SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Australian Government

Grape and Wine Research and Development Corporation

Management of Eutypa dieback and Botryosphaeria canker in south-western Western Australian vineyards



FINAL REPORT to
GRAPE AND WINE RESEARCH & DEVELOPMENT

Project Number: **RT 08/02-1**

Principal Investigators: **Mark Sosnowski & Adrian Loschiavo**

Organisation: **Wine Industry Association of Western Australia**
Sub-contracting agency: **South Australian Research and Development Institute (SARDI)**

Date: Jan 2010

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY 2
2. BACKGROUND 2
3. OBJECTIVES 3
4. WORKSHOPS 3
5. RESULTS/DISCUSSION 4
6. OUTCOME/CONCLUSION 7
7. ACKNOWLEDGEMENTS 7
8. REFERENCES 7
9. BUDGET RECONCILIATION 8
10. APPENDICES 9

1. EXECUTIVE SUMMARY

Eutypa dieback, a trunk disease of grapevines, reduces yields and causes a gradual decline and eventually death of grapevines. The disease is caused by the fungus, *Eutypa lata* and is found in cool climate wine regions throughout the world. Eutypa dieback is one of Australia's most important grapevine trunk diseases.

The status of eutypa dieback in Western Australian vineyards has been unclear, although two unconfirmed reports suggested it was present in Swan Valley and Margaret River. To increase awareness about this disease and botryosphaeria canker in grapevines, a workshop was presented in three wine growing regions of WA (Swan Valley, Margaret River and Great Southern) in November, 2009. Forty-five growers and industry personnel attended the workshops which focused on identification and management of eutypa dieback and botryosphaeria canker. Mr Adrian Loschiavo (SARDI) presented information on the recognition and identification of eutypa dieback and was followed by Dr Mark Sosnowski (SARDI) who spoke about research on management of the disease. Visiting scientist, Dr Florent Trouillas from the University of California, Davis USA, presented information on grapevine trunk diseases from the laboratory of Prof Doug Gubler, focussing on his own PhD research. Mr Andrew Taylor (Dept of Agriculture and Forestry WA) presented information on the presence and distribution of botryosphaeria canker in WA and was followed by Dr Wayne Pitt (Charles Sturt University) who presented research from NSW on botryosphaeria canker, including management of the disease.

The group visited 17 vineyards in the three growing regions and inspected the oldest blocks (around 200 vines in each) for symptoms of trunk diseases. Foliar symptoms of eutypa dieback were not observed in any vineyard. However, dieback and wedge shaped stained wood was present in all areas, particularly in older vines, suggesting that Botryosphaeria canker is widespread in WA. Isolations were made from samples collected from suspect vines. No *E. lata* was isolated, but related diatrypaceaous species of *Eutypella* and *Cryptovalsa* were present along with *Botryosphaeria* species, which were prevalent.

2. BACKGROUND

Grapevine trunk diseases limit the long term sustainability of Australian wine grape production. Eutypa dieback is a trunk disease that causes yield reductions, gradual decline and eventually death of grapevines. The disease is caused by the fungus *Eutypa lata* and infects open wounds via air-borne and rain splashed spores. Botryosphaeria canker has been associated with dieback of shoots, stunted growth, delayed bud burst and bud necrosis in grapevines resulting in vine decline and death (Taylor *et al.* 2005). Spores of the fungus *Botryosphaeria* spp. are spread by rain-splash and wind. Both of these trunk diseases are hosted by cultivated tree crops such as pome and stone fruits, which are commonly grown within south-western Western Australia (WA), often in close proximity to vineyards.

Surveys have shown eutypa dieback is widespread in many of the premium winegrowing areas of Australia including South Australia (SA), Victoria, Tasmania and New South Wales (Wicks 1975; Highet and Wicks 1998; Pitt *et al.* 2007) and in some vineyards, over 70% of vines are infected (Sosnowski et al. 2004). A recent survey in the Adelaide Hills of SA revealed that eutypa dieback is widespread at low levels in this region and workshops and publications have prompted growers to act early before the disease causes major economic losses (Loschiavo *et al*. 2007). Only one record from the Plant Pathology Branch of WA in 1975 of eutypa dieback (formerly known as *E. armeniacae*) exists on grapevines near Perth in WA (Shivas 1989). In addition, "*Eutypa*" was reported in a diagnostic sample with esca disease symptoms from the Margaret River region, although this was not confirmed as *E. lata* with DNA analysis (Edwards and Pascoe 2004). In 2003, a survey was undertaken in south-western WA for *Botryosphaeria* spp. and revealed that botryosphaeria canker occurred in many vineyards (Taylor *et al*. 2005). The impacts and management of *Botryosphaeria* spp. and eutypa dieback are similar.

The WA wine industry has undergone significant expansion into new and existing horticultural regions and as a result, many vines are at an age where foliar symptoms of eutypa dieback and any cordon dieback should be visible if the disease is present. Furthermore, grape growers in south-western WA may have limited knowledge of management strategies for eutypa dieback and botryosphaeria canker. Workshops to deliver information to growers about prevention and control of eutypa dieback and botryosphaeria canker will lead to more sustainable vineyard management in WA. Sampling of vineyards would clarify the status of eutypa dieback in this region.

3. OBJECTIVES

The primary objective was to deliver workshops to growers in Swan District, Margaret River and Great Southern wine regions of Western Australia to improve knowledge and awareness of eutypa dieback and botryosphaeria canker including recognising symptoms and understanding management options. Whilst in WA the secondary objective was to determine if eutypa dieback was present in Western Australia, and if so what was the incidence of the disease.

4. WORKSHOPS

Workshops were promoted via email and industry newsletters (see flyer attached) with the assistance of Mr Keith Pekin of the Wine Industry Association of Western Australia (WIAWA) and Ms Diana Fisher of the Department of Agriculture and Food Western Australia (DAFWA). The workshops were held at Jane Brook Estate, Swan Valley; Vasse Felix, Margaret River and West Cape Howe, Mt Barker from 2-6 November, 2009. Information on grapevine trunk diseases was presented, in particular eutypa dieback and botryosphaeria canker.

Mr Adrian Loschiavo (Scholefield Robinson Horticultural Services) delivered a presentation on the identification of eutypa dieback including recognition of foliar, bunch and wood symptoms. Dr Mark Sosnowski (South Australian Research and Development Institute, SARDI) presented information on eutypa dieback management from research conducted during the past 10 years in projects CRV 03/06S & SAR 06/01. This included information on disease prevention by pruning wound protection and control by remedial surgery (Sosnowski *et al.* 2009).

Dr Florent Trouillas (University of California Davis) who is in Australia collaborating with Charles Sturt University (CSU) and SARDI to investigate the taxonomy and biology of diatrypaceous fungi associated with grapevine trunk diseases in New South Wales and South Australia (GWT 09/05) also attended the workshops. His presentation included an overview of the Californian wine industry and the impact of trunk diseases, followed by results from his own research and that of his colleagues in the plant pathology laboratory of Prof Doug Gubler (UC Davis). The information covered distribution, epidemiology and management of eutypa dieback and botryosphaeria canker, distribution of diatrypaceous species associated with trunk disease in SA and NSW based on research conducted in a previous visit to SARDI in 2008.

Mr Andrew Taylor (DAFWA) presented information from a survey he conducted in WA wine regions for botryosphaeria canker, which showed that the disease is widespread in WA with at least 5 different *Botryoshpaeria* species recorded. Dr Wayne Pitt (CSU) presented information on the distribution of *Botryosphaeria* species in NSW and SA along with management strategies which are being developed for prevention and control of the disease. It was noted that progress was being made towards identifying strategies which are effective for both eutypa dieback and botryosphaeria canker which will lead to recommendations for dual management of the two trunk diseases.

Copies of presentation slides are attached in appendices.

Whilst travelling between workshops and regions, the group, which included Dr Trevor Wicks (SARDI) visited several vineyards to discuss eutypa dieback, botryosphaeria canker and other grape disease management strategies with growers and look for vines displaying eutypa dieback foliar symptoms. Cordons and trunks were cut to expose any stained, wedge wood symptoms and samples were returned to SARDI for laboratory assessment.

5. RESULTS/DISCUSSION

Forty-five industry members attended the WA workshops; Swan Valley (10), Margaret River (22) and Great Southern (13). The number of attendees in Swan Valley and Margaret River was less than expected considering the number of vineyards in these regions. Promotion should be increased before future viticultural workshops are held and should include extra media coverage to ensure growers are informed well in advance.

The presentations were received well at workshops with much interactive discussion between attendees and the speakers (Figure 1). Copies of the presentation slides are attached as an appendix at the end of this report. The take-home messages from the workshop included:

- Eutypa dieback and Bot canker cause significant economic losses in grapevines worldwide, reportedly costing Californian growers US$260 million each year
- Both diseases are caused by fungal pathogens spread by airborne spores that enter pruning wounds, colonise and kill wood
- Symptoms of both diseases include wood cankers, dieback of arms and wedge-shaped staining in cross-sections of cordons and trunks
- Foliar symptoms only develop on vines with Eutypa dieback and include stunted shoots with yellowing leaves that are cupped with dead edges
- The fungi that cause Bot canker also rot berries
- Fungi associated with Bot canker have been isolated from grapevines in NSW, Vic, SA, WA and the NT
- Eutypa dieback has been reported in SA, Vic, NSW and Tas
- Alternative hosts for both diseases include a number of introduced plant species such as apricot, other stone and pome fruit, poplar, ash etc., however fungi associated with Bot canker can also be found on many Australian native species
- Cultural practices such as avoiding pruning during and immediately after rain, delaying pruning until late winter/early spring and removing dead wood from vineyard will reduce the likelihood of infection
- Pruning wounds can be protected using fungicides, paints or biocontrol agents
- Infected wood should be removed, wounds protected and vines renewed from water shoots

The group visited 17 vineyards in the three growing regions to look for symptoms of trunk diseases (Figure 2). No foliar symptoms of eutypa dieback were observed. Dieback and wedge shaped stained wood was present in all areas, particularly in older vines, suggesting that Botryosphaeria canker is widespread in WA which concurs with a previous survey by Andrew Taylor.

Investigation of fruiting bodies on dead grapevine wood collected in vineyards and isolation from cankers in wood identified the presence of species of *Bortryosphaeria*, *Eutypella* and *Cryptovalsa*.



Figure 1. Presenting information to attendees at the workshops in Swan Valley (A), Margaret River (B) and Great Southern (C) wine regions.



Figure 2. (A) Presenter group in Mt Barker, from left to right; Mark Sosnowski, Trevor Wicks, Andrew Taylor, Florent Trouillas, Wayne Pitt and Adrian Loschiavo, (B) Inspecting vines in Swan Valley and (C) A large pruning wound in Margaret River

6. OUTCOME/CONCLUSION

Workshops were delivered in three major wine regions of Western Australia and were well received by attendees. Growers showed increased confidence in their ability to recognise the symptoms of eutypa dieback and botryosphaeria canker and how to prevent or manage trunk diseases. As a result of these workshops, trunk diseases are less likely to reduce yield and productivity of vines in Western Australia.

The importance of acting early to manage trunk diseases in the relatively young wine industry of WA was highlighted by the severe impact these diseases have had in older regions around the world. Future research aims to identify pruning wound protectants effective against both Eutypa dieback and Botryosphaeria canker, improving methods of applying the wound protectants using commercial spray equipment, understanding the effect of environmental stress on susceptibility and potential resistance to trunk diseases.

Extension articles have been published in Grapegrowers and Vignerons, Australian and New Zealand Grapegrower and Winemaker, Australian viticulture and the WA Wine Industry Newsletter (see articles attached).

Future workshops highlighting the importance of trunk disease management have been requested by industry personnel and will ensure adoption of preventative strategies to maintain the competitiveness of the Western Australian wine industry in the production of high quality wine for the world market.

7. ACKNOWLEDGEMENTS

We would like to thank Keith Pekin (WIAWA) and Diana Fisher (DAFWA) for organising the workshops and growers and industry representatives for attending the workshops, for their interaction and enthusiasm and the local hospitality that was extended to the visiting presenters. Also thanks to the GWRDC for their investment into this project through the Regional Innovation and Technology Transfer program and to each of the presenters for their time and professional expertise.

8. REFERENCES

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9. BUDGET RECONCILIATION

Budget	**Funding approved by GWRDC**		**Actual Expenditure**
Air fares	$3,500		$3,140
Accommodation/meals	$3,900		$4,108
Vehicle hire	$1,000		$1,152
Field day organisation	$1,500		$1,500
Total	$9,900	**Total**	$9,900
GST	$990	**GST**	$990
Total funds requested from GWRDC	$10,890	**Total funds expended**	$10,890



Western Australia Grapevine Trunk Disease Workshops



This workshop series, funded by GWRDC, will provide members of the WA wine industry with the latest information on identification and management of eutypa dieback and botryosphaeria canker diseases of grapevine. It aims to better equip you to recognise symptoms of these diseases in your own vineyard and how to control them effectively.





Workshop program

9am	Welcome and Introduction	
9.15	Eutypa dieback - symptoms and identification	*Adrian Loschiavo - Scholefield Robinson*
9.45	Eutypa dieback - management	*Mark Sosnowski - SARDI*
10.15	Grapevine Trunk Diseases in California	*Florent Trouillas - Uni of California Davis*
10.45	Morning tea	
11.15	Botryosphaeria canker - WA situation	*Andrew Taylor - DAFWA*
11.45	Botryosphaeria canker - management	*Wayne Pitt - Charles Sturt Uni*
12.15	Vineyard demo, lunch & discussion	

Workshop locations

Swan Valley - Mon 2 Nov 2009
Jane Brook Estate, 229 Toodyay Road, Middle Swan

Margaret River - Wed 4 Nov 2009
Vasse Felix Winery, Cnr Caves Road & Harmans Road Sth, Cowaramup

Mt Barker – Fri 6 Nov 2009
West Cape Howe Winery, ex Goundry site ‘The Arts House’,
14923 Muirs Highway, Mt Barker

Registration

Bookings can be made by contacting

Diana Fisher - Ph: 9777 000 email: diana.fisher@agric.wa.gov.au

Andrew Taylor - andrew.taylor@agric.wa.gov.au

Keith Pekin - keith@winewa.asn.au

WINE INDUSTRY ASSOCIATION WESTERN AUSTRALIA

Scholefield Robinson HORTICULTURAL SERVICES

Department of Agriculture Government of Western Australia

gwrdc GRAPE AND WINE RESEARCH AND DEVELOPMENT CORPORATION

NATIONAL Wine & Grape INDUSTRY CENTRE

UCDAVIS UNIVERSITY OF CALIFORNIA

SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Identifying Eutypa Dieback

Adrian Loschiavo
Viticultural Consultant,
Scholefield Robinson Horticultural Services





Background

- Eutypa dieback caused by the slow growing fungus *Eutypa lata*
- Mostly found in areas with rainfall > 350 mm per annum
- Affects woody plants, especially trees
- Wide host range (88 species)
- Australian native species not identified



Eutypa dieback

Cherry (Prunus avium)



Eutypa dieback symptoms on a cherry tree



Apricot (Prunus armeniaca)



Eutypa dieback symptoms on an apricot tree

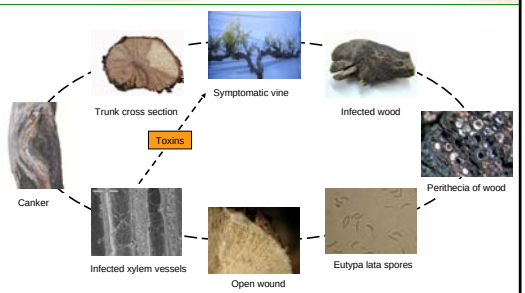


- Almond, apple and black currant also affected
- Pear, peach, olive, rose, fig, lemon, willow & poplar host *E. lata* but not affected

Eutypa dieback on grapevines

- Confirmed reports of eutypa dieback in SA, Vic, NSW and Tas
- Found through cool climate wine regions internationally
- No known resistance within genus *Vitis spp.*
- Symptoms expressed most readily in Grenache, Shiraz and Cab. Sauv.
- Can affect up to 100% of vines in some old premium red vineyards
- Imparts significant costs to industry
  - Australia - Shiraz alone cost growers $20M p.a. (Wicks & Davies 1999)
  - California - US$260 million p.a. (Siebert 2000)

Disease cycle



Foliar symptoms

Foliar symptoms include:

- Stunted shoots
- Chlorotic leaves
- Cupped leaves
- Necrotic leaf margins



Foliar symptoms



Foliar symptoms



Foliar symptoms



Foliar symptoms

Foliar symptoms:

- May be just one shoot
- Masked by healthy, neighboring foliage later in the season
- Most obvious in spring
- Shoots 30-70 cm



Foliar symptoms





Foliar symptoms



Foliar symptoms



Foliar symptoms



Similar foliar symptoms

Foliar symptoms may be confused with:

- Bud mite damage
- Salt stress
- Herbicide damage
- Frost injury



Bunch symptoms

Symptoms on inflorescence include:

- Inflorescence may not initiate
- Bunches may shrivel and drop off after flowering





Bunch symptoms

Bunch symptoms include:

- Smaller bunch size
- Uneven berry ripening



Wood symptoms

- Cankers along cordons or trunk
- Wedge of dead tissue in cross-section



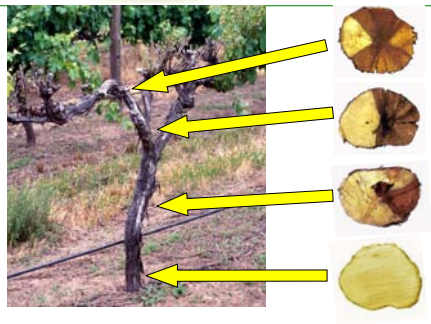


Wood symptoms





Disease progression



Disease progress

2001



2003



2001



2004





Contact details: Adrian Loschiavo
Scholefield Robinson Horticultural Services
adrian@srhs.com.au, 0421 480 747

Eutypa dieback Management





Eutypa dieback research program
1999-2009

SARDI
Mark Sosnowski
Adrian Loschiavo
Mette Creaser
Trevor Wicks

University of Adelaide
Richard Lardner
Sharmini John
Eileen Scott

Eutypa dieback management

1. Prevention
   - Wound protection



2. Control
   - Remedial surgery



Prevention

Pruning

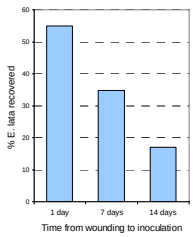




Prevention

Wound susceptibility to *Eutypa lata*
- up to 7 weeks from pruning





Wound protection

Factors to consider
- pruning time
  - rate of wound healing
  - sap flow







Wound protection

Factors to consider
- pruning time
  - rate of wound healing
  - sap flow
- size of wounds
  - rate of wound healing
  - surface area







Wound protection

Factors to consider

- pruning time
  - rate of wound healing
  - sap flow
- size of wounds
  - rate of wound healing
  - surface area
- age of wood
  - size of wound
  - number of wounds



Wound protection

Factors to consider

- pruning time
  - rate of wound healing
  - sap flow
- size of wounds
  - rate of wound healing
  - surface area
- age of wood
  - size of wound
  - number of wounds
- inoculum
  - rain / irrigation
  - alternative hosts
  - vineyard sanitation





Wound protection

History of wound protection

- Benomyl (Benlate®) most effective for wound protection
- Benlate® removed from market in 2002
- Carbendazim (Bavistin®) also effective - currently under review
- No registered fungicides in Australia
- Hand application





Aims of SARDI research

- Seek alternative wound protectants
- Evaluate products for registration
- Improve application methods

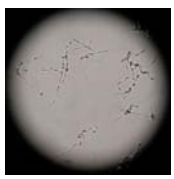


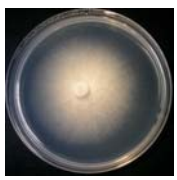
Wound protection

Laboratory evaluation

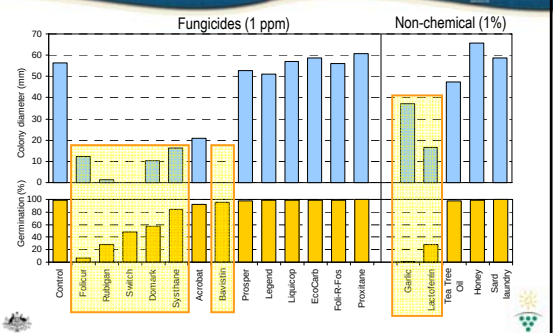
- Fungicides already registered for grapevines
- Spore germination
- Colony growth
- Enables rapid screening of many fungicides







Laboratory evaluation



Wound protection

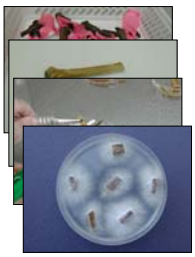
Field evaluation method



- Vines pruned (2 buds) in winter
- Pruning wound treatments applied with brush
- Wounds inoculated with a spore suspension

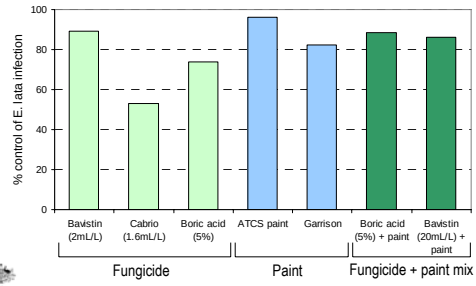
Wound protection

Field evaluation method

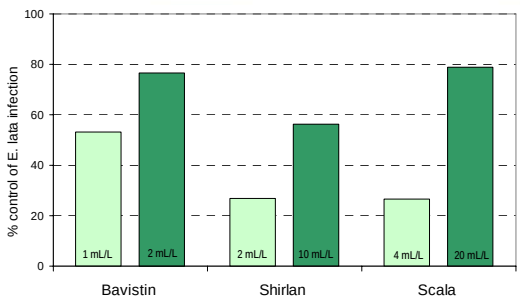


- Treated canes removed the following winter
- Bark removed and samples surface sterilised
- Samples cut into chips and placed on agar plates
- Incubated for 1 week and visually assessed for *E. lata*

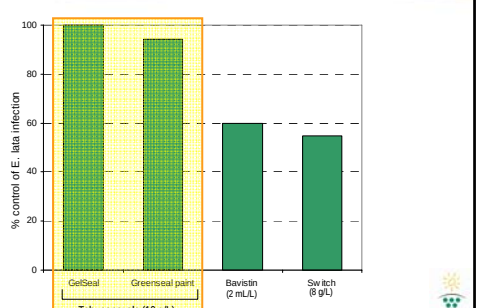
Field evaluation



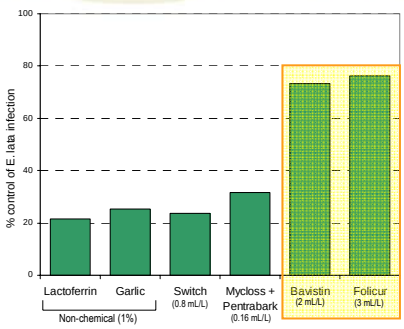
Field evaluation



Field evaluation



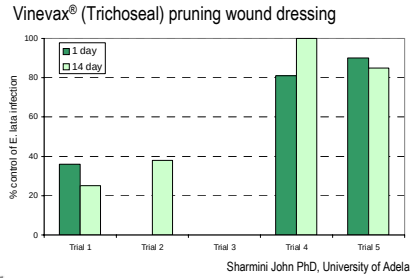
Field evaluation



Field evaluation

Trichoderma

Vinevax® (Trichoseal) pruning wound dressing



Sharmini John PhD, University of Adelaide

Summary of wound protection

Fungicides

- Bavistin® (carbendazim) ✓
- Folicur® (tebuconazole) ✓
- Scala® (pyrimethanil) ?
- Switch® (cyprodinil + fludioxonil) ?
- Cabrio® (pyraclostrobin) ?
- Shirlan® (fluazinam) ?

Paints & pastes

- Acrylic (ATCS) paint ✓
- Garrison® (cyproconazole + iodocarb) ✓
- Greenseal® (tebuconazole) ✓ (R)
- Gelseal (tebuconazole) ✓
- Biopaste (boric acid) USA only

Biocontrol

- Vinevax™ (*Trichoderma* sp.) ? (R)

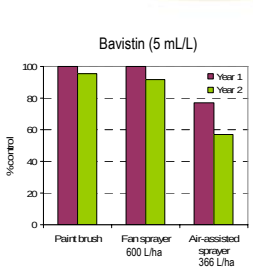
Eutypa dieback

Australian Government
Australian Pesticides and Veterinary Medicines Authority

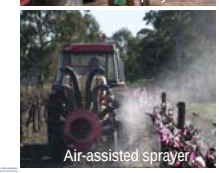
But if possible!

- Avoid rainfall
- Delay pruning
- Remove dead wood

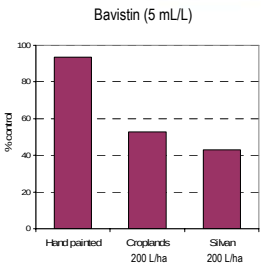
Improving application




SARDI fan sprayer


Air-assisted sprayer

Improving application




Silvan Turbomiser


Croplands Quantum mist

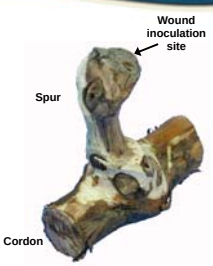
Control

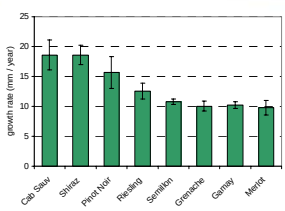






Disease progression





- Max stain progression - 50 mm/year
- Max beyond staining - 75 mm

Remedial surgery

- Cut out all vine wood infected by eutypa dieback (+ 10-20 cm)
- Infected wood removed and burnt or buried
- Vine stump to produce water shoot/s to replace missing vine





Low-cut

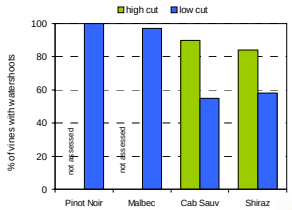


High-cut

Remedial surgery



Watershoot production
(1st season)

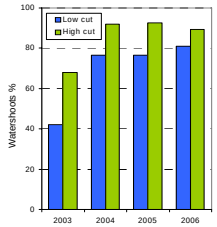


Remedial surgery

Water shoot production on Shiraz (1971 planting)

Remedial surgery conducted in winter 2003

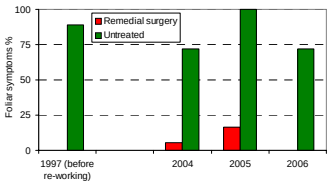




Remedial surgery

Low-cut

Remedial surgery compared with untreated vines Shiraz (1971)



Remedial surgery

High-cut



Low



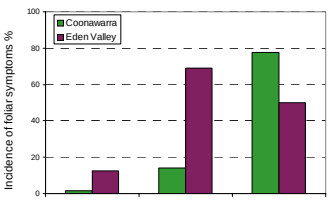
Mid



High

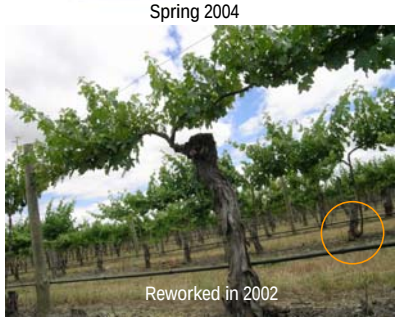
Remedial surgery

Foliar symptoms on Shiraz (1971) 4 years after remedial surgery



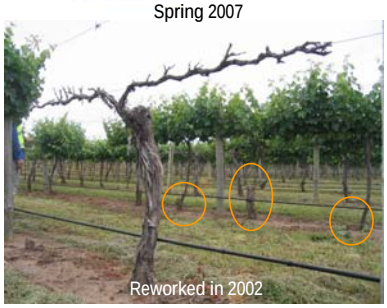
Remedial surgery

Spring 2004



Remedial surgery

Spring 2007



Remedial surgery



Summary

Eutypa dieback



Prevention
- Wound protection

Control
- Remedial surgery

Future
- Continue to develop wound protectants
- Improve application methods
- Determine effect of environmental stress
- Resistance

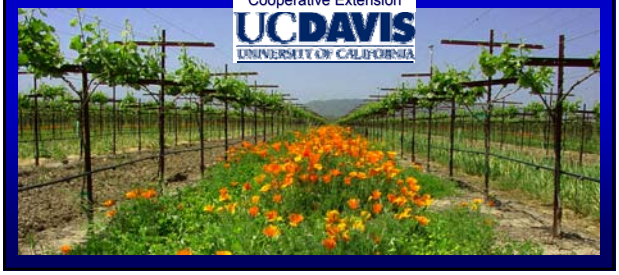
Acknowledgements

Special thank you to members of the eutypa dieback research team including technical staff, external collaborators and growers.

Grapevine canker diseases in California

F.P. Trouillas, J.R. Urbez-Torres and W.D. Gubler

University of California
Cooperative Extension
UCDAVIS
UNIVERSITY OF CALIFORNIA



CANKER DISEASES OF GRAPEVINE:

1 - Overview and generalities about California wine industry

2 - Eutypa dieback

3 - Bot canker

4 - Epidemiology

6 - Cultural practices to reduce infection

California wine regions







Facts about California wine industry



- California is America's top wine producer, making 90% of all U.S. wine.
- California is the fourth leading wine producer in the world behind the countries of France, Italy and Spain.
- California's high wine quality is tied directly to the state's ideal climate, topography, and soil for winegrapes, so the industry will always be based in California.
- California wine is world renowned with sales increasing every year since 1993 and accounting for two-thirds of all wine sales in the U.S.
- California's wineries are predominantly family owned and multi-generational.

Facts about California wine industry

California's Wine Industry Benefits the State and Nation

- Produces $51.8 billion in economic value for California.
- Generates $125.3 billion for the U.S. economy.
- Creates 309,000 jobs in California and a total 875,000 jobs nationwide.
- Pays $10.1 billion in wages in California and a total $25.2 billion nationwide.
- Makes $13 billion in state and federal tax payments.
- Attracts 19.7 million tourists annually to all regions of California.
- Generates wine-related tourism expenditures of $2 billion in California.
- Gives $115 million in annual charitable contributions from California wineries.

California Wine Industry Profile[1]

Number of Bonded Wineries	2687 Nearly all family-owned, up 233% from 807 wineries in 1990
Number of California Grape Growers	4,600
California Wine Sales to the U.S.	192 million cases in 2007 Up 21% from 136 million cases in 1990
Retail Value of California Wine in the U.S.	$18.9 billion in 2007
Share of U.S. Wine Market	63% by value Two out of three bottles sold in the U.S. are California wines
U.S. Wine Exports (95% from California)	$951 million winery revenues 2007 Up 394% from $127 million in 1990
	50 million cases to 125 countries Up 317% from 12 million cases in 1990
Winegrape Acres	527,000 Though vineyards cover less than 1% of the state's terrain
Tons Harvested of Winegrapes	3.2 million
Farm Gate Value of Winegrapes	$1.82 billion

Sources: [1] Wine Institute and MKF Research LLC.

- Grapevine trunk diseases

- One of the primary factors limiting vineyard longevity and productivity worldwide
- Increase considerable management costs
  - Cultural and chemical preventive measures
  - Removing diseased wood from the vine after infection
  - Re-train grapevines
  - Replacement of infected or death grapevines

- Grapevine Trunk Diseases in California

- Overall loss for wine grapes is estimated in

$260 million per year!!!

- Losses caused only by Eutypa dieback and Bot canker

(Siebert, J.B. 2001. Wines & Vines: 50-56)







Grapevine Trunk Diseases (GTD)

- Caused by fungal pathogens (Ascomycetes)
- Infect grapevines through wounds and openings
  - Most commonly through pruning wounds
  - Wounds caused by mechanical damage
- Symptoms include
  - Slow decline
  - Grapevine dieback
  - Eventual death of the plant

  } Interruption of xylem conductivity; Toxin production





Grapevine Trunk Diseases (GTD)

- **Eutypa dieback**
- **Botryosphaeria canker (Bot Canker)**
- **Esca - Black measles**





4 major groups of fungi involved with canker diseases

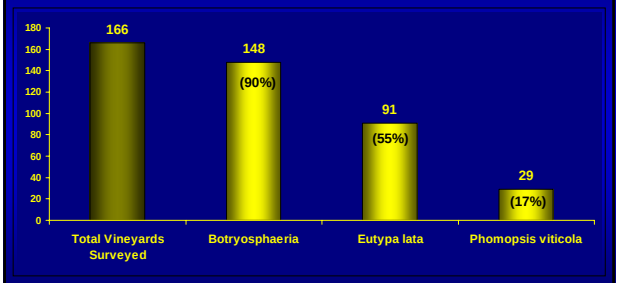
- *Eutypa* and Diatrypaceae spp (Eutypa dieback)

- Botryosphaeriaceae (Bot Canker)

- Togniniaceae (Esca disease – Young vine decline)
  - *Togninia*
  - *Phaeoacremonium*
  - *Phaeoamoniella*

Fungal pathogens associated with cankers in CA

Percentage of vineyards infected in California



Úrbez-Torres et al. 2006. Plant Dis. 90:1490-1502







1-Eutypa dieback of grapevine: Overview

- Perennial cankers in arms or trunk of grapevine
- Yield losses, Plant death
- Symptoms on vegetation: Stunted shoots, small leaves, dead arm dieback).

Eutypa dieback of Grapevine

Causal agent:

-*Eutypa lata* (Pers.: Fr.) L. R. Tul. & C. Tul., 1863 (Syn: *E. armeniacae* Hansford & Carter, 1957) (Ascomycota, *Diatrypaceae*)

Distribution:

-*E. Lata* is considered worldwide. The perithecia occur commonly where annual rainfall exceeds 600 mm. Unlikely to be found where rainfall is below 250 mm.

-Described from 88 hosts in 28 plants families. Mostly tree species, orchards and natural forests.



Stroma with perithecia on dead trunk





Ascospores Release

Disease cycle for Eutypa dieback



Fresh pruning wounds



Several Years After Infection



Canker

Where are the inoculum sources for *Eutypa lata* in California?









Stroma of *E. lata* on grape

Inoculum sources for *Eutypa lata*

Ramos et *al*, 1975, In phytopathology vol.65: 1364-1371

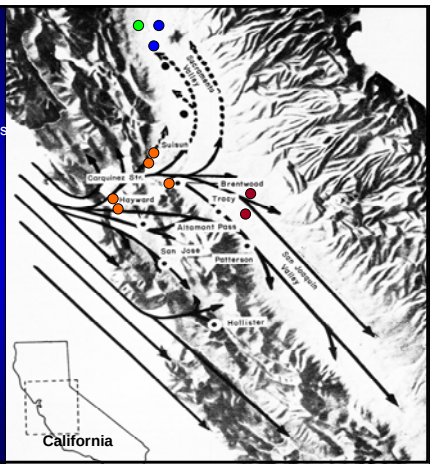
- Apricot trees in Solano and Contra Costa Counties as major sources of inoculum

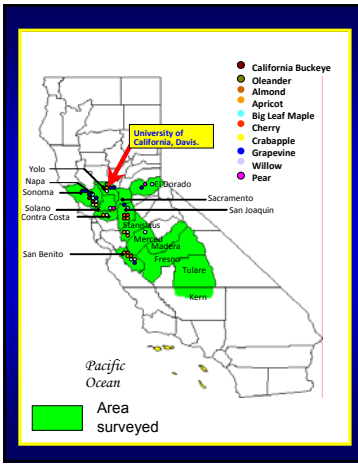
- No contribution of other crops or native plant species

Munkvold et *al*, 1994, In plant disease 78: 200-207

-More findings: Sacramento, San Joaquin, and Yolo Counties

- Apricot
- Cherry
- Grapevine
- Almond





Survey for *E. lata*:

Geographical distribution and host range of the perithecial stage of the pathogen *E. lata* in California.

Survey was realized in 2002. Areas represented in green color correspond to the areas that were visited.

Yearly average rainfall:

Tulare county = 266 mm
Kern county = 145 mm
Fresno county = 304 mm
Madera county = 304 mm

Host range of *Eutypa lata* in South Australia

- *Vitis vinifera*
- *Prunus* spp.
- *Schinus molle var. areira*
- *Ficus macrophylum*
- *Fraxinus angustifolia*
- *Ceanothus sp*
- *Populus nigra 'italica'*
- *Malus* sp.

Eutypa lata has not been observed on the native vegetation in Australia, however we found it on the naturalized vegetation: *Fraxinus angustifolia* (desert ash)

Spore trapping study







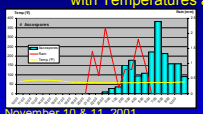
7 day recording volumetric spore trap

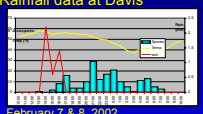
1 revolution in 7 days at 2 mm/hour.

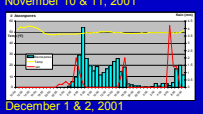
Spore count

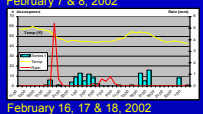
Spore Trapping Study

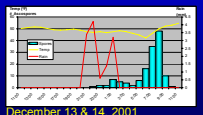
Number of *E. lata* ascospores trapped per hour superimposed with Temperatures and Rainfall data at Davis

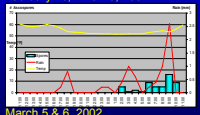

November 10 & 11, 2001


February 7 & 8, 2002


December 1 & 2, 2001


February 16, 17 & 18, 2002


December 13 & 14, 2001


March 5 & 6, 2002

Recommendation: Late Pruning


Colony of *Eutypa lata*


Conidia of *E. lata*

Importance of *E. lata*:

- For many years, *E. lata* was the major fungus associated with canker diseases in California (Eutypa dieback)

- Diagnosis was based mostly on colony morphology, conidial shape after reisolation of necrotic tissues in Agar medium


Ascospores of *E. lata*

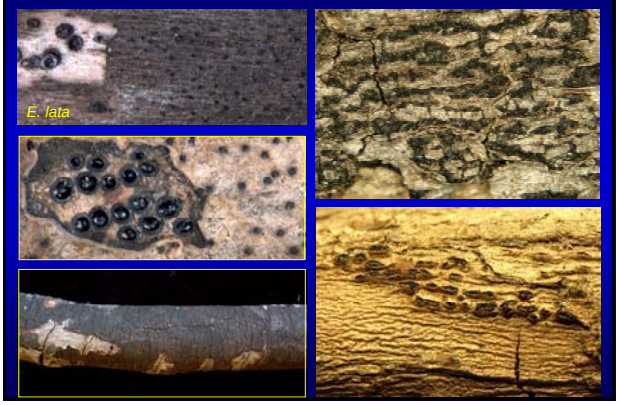
Diatrypaceous fungi in culture: Many species of Diatrypaceae were isolated from the margins of active cankers, or found as fruiting bodies on grapevine plants. No previous records or study on the occurrence and role of these fungi in vineyards

Colonies similar to *E. lata.*

Separation based on colony morphology only is impractical.



Separation based on morphology (Ex: Fruiting bodies)



Pathogenicity test of Diatrypaceous fungi in grapevine

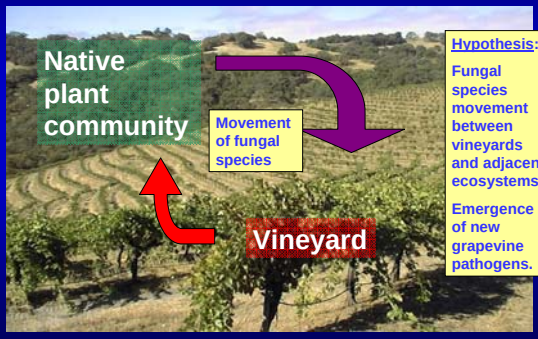


- Inoculation of green shoots during summer with 5 mm mycelium plug using a cork borer, incubation period 2.5 months.

Host range of these new pathogens in California

Vitis vinifera
Fraxinus latifolia
Sambuscus niger
Salix lasiolepsis
Prunus armeniaca
Juglans regia
Acer macrophylum
Umbellularia californica
Quercus sp

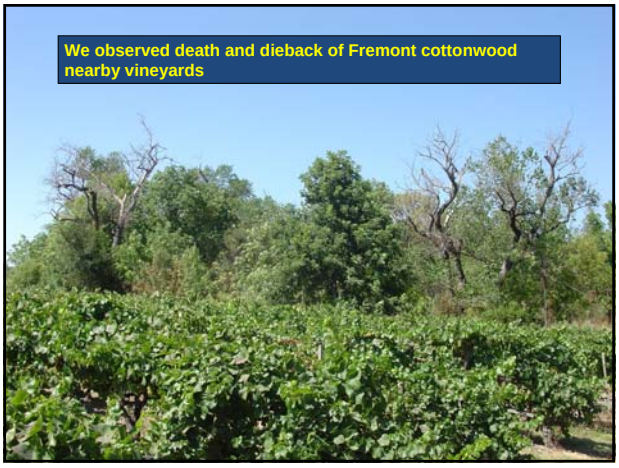
Study of fungal communities occurring in Natural Ecosystems nearby vineyards



Hypothesis:

Fungal species movement between vineyards and adjacent ecosystems:

Emergence of new grapevine pathogens.



Symptoms in the wood



Results of isolations



Constant isolation of one fungal species of Diatrypaceae from cottonwood cankers

Isolate UCD730 from grapevine canker

Signs and Symptoms of the disease occurring in California Fremont cottonwoods



Sexual fruiting bodies





Infection of heartwood and sapwood



Asexual fruiting bodies

Observations from NSW: the importance of Citrus trees as potential inoculum sources for grapevine pathogens





We isolate the same pathogen from diseased Citrus trees and from diseased grapevines

5 -Double pruning of grapevine:

a cultural practice to reduce Infection by *E. lata*.

E.A Weber, F.P. Trouillas and W.D. Gubler, Am. J. Enol. Vitic. 58:1 (2007)

Double pruning: Two passes through the vineyard, Pruning late / Pruning fast
-First pruning in November or December (tractor-mounted equipment)
-Final pruning in March (selective pruning)

Goal of our study: test the risk of spur infection using double pruning

-Grapevines were monthly pre-pruned 30 to 40 cm above spur position and inoculated with *E. lata* ascospore suspension from October to February, final pruning in March

-Attempt to recover *E. lata* from infected vines were made in March to:

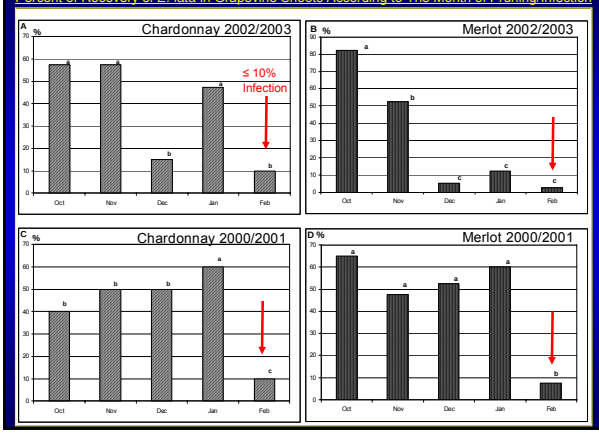
1- Estimate the susceptibility of grapevines at each pre-pruning time

2- Estimate downward distance of fungal colonization and risk of spur infection

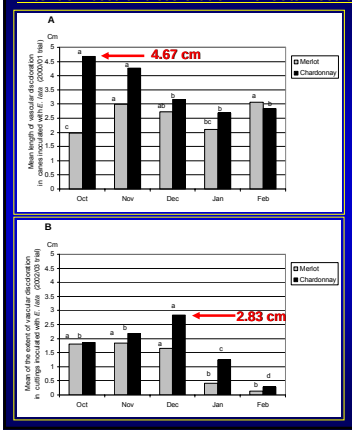
Final pruning (2 buds) late February - early March



Percent of Recovery of *E. lata* in Grapevine Shoots According to The Month of Pruning/Infection



Extent of vascular discoloration in shoots inoculated with *E. lata*



Maximum distance recovery was 4 cm below inoculation point

No risk of spur infection if canes were pre-pruned at 30 cm above the cordon

Double pruning should significantly reduce the risk of spur infection with *E. lata* and other diatrypaceous fungi

Bot canker of grapevine

"Bot Canker" has been largely overlooked on grapevines not only in California but worldwide

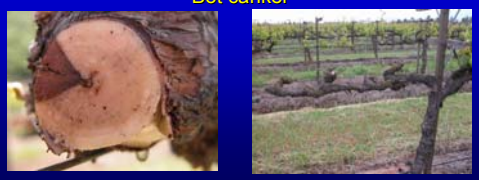
- *Eutypa lata* was thought to be the only canker-causing agent on grapes
- "Bot Canker" & "Eutypa dieback" vascular symptoms are undistinguishable
- Botryosphaeriaceae spp. thought to be secondary pathogens on grapes



Eutypa dieback



Bot canker



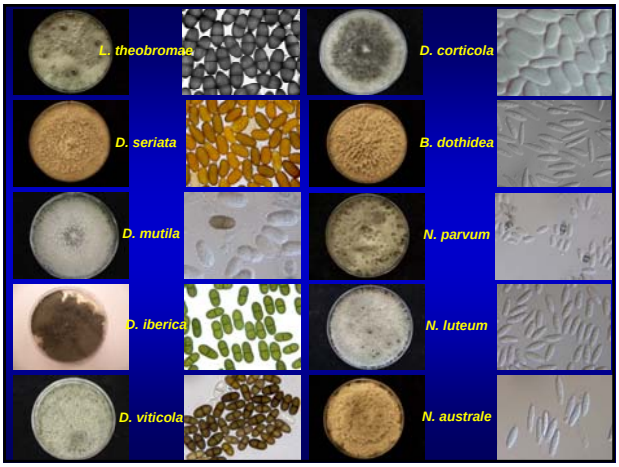
Identification of the causal agents

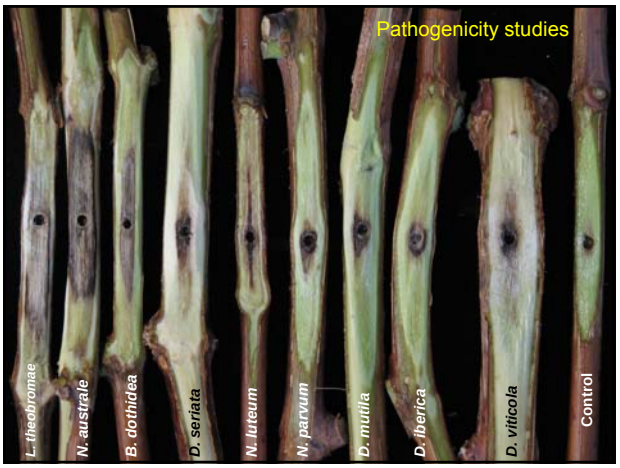


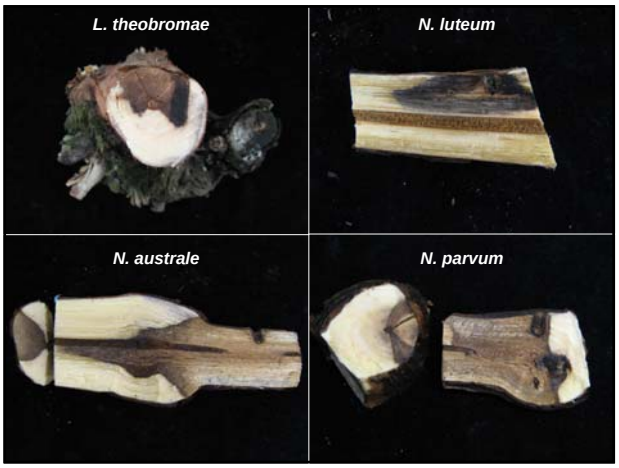




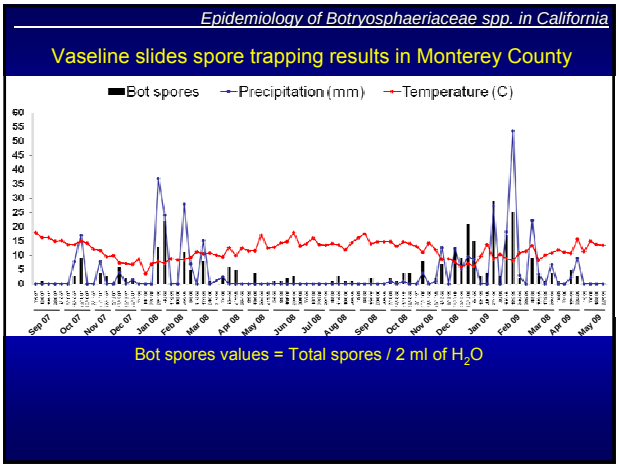
- 200 vineyards and over 1900 samples, 23 counties

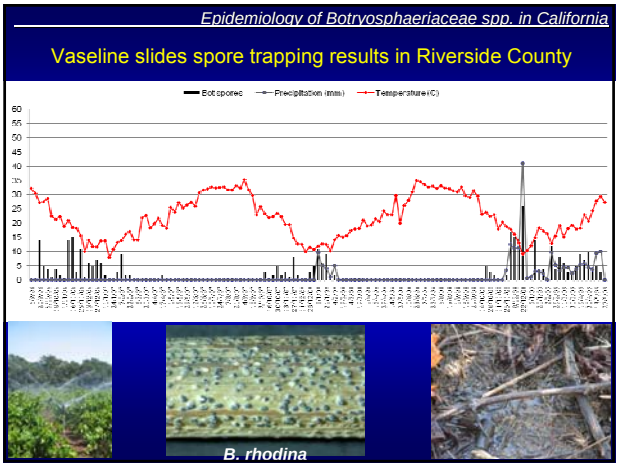


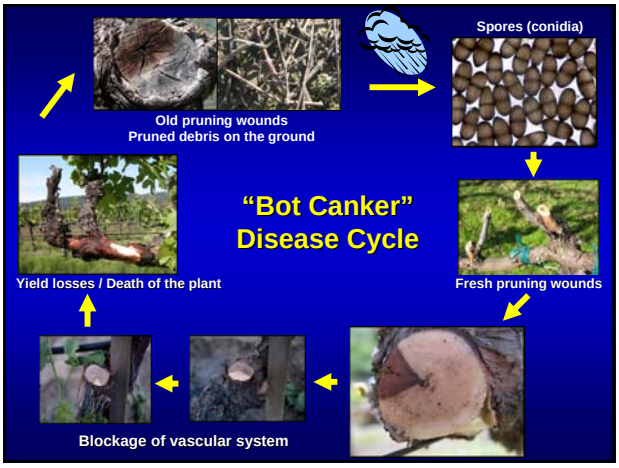

Pathogenicity studies
L. theobromae
N. australe
B. dothidea
D. seriata
N. luteum
N. parvum
D. mutila
D. iberica
D. viticola
Control


L. theobromae
N. luteum
N. australe
N. parvum


Epidemiology of Botryosphaeriaceae spp. in California
- Spore trapping studies
Mendocino
Sonoma
Napa
Colusa
San Joaquin
Monterey
San Luis Obispo
Riverside
Vaseline slides
Volumetric spore trap


Epidemiology of Botryosphaeriaceae spp. in California
Vaseline slides spore trapping results in Monterey County
Bot spores
Precipitation (mm)
Temperature (C)
Bot spores values = Total spores / 2 ml of H2O


Epidemiology of Botryosphaeriaceae spp. in California
Vaseline slides spore trapping results in Riverside County
B. rhodina


Spores (conidia)
Old pruning wounds
Pruned debris on the ground
"Bot Canker"
Disease Cycle
Yield losses / Death of the plant
Fresh pruning wounds
Blockage of vascular system

California bay laurel







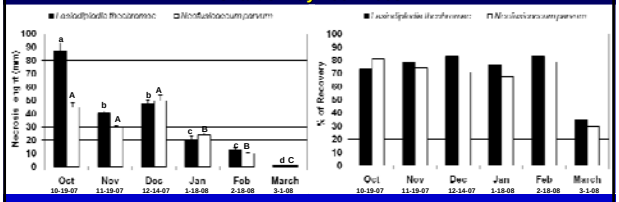
Phaeoacremonium inflatipes,
3 *Botryosphaeria* spp: *B. dothidea* (99% Max ident.), *B. sarmemtorum* (99% Max ident.), *Fusicoccum arbuti* (98% Max ident)
Eutypa leptoplaca, *Diatrype stigma*

5 -Double pruning of grapevine:

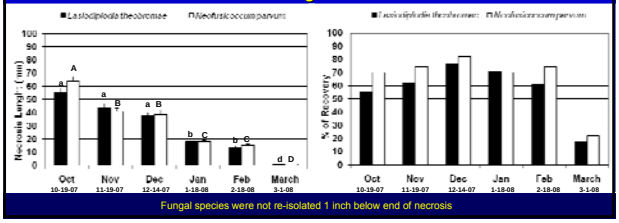
Reducing Infection by *Botryosphaeria* spp

Double pruning: Two passes through the vineyard, Pruning late / Pruning fast
-First pruning in November or December (tractor-mounted equipment)
-Final pruning in March (selective pruning)

Chardonnay 2007-2008



Cabernet Sauvignon 2007-2008



Fungal species were not re-isolated 1 inch below end of necrosis

Conclusion

-**Grapevine Trunk Diseases** constitute a severe challenge to the wine industry in California

-Great diversity of fungi in grapevine cankers and several of these are most likely occuring in natural ecosystems in California.

-They can now be separated from *E. lata* using morphology and phylogeny.

-Most of these fungi constitute opportunistic pathogens and participate in the dieback of grapevine.

Conclusion

- Species of Botryosphaeriaceae are the most prevalent fungi isolated from grapevine cankers in California

-10 Botryosphaeriaceae spp. associated with “Bot Canker” in CA

- All 10 Botryosphaeriaceae spp. are pathogenic on grapevines

- Knowledge of factors that favor spore release and consequently periods of high risk of infection in California: Late Pruning

- Double pruning has been shown to be effective in reducing infection by Eutypa and Botryosphaeriaceae spp.

Department of Agriculture and Food

GOVERNMENT OF WESTERN AUSTRALIA

Department of Agriculture and Food

Botryosphaeria: WA perspective

November 2009

Department of Agriculture and Food

WA perspective

- Little emphasis placed on trunk diseases in the past.
- Why? Small industry, concern centred at bunch rots.
- One record of *Eutypa armeniacae* in Perth in 1975.

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WA perspective

- Expansion occurred in the 1980's and 90's into the southwest.
- Majority of plantings were own rooted.
- As a young industry trunk disease problems were not noticed except young vine decline.

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Young vine decline

- Name used to describe a group of wood invading fungi.
- Can be misleading as the fungi can infect at a variety vine ages.
- Inconsistent reports that it was present throughout the southwest of WA.
- Generally vines will overcome this disease.

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Botryosphaeria

- Table grape expansion occurred into the Carnarvon region.
- Large losses began to occur as a result of *Lasiodiplodia theobromae*.
- One cultivar lost due to this disease.
- As a result it was decided to look at trunk diseases with wine grapes.

Botryosphaeria

- A survey was conducted in 2003.
- 16 vineyards were sampled for presence of trunk diseases.
- At the time we looked for symptoms based on Eutypa dieback.
- 10 of the vineyards returned a positive Botryosphaeria result (62.5%).
- Four species were recorded at the time:
  - *Lasiodiplodia theobromae (Botryosphaeria rhodina)*
  - *Neofusicoccum australe (Botryosphaeria australis)*
  - *Diplodia mutila (Botryosphaeria stevensii)*
  - *Diplodia seriata (Botryosphaeria obtusa)*
  - *Botryosphaeria viticola (new detection 2009) not on grapes*

Symptoms

- Variety of symptoms that look similar to those of Eutypa.
- Include bleached canes in winter.
- However there are no foliage symptoms associated with Botryosphaeria infections.





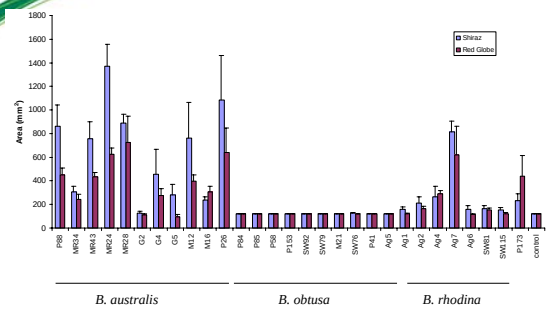








Pathogenicity



Bunch rot

- 2006/07 visited 24 vineyards in the southwest
- Surveyed between veraison and harvest.
- Botryosphaeria found in all regions.
- 60% incidence in the Swan Valley.
- Different species:
  - *Lasiodiplodia theobromae (Botryosphaeria rhodina)* Swan
  - *Neofusicoccum australe (Botryosphaeria australis)* Remainder







What we know

- Several *Botryosphaeria* species are present in WA vineyards.
- Present in all vineyards.
- Eutypa appears not as significant as in other states and at present not confirmed.
- *Phomopsis viticola* not confirmed.
- Differences in vine cultivar susceptibility exist.

What we know

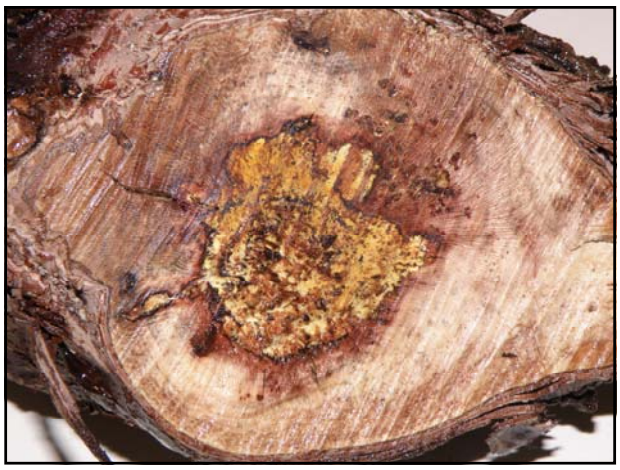
- We have some of the more aggressive species present.
- Occur on multiple hosts including native vegetation and other horticultural crops.
- Confirmed in WA from Eucalypts and other natives.
- As the industry gets older the problem may get worse.

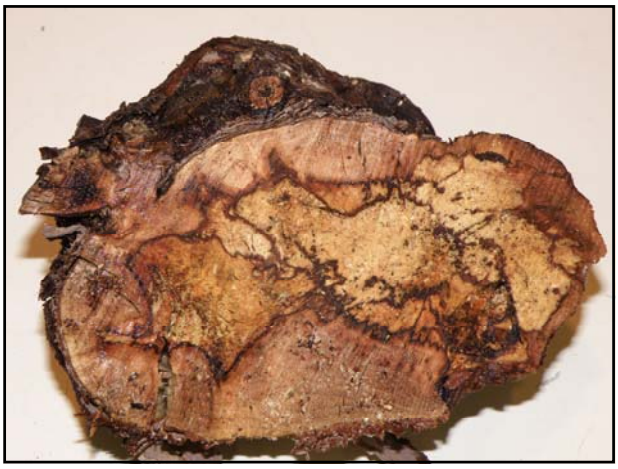
What we don't know

- Why some vines decline and others don't if Botryosphaeria is present in all vineyards.
- Whether the same fungus is causing both trunk disease and bunch rot.
- The significance of other horticultural crops and spread.
- Specific crop loss associated with Botryosphaeria.
- Other trunk diseases present in WA.

Other trunk diseases

- There has been what appears to be an increase in trunk diseases over the past few years.
- This may be the result of increased awareness and increase in age of plantings.







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Attendees at three Western Australian workshops received a wealth of information and strategies for reducing the effects of trunk diseases in vineyards.

Focus on trunk disease

A SERIES of workshops were held in Western Australia during the first week of November to increase awareness of grapevine trunk diseases and provide growers with information on disease management.

Funded by the Grape and Wine Research and Development Corporation, speakers travelled to the Swan Valley, Margaret River and Great Southern wine regions, presenting information on symptom identification, disease distribution and management of both eutypa dieback and bot (botryosphaeria) canker.

The speakers included Mark Sosnowski, of the South Australian Research and Development Institute, Scholefield Robinson Horticultural Services consultant Adrian Loschiavo, WA Department of Agriculture and Food representative Andrew Taylor, Wayne Pitt, from Charles Sturt University, and visiting University of California scientist Florent Trouillas.

Forty-five industry members attended the workshops.

Attendees received a wealth of information and strategies for reducing the effects of trunk diseases in vineyards.

Eutypa dieback and bot canker cause significant economic losses in grapevines worldwide, reportedly costing Californian growers $US260 million each year.

AT A GLANCE
- Industry experts collaborate
- Rapid disease response essential
- Evidence of bot canker found

The diseases are caused by fungal pathogens spread by airborne spores that enter pruning wounds, colonise and kill wood.

Symptoms of the diseases include wood cankers, dieback of arms and wedge-shaped staining in cross-sections of cordons and trunks.

Foliar symptoms only develop on vines with Eutypa dieback and include stunted shoots with yellowing leaves that are cupped with dead edges. The fungi that cause bot canker also rot berries

Fungi associated with bot canker have been isolated from grapevines in New South Wales, Victoria, SA, WA and the Northern Territory. Eutypa dieback has been reported in SA, Vic, NSW and Tasmaina. Alternative hosts for both diseases include a number of introduced plant species, however fungi associated with bot canker can also be found on many Australian native species.

Cultural practices, such as avoiding pruning during and immediately after rain, delaying pruning until late winter or spring and removing dead wood from vineyards will reduce the likelihood of infection.

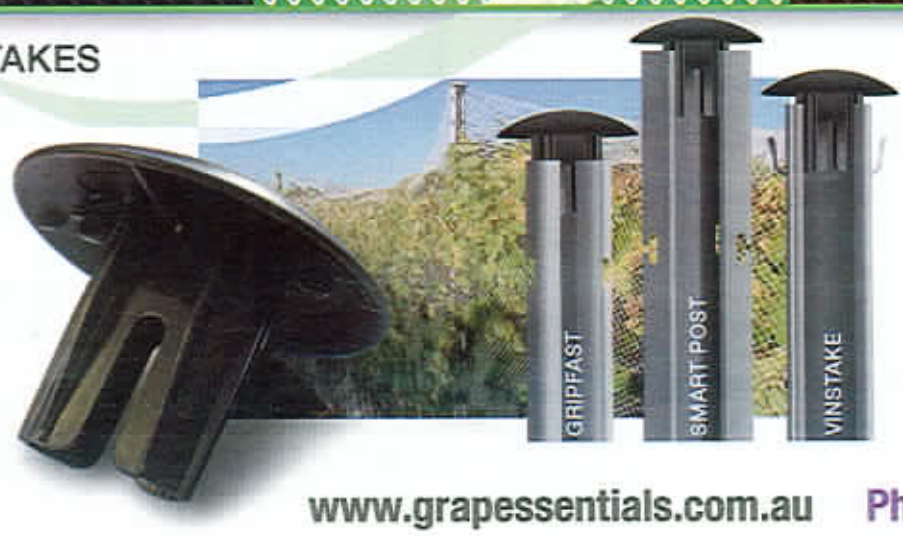
Pruning wounds can be protected using fungicides, paints or biocontrol agents. Infected wood should be removed, wounds protected and vines renewed from water shoots. The group visited 17 vineyards in the three growing regions to look for symptoms of trunk diseases. No foliar symptoms of eutypa dieback were observed. Dieback and wedge-shaped stained wood was present in all areas, particularly in older vines, suggesting that bot canker is widespread in WA which concurs with a previous survey.

The importance of acting early to manage trunk diseases in the relatively young wine industry of WA was highlighted by the severe impact these diseases have had in older regions around the world. Future research aims to identify pruning wound protectants effective against both eutypa dieback and bot canker, improving methods of applying the wound protectants using commercial spray equipment, understanding the effect of environmental stress on susceptibility and potential resistance to trunk diseases.

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Trunk disease workshops in WA

Andrew Taylor, Horticulture Pathologist, Bunbury and Dr Mark Sosnowski, Research Scientist South Australian Research and Development Institute

Recently, a series of workshops were held in WA, to increase awareness of grapevine trunk diseases and provide growers with information on disease management. Funded by GWRDC, the speaker group travelled to the Swan Valley, Margaret River and Great Southern wine regions. The presenters included Mark Sosnowski (South Australian Research and Development Institute), Adrian Loschiavo (Scholefield Robinson Horticultural Services), Andrew Taylor (Dept of Agriculture and Food WA), Wayne Pitt (Charles Sturt University, NSW) and visiting scientist Florent Trouillas (University of California Davis, USA) and are currently collaborating on research to develop strategies for the dual management of eutypa dieback and bot canker. Forty-five industry members attended the WA workshops which were held at Jane Brook, Vasse Felix and West Cape Howe wineries.



Eutypa canker

The talks focused on symptom identification, disease distribution and management of both eutypa dieback and botryosphaeria canker. Despite not officially being recorded in WA eutypa is present in several regions in SA, Vic, Tas and NSW. Symptoms of a eutypa infection include wedge shaped lesions in cross sections of cordons and arms, cankers on trunks, dieback of arms and characteristic symptoms of stunted shoots with cupped leaves and chlorotic margins. Eutypa dieback can be found on a number of hosts include apricots and apples but has yet to be recorded on eucalypts.

Botryosphaeria however, has been recorded in WA and is distributed widely amongst all growing regions. Different species occur in different locations based on the ability to withstand different temperatures and it is known that WA has two of the most aggressive species found on grapevines. Symptoms of Botryosphaeria are very similar to those of eutypa except there are no foliar symptoms. Therefore wedge shaped lesions, dead arms and cordons and cankers are all symptoms of a Botryosphaeria infection. Like eutypa dieback *Botryosphaeria species* have been recorded on a number of hosts including several native eucalypts in the south west of WA.

Due to the similarity between the symptoms of the two diseases it is difficult to differentiate without laboratory analysis. For correct identification it is best to send potential samples to accredited laboratories for diagnosis.

At present both diseases are considered to require the same management. Given spores of both fungi are released during, and for a short period of time after rainfall, it is recommended that no pruning occurs during rain events to prevent spores from landing on fresh pruning wounds. Also methods of double pruning have been investigated whereby a first pass is made over the vines in early winter, leaving canes approximately 30-40cm long, then when rain is less likely the pruning is finished. This procedure ensures that if any infection occurs during the most susceptible part of the season it is removed on the second pass of the pruning before entering the cordon.



Eutypa foliar symptoms

Pruning wounds should be protected with fungicides, paints or biocontrols so a physical barrier is present if spores do land on the open wounds. Pruning debris should be removed from the vineyard as this provides spore inoculum for the next season. If an infected plant is found and still alive, removing the infected wood and the next 10-20cm below the infected area before retraining a new water shoot has been successful in removing the infection.

A great deal of information on grapevine trunk rots has been discovered in recent years but more work in the area is required. Studies investigating fungicides that will be useful against both eutypa and bot canker are continuing as well research into spray

applications for pruning wound products. Areas of environmental stress on the influence and presence of trunk rots are also an area of interest as it appears that vines under stress are more susceptible to infection.



Botryosphaeria trunk infection



Wedge: Botryosphaeria infection

Good news for growers

Janis Hadley, Executive Manager, ChemCert WA

ChemCert WA has some good news for growers. The 2-day accreditation programme *"Risk Management in Pesticide Use"* is now an approved training course under the FarmReady Reimbursement Grants program. This means that eligible growers can claim up to $1500 per financial year to reimburse the cost of attending approved courses.

FarmReady, a part of the Australia's Farming Future initiative, is funded by the Department of Agriculture, Fisheries and Forestry. This program offers timely support to growers to assist them to raise their skills and competence to compete in markets with increasingly higher standards and expectations, and to deal with the impacts of climate change.

Under FarmReady, primary producers, their family and managerial workers (eg farm overseers) are eligible for the reimbursement of the course cost of $425 for Risk Management in Pesticide Use. To apply for FarmReady please go to www.farmready.gov.au where there are application forms and information on how to apply.

Growers need to send the form for pre-approval of the reimbursement to FarmReady at least 10 working days before the ChemCert WA course. After the course, growers use the claim form to apply for reimbursement. This form must be submitted within 30 days of the course conclusion.

For FarmReady queries please contact the FarmReady administrator on 1800 087 670.

ChemCert WA scheduled courses are available at www.chemcertwa.com.au. If you have a group interested in this training please contact us on Tel: 08) 9341 5325 and we'll organise a course in your area.

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ChemCert WA's "Risk Management in Pesticide Use" Course (2 days for accreditation) is now an approved training course under the FarmReady Reimbursement Grants programme. Eligible growers can claim up to $1500 per financial year to reimburse the cost of approved training.
Applications forms are at www.farmready.gov.au. Apply to FarmReady for pre-approval for reimbursement 10 working days prior to the "Risk Management in Pesticide Use" course.
ChemCert WA scheduled course details are at the website www.chemcertwa.com.au or get a group of at least 12 together in your area.

www.chemcertwa.com.au 08 9341 5325 farmcarewa@bigpond.com