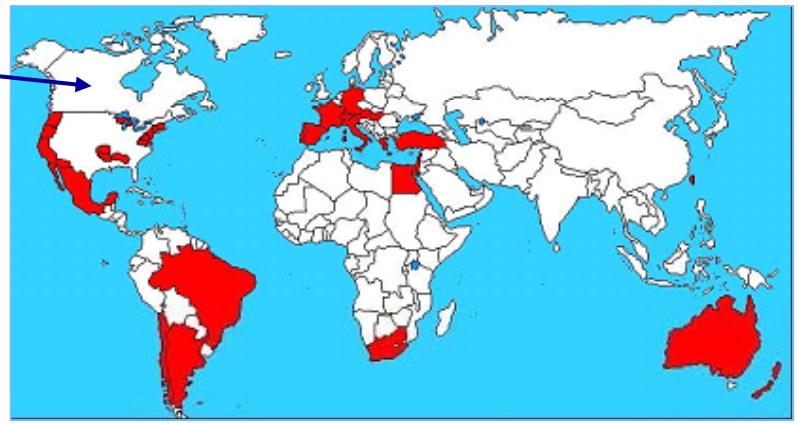
Canada

Root and trunk diseases causing "Vine Decline" in the Okanagan Valley

- Vine decline is considered a syndrome caused by a number of different diseases (Esca, *Botryosphaeria*, Blackfoot, Eutypa, Phomopsis and others)
- These diseases cause progressive decline over a 3-4 year period
- They are found in all the grape growing regions of the world
- In the Okanagan we only started seeing this problem in 2007

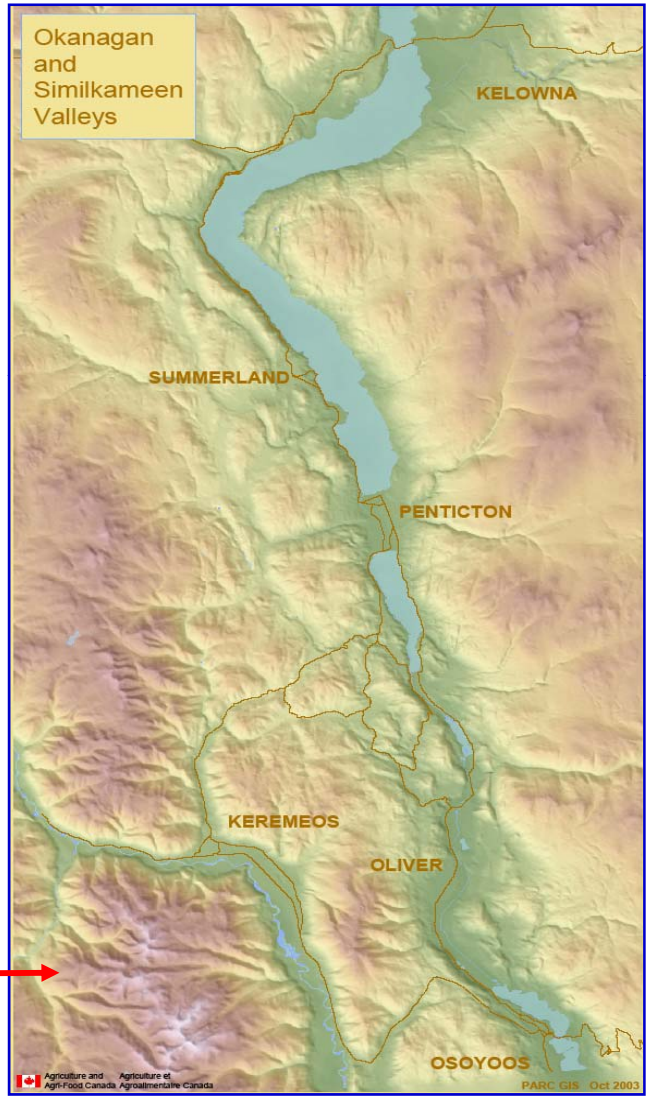
The Great White North

Trunk Diseases Worldwide



Map from Dr. Doug Gubler presentation at PARC in October 2007

BC's Okanagan and Similkameen Valleys



Disease survey initiated in August 2007

- *Vineyard managers were concerned about new disease problems causing vine decline*

General Decline Symptoms:

- rapid decline and plant death
- delayed growth
- general loss of vigour
- yellowing and loss of leaves
- tendril dieback
- trunk dieback
- dead arm

- *Esca (aka: Young vine decline / Black goo / Petri disease) ???*

Eutypa dieback ???

Early symptoms on young vines

delayed and stunted growth

Symptoms on older vines

delayed and stunted growth

Foliar symptoms

stunted and yellow leaves

Decline of older vines

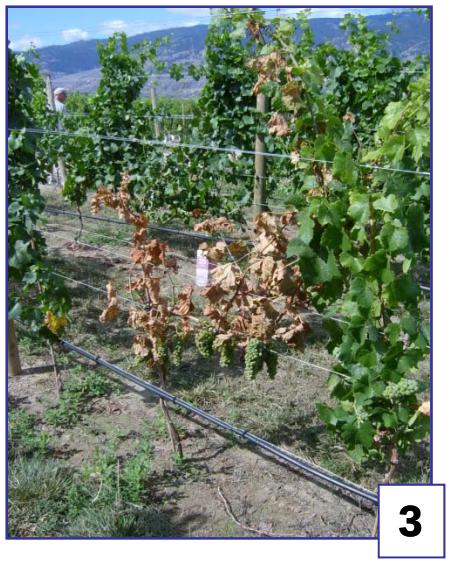
chlorotic foliage

trunk dieback and dead arm

Sudden wilting and death of vines or cordons

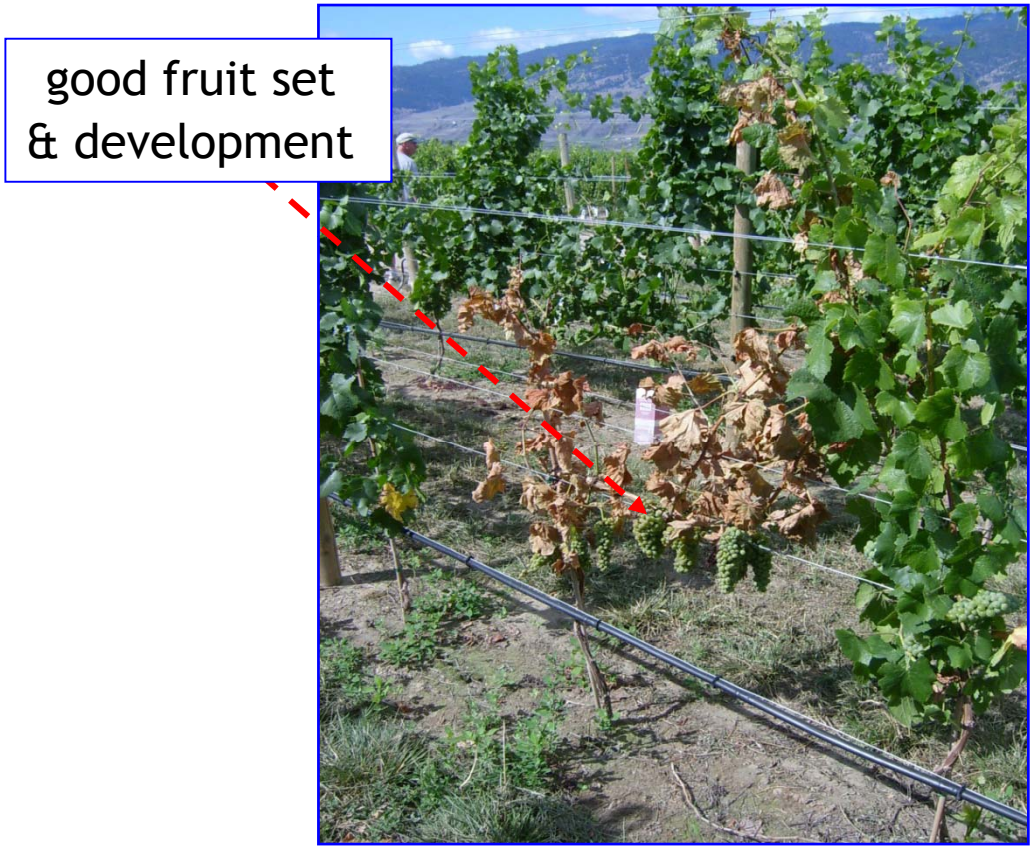
progression of visual field symptoms

~ 7 - 10 days



Sudden collapse of vines

Apparently healthy vines until disease onset and rapid decline



Root Rot: Blackfoot disease

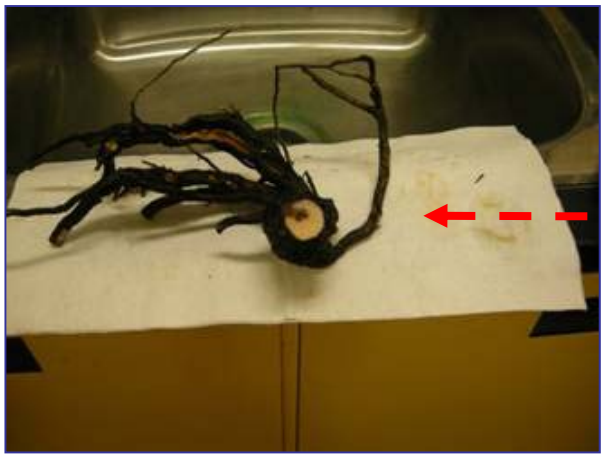
Pathogen

Cylindrocarpon spp.

Cylindrocarpon sp.

Symptoms

- black, sunken, necrotic lesions in the roots
- black vascular tissue below the graft union
- leaves may appear to be water stressed/scorched
- stunted or slow growing vines
- vine death



black vascular tissue below the graft

sudden collapse and death of vine

Esca

Pathogens

- *Phaeomoniella chlamydospora* and *Phaeoacremonium* spp.

Field Symptoms

- delayed / stunted growth
- progressive loss of vigour over several years
- yellowing and loss of leaves
- shot tip and tendril dieback

Vascular symptoms

- blackened / clogged vascular tissue

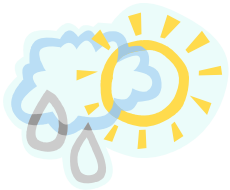
delayed and stunted growth

clogged vascular tissue

Esca

Esca Infection sites:

- Spores are released under wet conditions



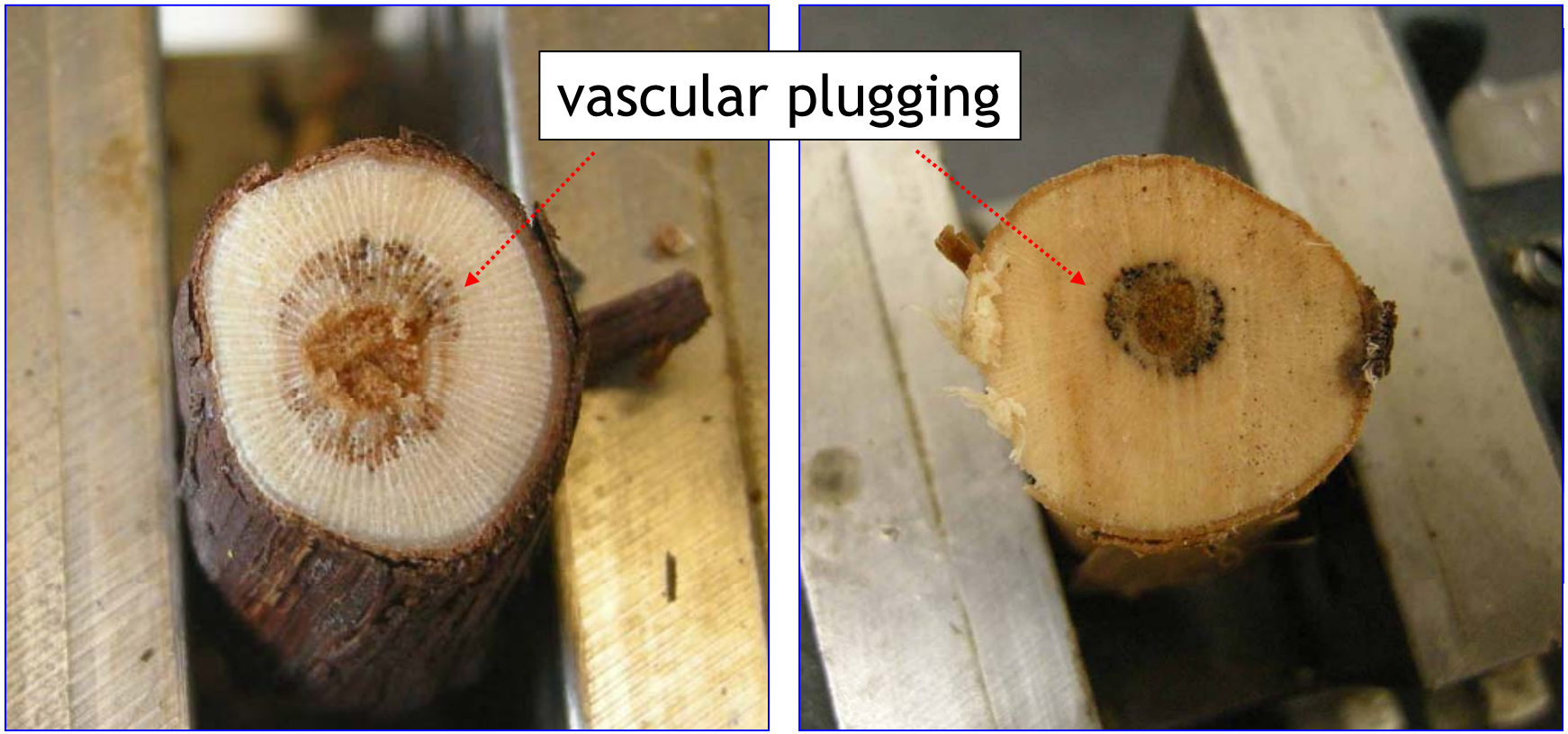
- Pruning wounds act as entry point for fungal spores

ascospores

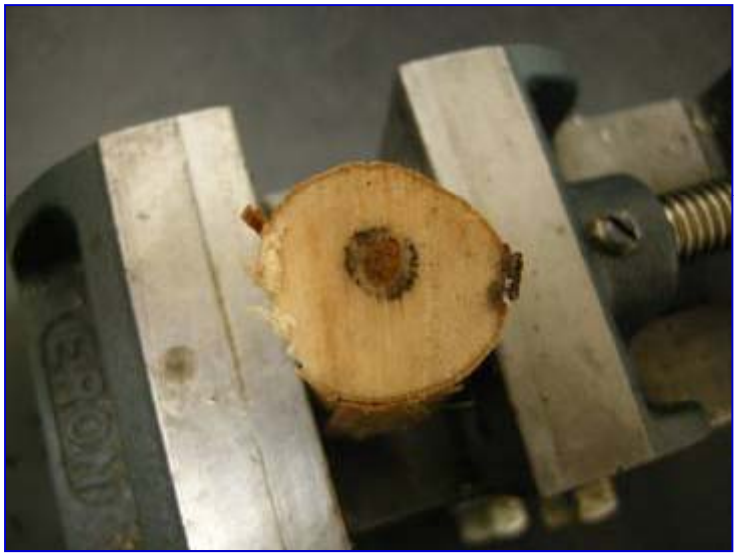
- Spores germinate and colonize the vascular system

Esca: vascular symptoms

Black or brown speckling of the vascular tissue



Esca



vascular symptoms on an infected cane

pathogen isolated from diseased tissue and grown in the lab

Eutypa dieback

Pathogen

- *Eutypa lata*

Early spring symptoms

- delayed growth
- stunted shoots and leaves

Other symptoms

- dead arm
- trunk dieback
- cankers
- Eutypa symptoms are more commonly seen in older vines >10 yrs

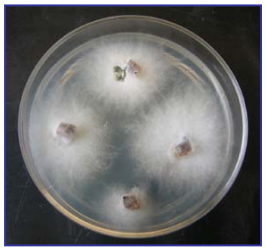
vine affected by Eutypa dieback.
Photo by William J. Moller.

Eutypa dieback

Vascular symptom

cankers

Eutypa lata culture and spores



Eutypa culture: isolated from margin canker

ascospores

Loschiavo et, al.

conidia

www.asturnatura.com/.../eutypa-lata-2.jpg

Infection sites and canker development

Pruning wounds act as entry point for fungal spores

Cankers extending down from old (Large) pruning wounds

Variable canker symptomology

Typical Eutypa and Bot cankers described as V shaped

In the Okanagan we have found Bot and Eutypa cankers of many different descriptions (many are not "V" shaped)

Bot- canker

To "V" or not to "V"

Eutypa canker

Bot- canker

Bot- canker

Eutypa canker

Bot- canker

Botryosphaeria canker (Bot-canker)

Pathogens

Botryosphaeria spp.

Early spring symptoms

bud necrosis
delayed & stunted growth
short internodes

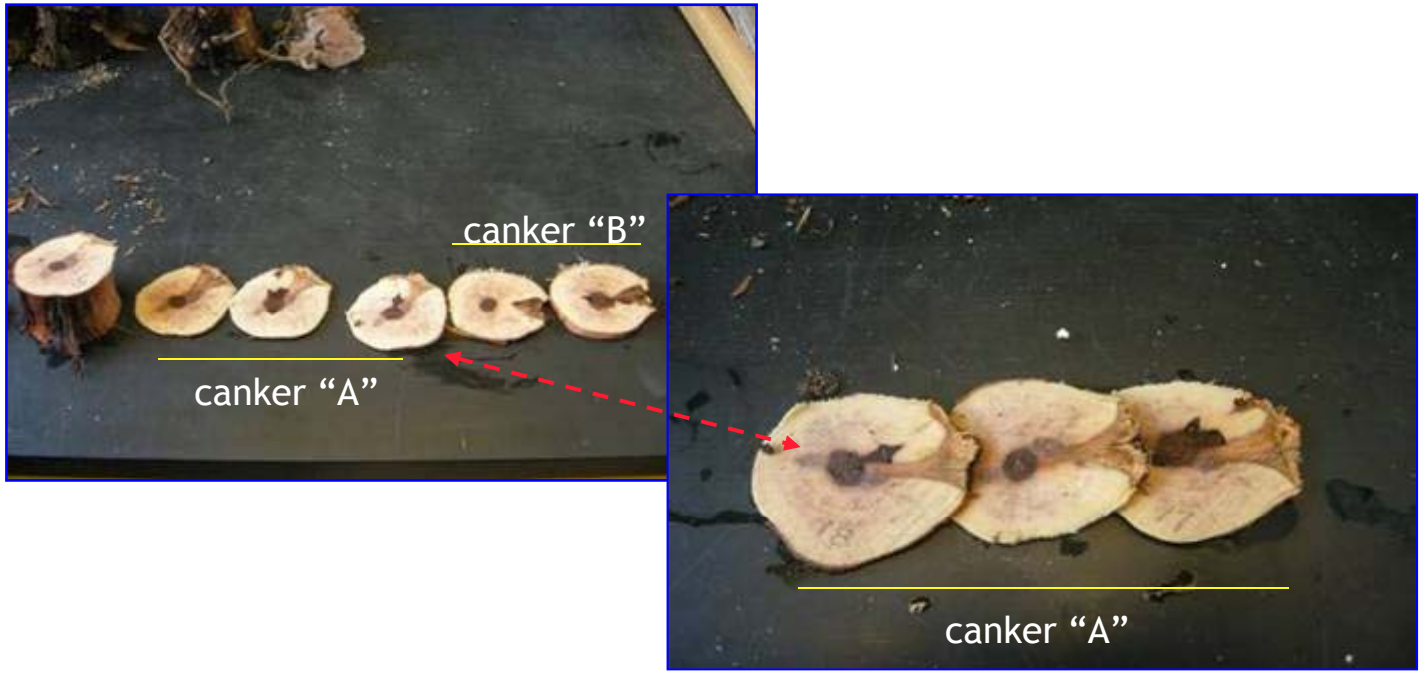
Other symptoms

cane dieback
trunk dieback
canker
dead arm

Bot-canker: Vascular symptoms

V-shaped canker typical of Bot-canker
(but also find "U" and irregular shaped cankers)

Cankers found penetrating vascular tissue at old pruning wounds



Disease survey results (Fall 2007)

dominant pathogen species isolated from grape

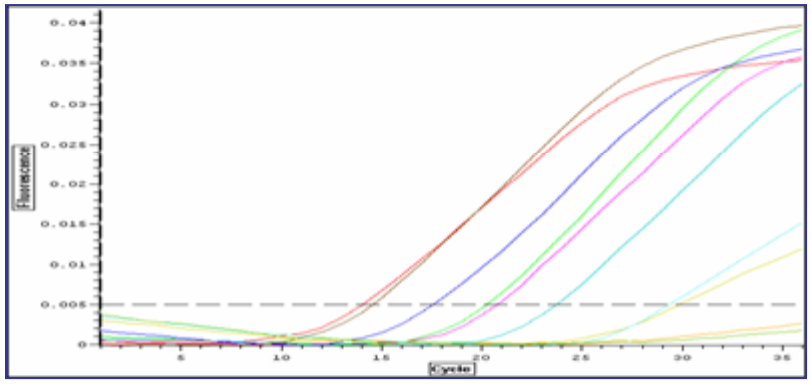
- Black Foot: *Cylindrocarpon spp.*
- Bot- Canker: *Botryosphaeria spp.*

Detection of *Botryosphaeria sp.* using spore traps

Spore trap samples collected weekly to determine:

- date of spore release in Okanagan vineyards
- weather conditions for spore release
- spore loads in individual vineyards

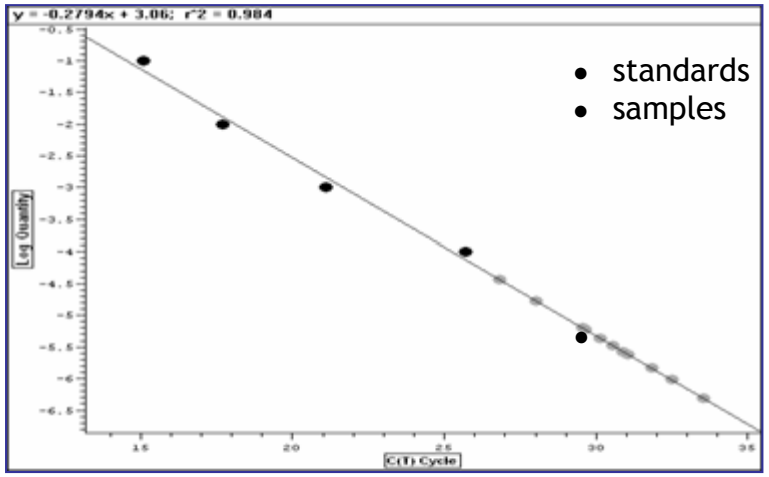
Q-PCR: Detection of *Botryosphaeria spp.* from spore traps



Amplification curves

Detection

DNA amplification curves provide detection of *Botryosphaeria* spores from vineyard spore trap samples.

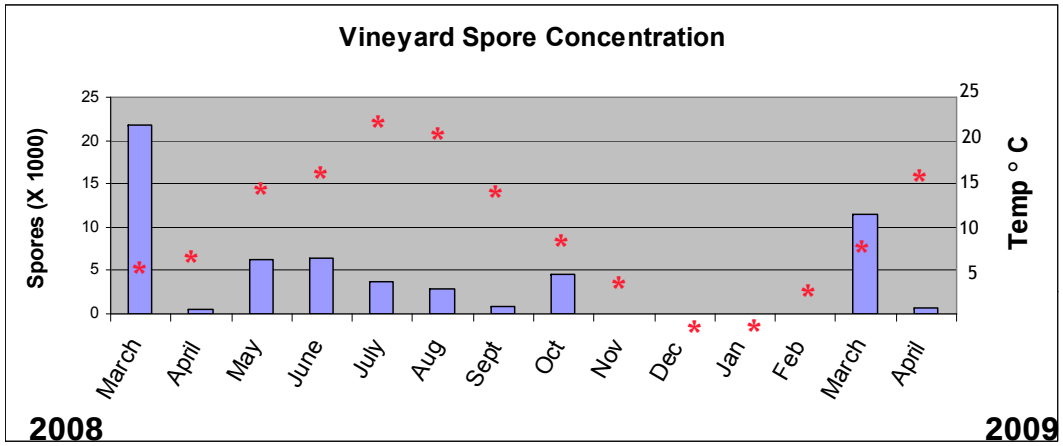


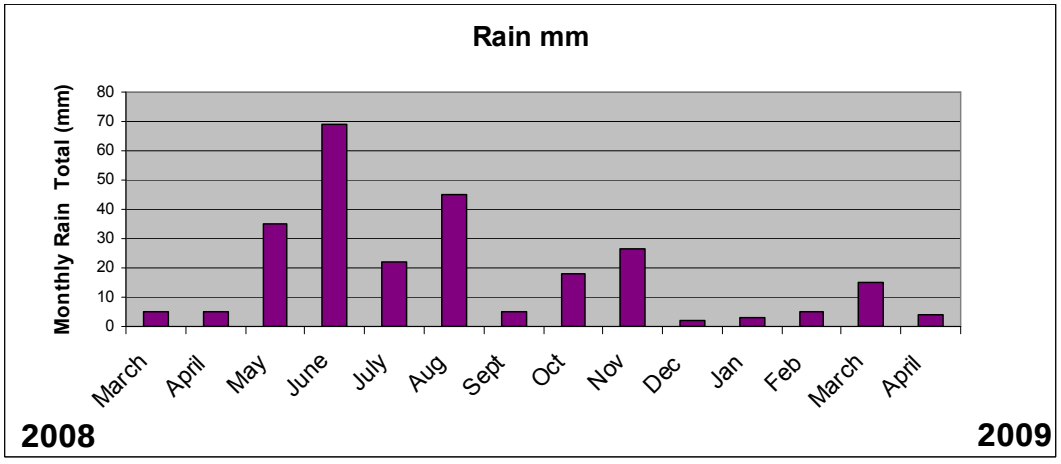
Standard curve

Quantification

standard curve calculates the number of spores from individual spore trap samples.

Botryosphaeria spore concentration from spore traps





* Mean Temp

Spore conc.

Rain (mm)

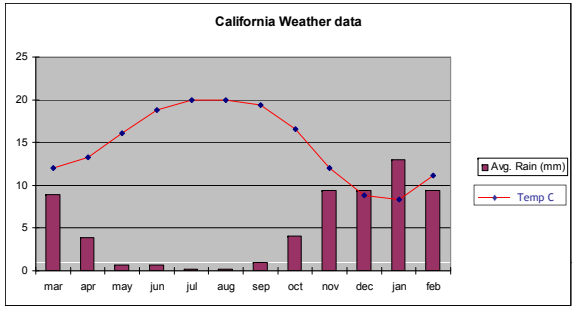
Management recommendations of Bot-Canker

No chemical control products registered in Canada

Recommendations

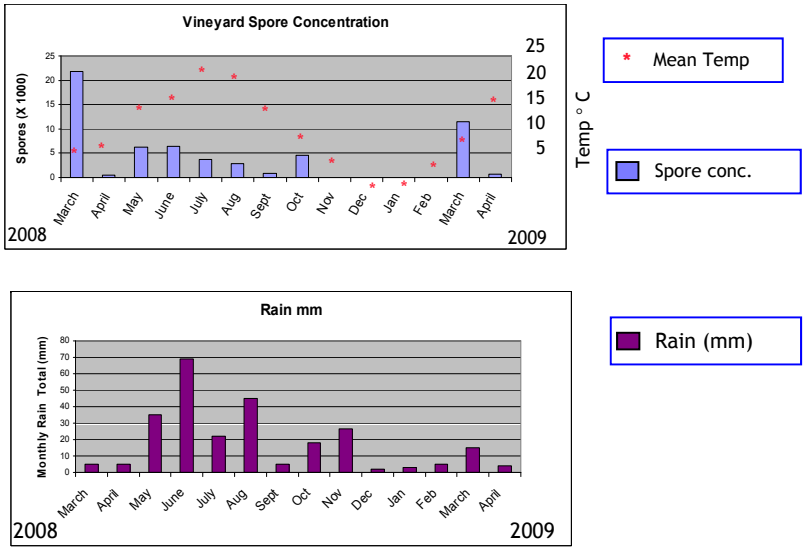
- eliminate and burn pruning debris
- dormant lime sulfur applications
  10 gal per acre in 100 gal water
- protect pruning wounds:
  5 % boric acid in latex paint
- double pruning ?
- late pruning ?

California weather: Napa



Okanagan Valley weather

(and spore trap data)



Okanagan rainy season: May-June

Multiple infections and synergistic response

Observations:

- Different symptoms in the roots and trunk indicating presence of multiple diseases

- Vineyards showing high mortality were often infected by multiple pathogens (*often young plantings < 5 yrs*)

Multiple infections and synergistic response

x-section above union

- different disease symptoms above and below graft union

longitudinal section of graft union
vine: pinot blanc (rapid decline)

x-section below union

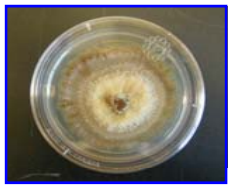
Multiple infections and synergistic response

Blackfoot: vascular symptoms

+

Esca: vascular symptoms

both pathogens isolated from diseased vine



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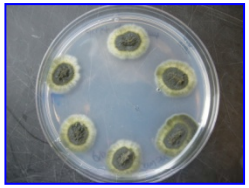
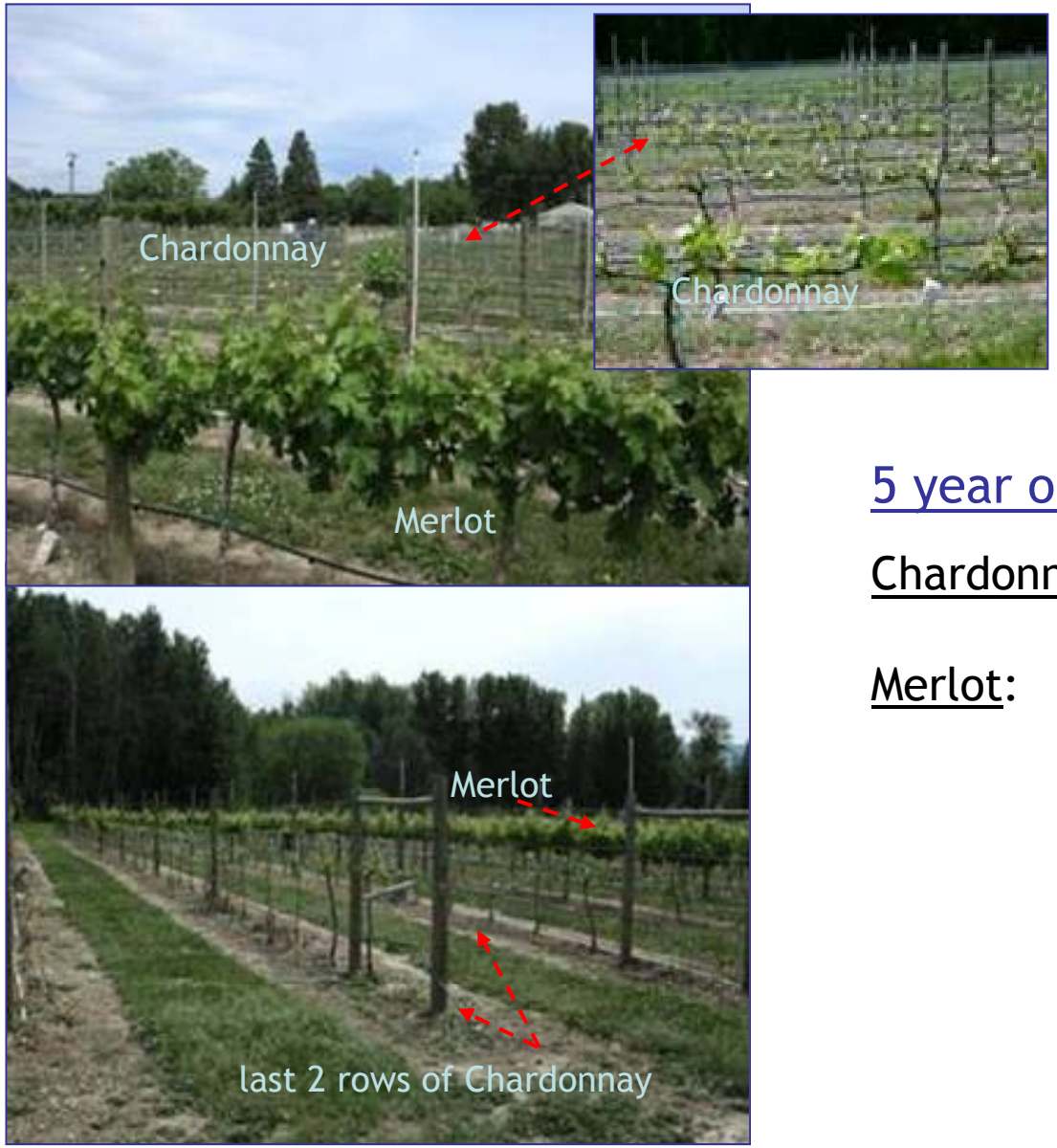


Cylindrocarpon sp. (Black foot)

Phaeomoniella sp. (Esca)

Multiple infections and synergistic response



5 year old vines

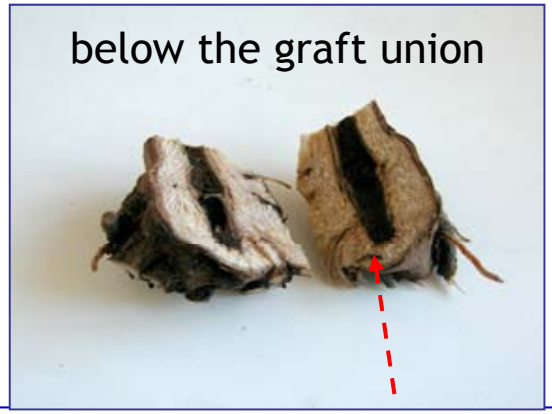
Chardonnay: clone 76 on 3309

Merlot: clone 81 on Riparia

Multiple infections and synergistic response

+

cankers



blackened pith & sunken lesions

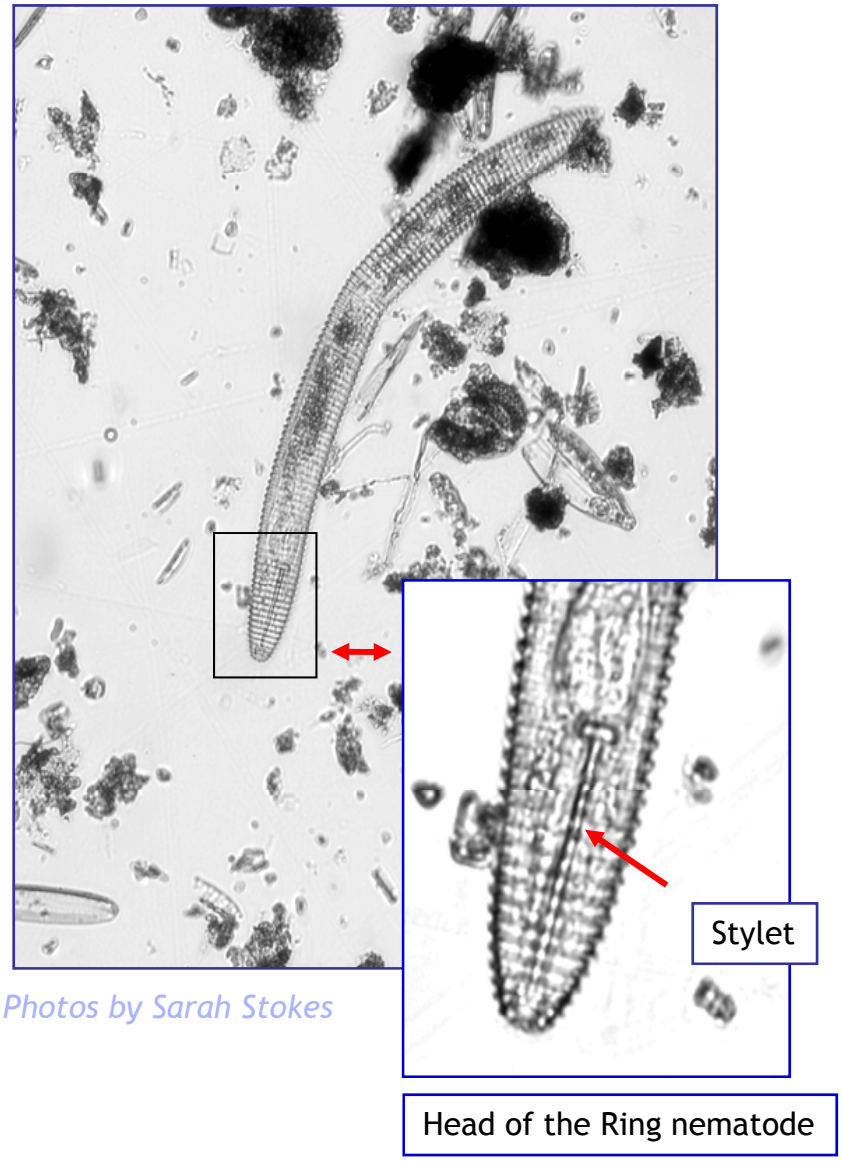
pathogens isolated from diseased vine:

+

Cylindrocarpon sp.

Botryosphaeria parva

Multiple infections and synergistic response



Photos by Sarah Stokes

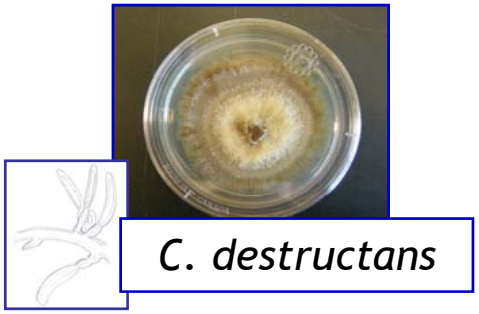
Ring nematode

- characteristic ringed body
- the Ring nematode has a stylet which can protrude and penetrate plant cells like a hypodermic needle

Multiple infections and synergistic response

The Ring nematode

+



C. destructans

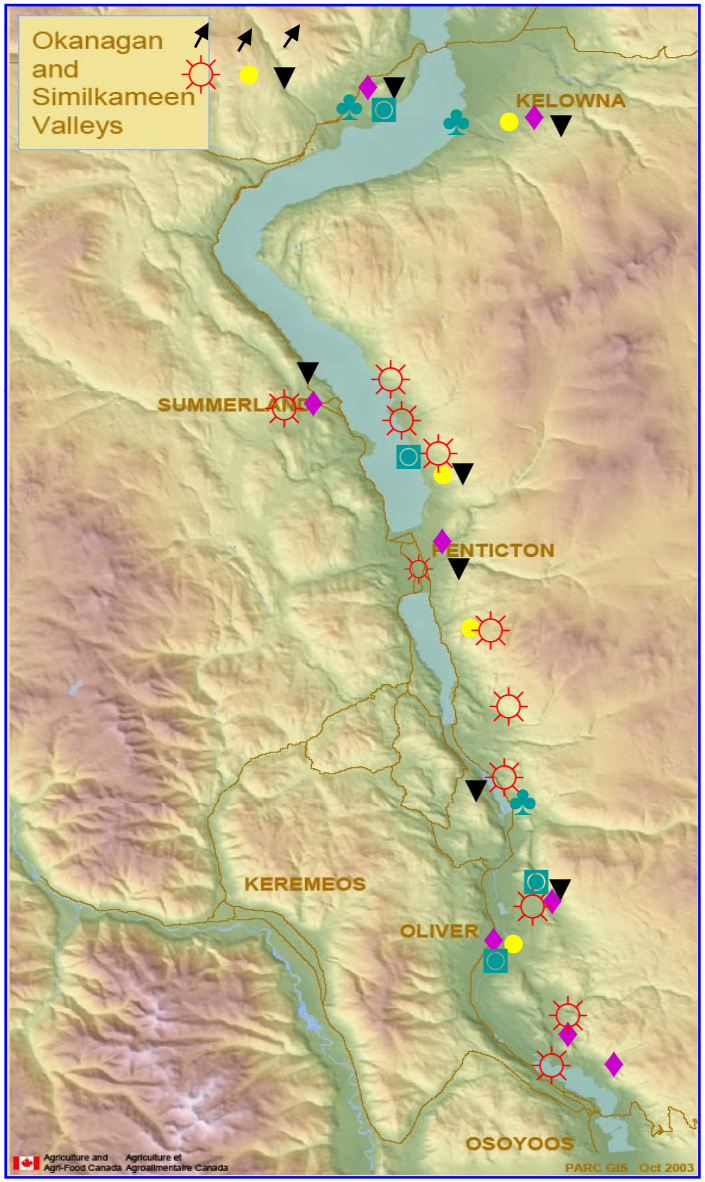
- established populations of Ring nematode found in vineyards (3000-4000/kg soil)
- found in association with root rot pathogen *C. destructans*

Map of the Okanagan: *Disease survey*

♣ *Roeslaria*
& *other root rots*

☼ Bot-canker

▣ Phomopsis canker



▼ Blackfoot disease

♦ Esca

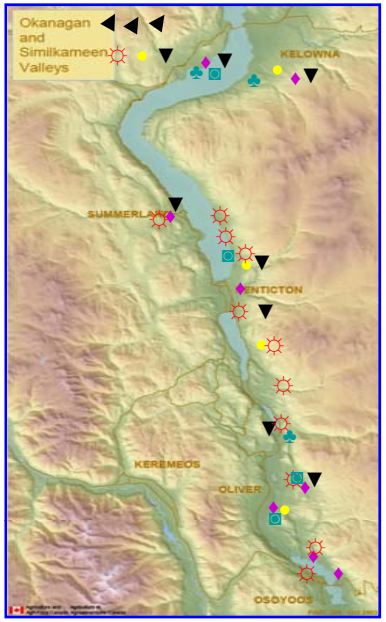
● Eutypa dieback

Map of the Okanagan: *Disease survey*

♣ *Roeslaria*
& *other root rots*

☼ Bot-canker

◙ Phomopsis canker



▼ Blackfoot disease

♦ Esca

● Eutypa dieback

Grapevine Trunk Diseases: Past, Present and Future

Eutypa dieback

Eutypa lata

Over 40 different fungi

Esca / YVD

Phaeomoniella chlamydospora
Phaeoacremonium aleophilum

Over 20 different fungi

Black foot

Cylindrocarpon destructans

Over 10 different fungi

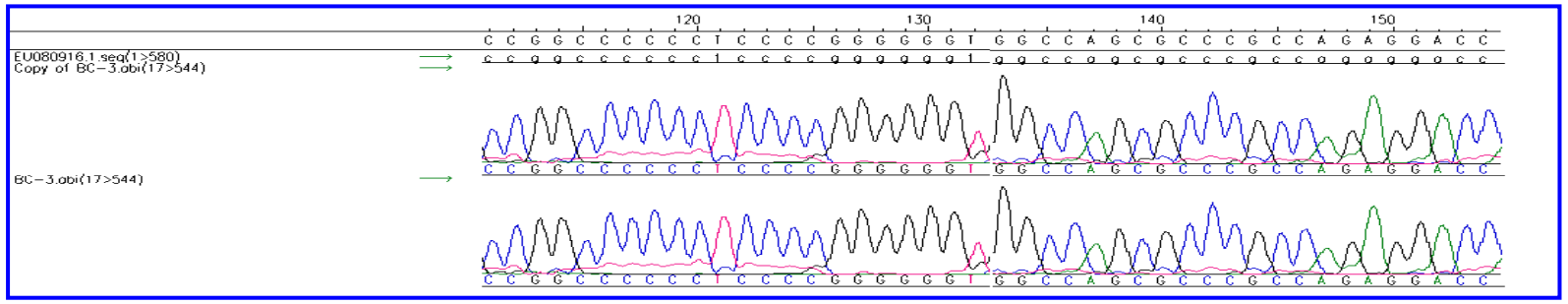
Species identification and characterization based on DNA sequencing:

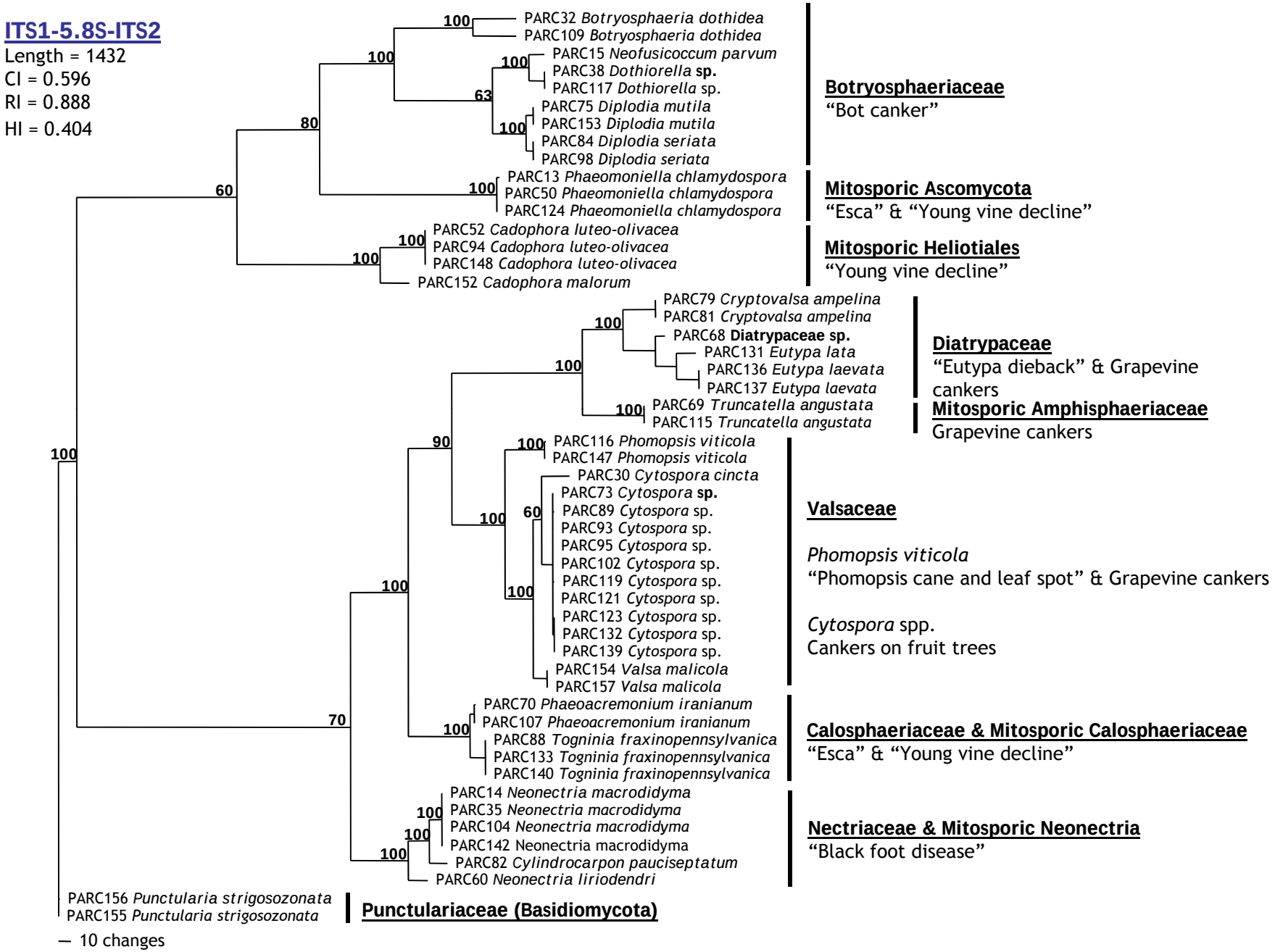
1) DNA sequencing of isolates

- targeting the rDNA (ITS), *β-tubulin* and *EF1a* genes to generate sequence data

2) Identification

- search sequence database (Genbank) for the identical or closest match and;
- phylogenetic analysis of DNA sequences from survey isolates and type cultures




ITS1-5.8S-ITS2
Length = 1432
CI = 0.596
RI = 0.888
HI = 0.404
PARC32 Botryosphaeria dothidea
PARC109 Botryosphaeria dothidea
PARC15 Neofusicoccum parvum
PARC38 Dothiorella sp.
PARC117 Dothiorella sp.
PARC75 Diplodia mutila
PARC153 Diplodia mutila
PARC84 Diplodia seriata
PARC98 Diplodia seriata
Botryosphaeriaceae
"Bot canker"
PARC13 Phaeomoniella chlamydospora
PARC50 Phaeomoniella chlamydospora
PARC124 Phaeomoniella chlamydospora
Mitosporic Ascomycota
"Esca" & "Young vine decline"
PARC52 Cadophora luteo-olivacea
PARC94 Cadophora luteo-olivacea
PARC148 Cadophora luteo-olivacea
PARC152 Cadophora malorum
Mitosporic Heliotiales
"Young vine decline"
PARC79 Cryptovalsa ampelina
PARC81 Cryptovalsa ampelina
PARC68 Diatrypaceae sp.
PARC131 Eutypa lata
PARC136 Eutypa laevata
PARC137 Eutypa laevata
Diatrypaceae
"Eutypa dieback" & Grapevine cankers
PARC69 Truncatella angustata
PARC115 Truncatella angustata
Mitosporic Amphisphaeriaceae
Grapevine cankers
PARC116 Phomopsis viticola
PARC147 Phomopsis viticola
PARC30 Cytospora cincta
PARC73 Cytospora sp.
PARC89 Cytospora sp.
PARC93 Cytospora sp.
PARC95 Cytospora sp.
PARC102 Cytospora sp.
PARC119 Cytospora sp.
PARC121 Cytospora sp.
PARC123 Cytospora sp.
PARC132 Cytospora sp.
PARC139 Cytospora sp.
PARC154 Valsa malicola
PARC157 Valsa malicola
Valsaceae
Phomopsis viticola
"Phomopsis cane and leaf spot" & Grapevine cankers
Cytospora spp.
Cankers on fruit trees
PARC70 Phaeoacremonium iranianum
PARC107 Phaeoacremonium iranianum
PARC88 Togninia fraxinopennsylvanica
PARC133 Togninia fraxinopennsylvanica
PARC140 Togninia fraxinopennsylvanica
Calosphaeriaceae & Mitosporic Calosphaeriaceae
"Esca" & "Young vine decline"
PARC14 Neonectria macrodidyma
PARC35 Neonectria macrodidyma
PARC104 Neonectria macrodidyma
PARC142 Neonectria macrodidyma
PARC82 Cylindrocarpon pauciseptatum
PARC60 Neonectria liriodendri
Nectriaceae & Mitosporic Neonectria
"Black foot disease"
PARC156 Punctularia strigosozonata
PARC155 Punctularia strigosozonata
Punctulariaceae (Basidiomycota)
— 10 changes

Grapevine Trunk Diseases: Past, Present and Future

Etiology of Grapevine Trunk Disease

Eutypa dieback

Eutypa lata
Eutypa leptoplaca
Eutypa laevata
Eutypella cryptovalsoidea
Eutypella microtheca
Eutypella vitis
Eutypella sp. 1
Eutypella sp. 2
Eutypella sp. 3
Eutypella sp. 4
Cryptosphaeria lygniota
Cryptosphaeria pullmanensis
Cryptovalsa ampelina
Cryptovalsa rabenhorstii
Diatrype brunneospora
Diatrype oregonensis
Diatrype stigma
Diatrype whitmanensis
Diatrypaceae sp.
Diatrypella verrucaeformis
Diatrypella vulgaris

21 fungal species

Esca / YVD

Phaeomoniella chlamydospora
Phaeoacremonium aleophilum
Phaeoacremonium angustius
Phaeoacremonium argentiniense
Phaeoacremonium armeniacum
Phaeoacremonium australiense
Phaeoacremonium austroafricanum
Phaeoacremonium cinereum
Phaeoacremonium croatiense
Phaeoacremonium globosum
Phaeoacremonium hispanicum
Phaeoacremonium hungaricum
Phaeoacremonium iranianum
Phaeoacremonium mortoniae
Phaeoacremonium occidentale
Phaeoacremonium scolyti
Phaeoacremonium sicilianum
Phaeoacremonium tuscanum
Phaeoacremonium viticola

19 fungal species

Bot canker

Botryosphaeria dothidea
Diplodia corticola
Diplodia mutila
Diplodia seriata
Dothiorella **sp.**
Dothiorella americana
Lasiodiplodia crassispora
Lasiodiplodia missouriana
Lasiodiplodia theobromae
Lasiodiplodia viticola
Neofusicoccum australe
Neofusicoccum luteum
Neofusicoccum macroclavatum
Neofusicoccum mediterraneum
Neofusicoccum parvum
Neofusicoccum ribis
Neofusicoccum viticlavatum
Neofusicoccum vitifusiforme
Phaeobotryosphaeria porosa
Spencermartinsia viticola

20 fungal species

Grapevine Trunk Diseases: Past, Present and Future

Etiology of Grapevine Trunk Disease

Black foot

Cylindrocarpon destructans
Cylindrocarpon fasciculare
Cylindrocarpon pseudofasciculare
Cylindrocarpon pauciseptatum
Cylindrocarpon liriodendri
Cylindrocarpon macrodydimum

6 fungal species

GTD Pathogens?

Cadophora luteo-olivacea
Cytospora spp.
Macrophomina phaseolina
Phomopsis viticola
Pestalotiopsis sp.
Pestalotiopsis uvicola
Truncatella angustata
Verticillum dahliae

8 fungal species

Bot- canker

Black foot

Esca / YVD

Eutypa dieback

Where do we go from here ?

- Continue and expand the disease survey
- More spore trap studies: to gain a better understanding of the biology of these pathogens in our northern climate
- Develop molecular diagnostic test that will allow us to easily detect and differentiate the different species involved
- Investigate additional disease control measures

The PARC Plant Pathology Team

Grapevine trunk disease project members

- Paula Haag – Technician (*aka Godess of Black Goo*): grapes and grapevine diseases

- Dr. José Úrbez Torres - Post Doc: grapevine trunk diseases

Other members of the plant path team

- Julie Boulé – Technician: tree fruit pathology

AAFC
Developing Innovative Agri-Products Initiative (DIAP)

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

BC Wine Grape Council

Problem or Opportunity

South Australia

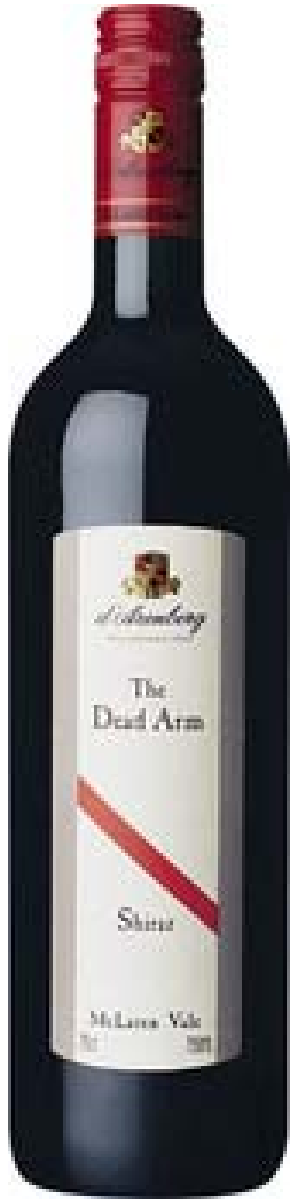
Shiraz

The Dead Arm

The Story Behind The Name:

Dead Arm is a vine disease caused by the fungus Eutypa Lata that randomly affects vineyards all over the world. Often vines affected are severely pruned or replanted. One half, or an ‘arm’ of the vine slowly becomes reduced to dead wood. That side may be lifeless and brittle, but the grapes on the other side, while low yielding, display amazing intensity.

produced by: **d'Arenberg**



Thank you

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www.agr.gc.ca/ResearchCentre/Agassiz-Summerland

Canada