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Trunk Health of New Zealand Vineyards

Mundy DCM

June 2010

A report prepared for:

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Mundy DCM
Plant & Food Research, Marlborough

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Date: 22 Jun 2010

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Date: 22 June 2010

Sustainable Farming Fund
Ministry of Agriculture and Forestry
Te Manatū Ahuwhenua, Ngāherehere

Final Report

Project Title:	Trunk Health of New Zealand Vineyards
Project Number:	07/068
Date of Report:	June 2010

Note: The Final Report is due in the SFF Office within two months after the project completion date.

If any material supplied in, or attached to, this report contains confidential information, or is otherwise unsuitable for wider dissemination, please clearly mark accordingly and highlight directly with your Project Adviser (including the reason for wishing to treat the material in this manner).

We have a paper in draft form in the appendix and the three student reports which are confidential until published. These are all marked in the text headings.

This information from Sections 2 – 5 and Section 11 will be published on the SFF website unless you advise us otherwise.

1. Milestone Summary Table

Milestone Number	Milestone [As per SFF contract schedule]	Completion Date Original	Completion Date Actual	Percent Complete
1	Selection of experimental and demonstration sites for monitoring rate of expression over time, and for studies on infection pathways established	September 2007	October 2007	100
2	Field survey of New Zealand vineyards, awareness workshops, poster publication and sampling from infection pathways site	December 2007	June 2008	100
3	Year 1 project report submitted Progress report of industry-funded PhD students	June 2008	June 2008	100
4	Identification of species collected during field survey completed Disease expression data for second season collected Findings presented at the	September 2008	October 2008	100

	international workshop on grapevine trunk diseases in Italy 2008, with review of management tools used in other countries presented at the conference, for use in New Zealand			
5	Relative importance of major pathogens (*Botryosphaeria, Eutypa, Phomopsis*) in different climatic zones established Second-year sampling from pathways demonstration site completed Year one of Infection of pruning wounds over time completed	December 2008	February 2009	100
6	End of year two reporting Progress report of industry-funded PhD students	June 2009	June 2009	100
7	Complete the collection of expression data allowing the calculated cost to industry to start	September 2009	November 2009	100
8	Completion of the second season of infection pruning wounds demonstration	December 2009	December 2009	100
9	Complete the calculated cost to industry and provide spreadsheet-based tool for growers to decide if vines need replacing	March 2010	March 2010	100
	Progress report of industry-funded PhD students			
10	Completion of regional workshops, with research findings presented to growers and recommendations for managing vineyard vine health	June 2010	June 2010	100

2. Project Objectives

Aims of the project

1. To increase grower knowledge of trunk diseases in New Zealand
2. To provide tools for actively managing trunk diseases in each region
3. To increase the use of wound dressings and other management options
4. To provide demonstrations and fact sheets on vine surgery to prolong vine life
5. To provide economic data for growers, to allow financial decisions to be made on vine replacement

3. Approach

We conducted a national survey of vineyards for diseases while conducting research to allow the production of fact sheets for growers. We started the project with talks to growers in the main regions and visiting vineyards to determine how vineyards were currently managed. The science team also interacted with researchers in other wine-growing regions of the world to learn about which methods had been successful in other countries. The focus of all of the work was to produce a set of fact sheets which meet the aims of the project where possible, or to provide web-based information that growers could access to meet the five aims of the project.

4. What were the main findings from this project?

Vineyards in Auckland, Gisborne, Hawke's Bay, Nelson, Marlborough and Canterbury were surveyed. The incidence of species of *Botryosphaeria, Phaeomoniella* and *Eutypa* in many of the vineyard blocks surveyed suggests that these fungi should be the focus of more detailed research to establish their importance to the industry. Growers need to have a better knowledge of these fungi in order to recognise disease symptoms and to plan management strategies. The correct identification of the cause of the disease is important for making management decisions.

When we studied the rates of deaths of vines in infected blocks we were able to provide growers with some valid data to use when estimating future costs of vine death. Using the information collected on the rate of vine deaths in infected blocks and calculating the cost of vine replacement and crop loss from not replacing vines in the calculation spreadsheet, we have provided a tool which allows the vineyard manager to calculate, for a future date, whether it would be economic to replace vines or not. Growers who had not been able to do such a calculation previously appreciated having a system in which they could enter their own data and calculate the potential costs without having to worry about the details of the mathematics

Feedback received during the project suggests that in many cases growers have access to some information but they are looking for easy methods to access more details when they have a question or encounter a new problem. They want to be able to have the results of research presented in simple terms that allow them to decide what to do next for their vineyard. Sometimes that may simply be the reassurance that what they are already doing is the best that they can do.

5. What difference has this project made to your group / community of interest / industry?

(Include intangible benefits where significant — e.g. "enabled us to develop a strong on-going working relationship with the scientists").

1. More growers are aware of trunk diseases generally and particularly which trunk diseases are prevalent in the district where they grow grapes.
2. Growers now have access to information that enables them to identify which diseases are present and to calculate the extent of losses that might be incurred over the next ten years.
3. The research team is now investigating the role of stress on plants for disease expression following questions that arose during the project.

4. The research team have received requests for information from other grape-growing regions around the world interested in what New Zealand growers are doing to manage grapevine trunk diseases.
5. The promulgation of information from this project has helped to establish the Marlborough Wine Research Centre as site for national (and not just regional research) in the minds of growers.

6. If you did the project again what would you do differently?

It was very important to speak to as many regional groups as possible early in the project to generate buy-in and involvement. Making contact with the right person in each region was important and the contacts of all of the committee members (both industry and science representatives) were important when visiting regions were the science team was not based. Passing of information by word of mouth was very important as growers do not always want to stand up at a meeting and say they have a problem with trunk diseases.

If we did the project again, a database recording names and contact details of people who had an interest in the project would have been helpful so that we could have sent newsletter updates following each SFF report to interested stakeholders. Something as simple as emailing a copy of the relevant information on the SFF website blurb to stakeholders has helped to keep the project current in the minds of industry people.

Trying to organise regional presentations to grower groups and set dates for these talks was more time consuming than we had expected. If we did a large project like this again, we would consider alternatives such as providing to growers access to presentations on a website (such as NZ Winegrowers currently do with Grape Day presentations). People who visit the site could register to be updated on the project.

7. Is there anything the SFF could have done differently?

SFF show a good understanding of how sometimes presentation dates have to be changed due to seasonal factors. The continued contact with the SFF staff during the project has really helped us manage the project and we would suggest that SFF continue to have the same active role in the projects. The presence of SFF staff at field days and seminars is extremely valuable as it conveys to the industry members just how important the relationship between SFF and the project teams is.

8. Is there anything that you have learnt that would be useful for new project teams?

The plans that one makes a year before the start the project need to be flexible as one often cannot predict all of the changes that may occur during a three-year project. Good communication with the research providers and management team is important and changes should be discussed as soon as possible with SFF. Things will change and you need to be able to respond and make the most of these changes.

9. Where to from here – what are the next steps?

1. The results of the disease survey will be presented as a poster at the 14th Australian Wine Industry Technical Conference, July 2010.
2. The Central Otago growers will have a presentation on the project on July 16 in conjunction with of the young Viticulturalist of the year day.
3. Results from the project will be presented in a Trunk Disease Workshop on Friday 27 August at the Romeo Bragato conference
4. A paper on the common trunk diseases in New Zealand will be presented at the New Zealand Plant Protection conference in August 2010 and the paper will be available to growers to download within two months of the conference via the trunk disease website.
5. The Marlborough Wine Research Centre trust will continue to support and update the trunk disease website that was set up as part of this project.
6. The New Zealand Foundation for Research, Science and Technology (Contract CO6X0810) project started during this SFF project. The FoRST funded experiments have been designed to answer some of the questions which were outside the scope of the SFF project. The results of this underpinning, research conducted by Plant & Food Research will be released to the wine industry via the SFF project where they are relevant to the grower needs. The continued release of these results will be via the Marlborough Research Centre Trust website and annual report.
7. The new SFF project of disease expression under stress will build on knowledge from this project and provide a continued interaction with interested stakeholders

10. Financial summary

Provide a brief comment as to whether the project was completed on budget; whether there is any grant money left unspent. Please provide a financial statement to summarise the incomings/ outgoings over the life of the project – you can either attach a copy of your own financial statement or use the "final financial template" available at our website http://www.maf.govt.nz/sff/forms/index.htm

11. List and attach any major outputs from the project.

Examples could include:

- Appendix 1 Scientific reports

1. Mundy D, Cocchi C 2007. An evaluation of the impact of grapevine trunk disease on fruit quality and vine performance in the Marlborough region, New Zealand. 13th Australian Wine Industry Technical Conference, 28 July - 2 August 2007, Adelaide, South Australia. Pp. 79. (Information and Abstracts / Poster Abstract.)
2. Mundy DC, Manning MA 2007. Vascular disease of grapevines in Marlborough, New Zealand. 16th Biennial Australasian Plant Pathology Society Conference in conjunction with the 9th Annual Australasian Mycological Society Meeting Back to Basics :Managing Plant Disease, 24-27 September 2007, Adelaide. Pp. 206. (Conference Handbook: Poster Abstract.)

3. M. A. Manning, D.C. Mundy. Fungi associated with grape vine trunk disease in established vineyards in New Zealand. 6th International Workshop on Grapevine Trunk Diseases September 2008, Florence Italy.
4. D.C. Mundy, V. Raw and C. Cocchi. An evaluation of the impact of grapevine trunk disease on fruit quality and vine performance in the Marlborough region, New Zealand. Romeo Bragato conference, Christchurch, August 2008.
5. D.C. Mundy, M.A. Manning. Vascular disease of grapevines in Marlborough, New Zealand. Romeo Bragato conference, Christchurch, August 2008.
6. D. C. Mundy, V. Raw, M. A. Manning. Preliminary results of grapevine trunk disease monitoring in two vineyards in Marlborough, New Zealand. 6th International Workshop on Grapevine Trunk Diseases September 2008, Florence Italy.
7. Mundy DC, Casonato SG, Manning MA 2009a. Incidence of fungi isolated from grape trunks in New Zealand vineyards. The Australasian Plant Pathology Society 2009, Newcastle City, NSW Australia. Pp. 86.
8. Mundy DC, Casonato SG, Manning MA 2009b. Sampling techniques for isolating trunk disease fungi from a Nelson vineyard. New Zealand Plant Protection 62: 406.
9. D.C. Mundy, M.A. Manning. Ecology and management of grapevine trunk diseases in New Zealand: a review .New Zealand Plant protection Journal 63 (in press and hence confidential)

- Appendix 2 Student reports (confidential so that students may publish results and complete studies)

1. Student report 1
2. Student report 2
3. Student report 3

- Appendix 3 Fact sheets and

1. Grapevine trunk diseases in older New Zealand vines
2. Identification of bleached canes and other diseases at pruning
3. Phomopsis stem and leaf spot
4. Effects of trunk disease on crop quality
5. Retrunking of old vines
6. Fungi associated with trunk diseases in the New Zealand wine-growing regions
7. *Phaeoacremonium* spp. In New Zealand vineyards
8. Vineyard hygiene and prevention of trunk diseases

- Appendix 4 Popular articles
    1. Mundy DC, Manning MA 2007. Survey and isolation of fungi from Marlborough grapevines. Australian & New Zealand Grapegrower & Winemaker 525(October): 50-51, 53.
    2. Mundy D 2008. Taking our research to the world. Winepress 176(November): 16-17.

- Industry Presentation
    1. On 20 November' 2007 Dion Mundy gave two presentations in Hawke's Bay titled "Results of an initial investigation of grapevine trunk health in Marlborough" and "Introduction to the Trunk health of the New Zealand vineyard".
    2. On 26 November' 2007 Dion Mundy gave two presentations in Marlborough titled "Results of an initial investigation of grapevine trunk health in Marlborough" and "Introduction to the Trunk health of the New Zealand vineyard".
    3. On 27 May 2008 Dion Mundy gave two presentations in Nelson titled "Results of an initial investigation of grapevine trunk health in Marlborough" and "Introduction to the Trunk health of the New Zealand vineyard". Dion also spent the following day visiting grower blocks and discussing management options with growers that had attended the workshop.
    4. On 29 May 2008 Dion Mundy gave three presentations in Gisborne titled "Results of an initial investigation of grapevine trunk health in Marlborough", "Introduction to the Trunk health of the New Zealand vineyard" and "Basic biology of grape vine trunk diseases". Dion also spent the following day visiting grower blocks, collecting samples and discussing management options with growers that had attended the workshop.
    5. June 21 2008 2010 Marlene Jaspers and Dion Mundy gave a presentation to Canterbury grape growers about the SFF trunk disease project
    6. On 4 June 2010 Dion Mundy gave a presentation to Nelson grape growers on the results of the Trunk Health of New Zealand Vineyards
    7. On 21 June 2010 Marlene Jaspers and Dion Mundy gave a presentation to Marlborough grape growers on the results of the Trunk Health of New Zealand Vineyards and related student projects
    8. On 25 June 2010 Dion Mundy gave a presentation to Hawke's Bay grape growers on the results of the Trunk Health of New Zealand Vineyards

- Other Publications
    1. Trunk disease section on Marlborough Wine Research Centre website http://www.wineresearch.org.nz/publications/MarlboroughTrunkDiseaseWeb.htm
    2. Web-based replant calculation sheet.

3. As part of Dion Mundy's visit to Bologna University, he presented a talk to growers and researchers on trunk diseases in New Zealand. His talk included detailed discussion of how Industry (New Zealand Winegrowers and Marlborough Wine Research Centre), Government (in the form of MAF SFF) and researchers (HortResearch and Lincoln University) are working in a proactive manner to provide solutions and positive outcomes before grapevine trunk disease problems grow to the size that they have in Italy.

- Dion Mundy presented a seminar **Grapevine trunk diseases in New Zealand**. Experimental station of Tebano, Italy. 8th September 2008

If appropriate, we would like to publish a copy of the above on our website: please provide an electronic copy for this purpose preferably in Word format.

Report Confirmation

Name [Project Manager]	Confirmation	Date
	I hereby confirm the above information is true and correct:	

Submission Note - By the due dates Final Reports should be sent:

1. Electronically to the SFF Process Coordinator **and** copy/cc. your Project Adviser (usually in the same e-mail as the final Request for Payment (R4P) form).

Please ensure you put your project number in the e-mail's subject line:
e.g., 06/999 Final report 2007.

2. In hardcopy, together with any associated attachments, to **both** the Process Coordinator **and** your Project Adviser.

Appendix 25

Science publications

Abstracts for the 6th International Workshop on Grapevine Trunk Disease (6th IWGTD) in Italy

Fungi associated with grape vine trunk disease in established vineyards in New Zealand

M. A. MANNING[1] and D. C. MUNDY[2]

[1]The Horticulture and Food Institute of New Zealand Limited, Mt Albert Research Centre, Private Bag 92169, Auckland, New Zealand. [2]The Horticulture and Food Institute of New Zealand Limited, Marlborough Wine Research Centre, P.O. Box 845, Blenheim, New Zealand.

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Twenty-three-year-old Cabernet Sauvignon grapevines vines removed from a vineyard in the Marlborough region of New Zealand in 2006 were observed to have fungal decay symptoms. A survey was begun in 2007 to find out how widespread these symptoms are in other New Zealand vineyards and to identify the various fungi associated with grapevine trunks. Forty vineyards, most over 10 years old, were selected from the major grape-growing regions of New Zealand for the study. Wood tissue was sampled using a Mattson corer from five vines on each vineyard block. Core samples were observed to be either non-symptomatic or had a range of symptoms including red/brown staining. The fungi most frequently isolated from grape wood tissue were *Botrtyosphaeria lutea*, *B. parva*, *B. obtusa*, *Eutypa lata*, *Eutypella vitis*, *Phaeomoniella chlamydospora*, *Cylindrocarpon destructans*, *C. liriodendron* and *Phomopsis viticola*. Fungi isolated less frequently included *Cadophora luteo-olivacea*, *Ca. mellinii*, *Phaeoacremonium rubrigenum*, and *P. aleophylum*. These fungal species included many of the fungi commonly reported from other grape-growing countries. We discuss the incidence of disease and the distribution of fungal species associated with grapevines in the various wine-producing regions of New Zealand.

Preliminary results of grapevine trunk disease monitoring in two vineyards in Marlborough, New Zealand

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The New Zealand wine industry has been expanding since 1993 and has grown to become New Zealand's second largest horticultural export crop by value. With the investment made in planting grapes into new regions and the expansion within established growing areas, vineyard managers want to know how to ensure long-term sustainable production. A Sauvignon blanc and a Riesling vineyard were chosen in the Marlborough district to monitor trunk disease development and to provide information on the potential for control. Our results are from the first three years of a five-year programme. At the Riesling site, 1870 vines were mapped. In summer 2006, 8.3% of these vines were dead. By the summer of 2008, the proportion of dead vines had increased to 9.8%. At the Sauvignon blanc site, where 3772 vines were surveyed, the percentage of dead vines was lower than the Riesling site in 2006, with only 0.9% dead. By 2008, the proportion of dead vines at that site had increased to 2.8%. The two fungi most commonly isolated from those two sites were *Botryosphaeria* spp. and *Eutypa lata*. Regardless of which fungi are killing the vines, the loss of vines is reducing productivity for the grower, and replacement vines take time to restore full production. The rate of vine death will be used to develop an initial model of the potential economic impact of trunk disease fungi.

An evaluation of the impact of grapevine trunk disease on fruit quality and vine performance in the Marlborough region, New Zealand

D.C. Mundy[1], V. Raw[1] and C. Cocchi[2]

[1]The Horticulture and Food Research Institute of New Zealand Limited, Marlborough Wine Research Centre, PO Box 845, Blenheim, New Zealand.

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Abstract

Grapevine longevity is one of the major research themes in the New Zealand Winegrowers' Research & Development Plan 2005. In the plan, the two issues of concern are infection of grapevines by virus and trunk diseases. Grapevine trunk diseases are starting to appear in the Marlborough region. Visual symptoms of vascular diseases can be seen in some of the older vineyards where vines are fifteen years or older. In order for growers to manage vineyards containing vines with trunk diseases, they need information on the impact of the trunk fungi on the fruit quality, vine productivity and overall profitability.

An evaluation of vines with and without visual symptoms of trunk disease was conducted in two varieties (Sauvignon blanc and Riesling) by following changes in fruit composition during ripening and at harvest.

During ripening, soluble solids for the Sauvignon blanc fruit were consistently lower by 0.5 – 1.0 °Brix for vines that had visual trunk disease symptoms compared with vines without visual trunk disease symptoms. Differences in soluble solids were less consistent in the ripening Riesling fruit. The reduction in soluble solids is consistent with reports for grapes with other vascular disorders, such as leaf roll virus, and indicates that the diseases are having an impact on the fruit composition.

Sub-optimal fruit composition caused by trunk diseases will lower wine quality. This problem will compound as an increasing number of vineyards reach the critical age and it may have significant economic impact on the New Zealand wine industry in the longer term.

First published in the proceedings of The 13th Australian Wine Industry Technical Conference, 2007, page 327.

Republished in Romeo Bragato conference proceeding 2008

VASCULAR DISEASE OF GRAPEVINES IN MARLBOROUGH, NEW ZEALAND

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[B]The Horticulture and Food Research Institute of New Zealand Limited, Private Bag 92 169, Mt Albert, Auckland, New Zealand

INTRODUCTION

The Marlborough vineyard planted area has developed very quickly from 1,900 ha in 1992 to an estimated 18,500 in 2007. While the majority of the vines in the district are less than 15 years old concerns have started to arise as older plantings in the district show symptoms of vascular diseases (1). Due to the young nature of the industry in the district no systematic investigation of the fungi present in the older vines has been under taken.

Most vines in Marlborough are pruned to four canes and vertically positioned in the canopy so that symptoms associated with dead arm or die back are not normally observed. For some growers the first sign that they have a trunk disease problem is when vines start to die.

Previous investigations of nursery stocks of vines in New Zealand (2, 3) and in Marlborough (4) have been published but the current investigation is the first survey establishing which fungi are present in vines in the district.

MATERIALS AND METHODS

In spring 2006 vineyards were assessed for the presence of vines with reduced vigour. Samples were collected from vines with and without visual symptoms at three vineyards in Marlborough.

Internal trunk samples were collected using a 5mm diameter core sample. Samples of core tissue were plated onto PDA and the resultant fungi identified.

RESULTS

Table 1 lists the fungi isolated from vines with symptoms and vines without visual symptoms at two Riesling blocks and a Sauvignon blanc block.

Table 1. Fungi isolated from vines with symptoms (Sick) and vines without visual symptoms (Healthy) of trunk disease

	Bot.	Cyl.	Eut.	Pho.	Bas.
Riesling 1					
Sick (n=5)	5				
Healthy (n=5)	3				1
Riesling 2					

Sick (n=10)	3		4		1
Healthy (n=10)	2				
Sauvignon blanc 1					
Sick (n=10)	3		5	2	2
Healthy (n=10)	5	2	2	3	1

Bot. = *Botryosphaeria*, Cyl = *Cylindrocarpon*, Eut = *Eutypa*, Pho= *Phomposis* and Bas= *Basidiomycete*.

Basidiomycete fungi were always isolated with at least one other fungus present in the core. All cores collected had some region that was brown or discoloured.

DISCUSSION

All of the fungal species isolated have been reported to be involved in the pathology of grapevines. Of interest in this study was the occurrence of both *Botryosphaeria* and *Eutypa* at Marlborough sites as both can form wedge-shaped discolouration in the wood of vines in cross section.

Botryosphaeria dead arm and Eutypa dieback can both lead to the death of arms or cordons of the grapevine over time. In four cane pruned vines such as those grown in Marlborough no arms or cordons are used so these symptoms will not be observed.

Of the vines for which these fungi were isolated the vines were divided into two groupings based on reduced vigour which is a generalised symptom of poor vascular function. The vines without visual symptoms may still be infected with trunk disease which has yet to block the vascular system to the extent required for the whole vine to show symptoms. This possibility is supported by the number of occurrences of the fungi isolated from "healthy" vines. Over time we would suggest that the vines with no symptoms will develop reduced vigour and eventually die.

ACKNOWLEDGEMENTS

This work was funded by the Marlborough Research Centre and the Ministry of Agriculture and Forestry Sustainable farming fund. This project would not have been possible without the support of Pernod Ricard NZ and Matua Wines

REFERENCES

1. Mundy DC, Manning MA. 2006. Initial investigation of grapevine trunk health in Marlborough, New Zealand. 5th International Workshop on Grapevine Trunk Diseases, Davis, CA.pp.26

2. Graham A. 2006. Hot water treatment of grapevine rootstock cuttings grown in a cool climate. 5th International Workshop on Grapevine Trunk Diseases, Davis, CA. pp.77

3 Jasper MV, Bleach CM, Harvey IC. 2006. Susceptibility of grapevine rootstocks to cylindrocarpon disease. 5th International Workshop on Grapevine Trunk Diseases, Davis, CA. pp.47

4 Whiteman SA, Stewart A, Ridgway HJ, Jasper MV. 2007. Infection of rootstock mother-vines by *Phaeomonieela chlamydospora* results in infected young grapevines. Australasian Plant Pathology 36:198-203.

First published in the proceedings of The 16th Australasian Plant Pathology Society Conference 2007, page 206.

Republished in Romeo Bragato conference proceeding 2008.

HortResearch

An evaluation of the impact of grapevine trunk disease:

on fruit quality and vine performance in the Marlborough region, New Zealand

D.C Mundy[1]

Presented by Dion Mundy

www.hortresearch.com

Introduction

Grapevine longevity is one of the major research themes in the New Zealand Winegrowers' Research & Development Plan 2006. In the plan, the two issues of concern are infection of grapevines by virus and trunk diseases. Grapevine trunk disease symptoms are starting to appear in older vines in the Marlborough region. In order for growers to manage vineyards containing vines with trunk diseases, they need information on the impact of the trunk fungi on the fruit quality, vine productivity and overall profitability.

Method

An evaluation of vines with and without visual symptoms of trunk disease was conducted in two varieties (Sauvignon blanc and Riesling) by following changes in fruit composition during ripening and at harvest.

Results

At harvest significant differences were observed for soluble solids, amino acids and total yeast assimilable nitrogen (YAN) of Sauvignon blanc vines only. However the trend across a number of measurements was for lower values for vines with symptoms.

Table 1. Summary of physiological measurements of vines at harvest 2007, vines with (Sick) and without (Healthy) grapevine trunk disease symptoms.

	Sick vines		Healthy Vines	
	Riesling	Sav. blanc	Riesling	Sav. blanc
50 berry sample weight (g)	65.1	58.0	61.5	56.7
Bunch number	56.4	55.0	49.6	55.0
Total yield per vine (Kg)	3.78	4.27	2.90	3.78
Soluble solids (Brix°)	20.70	21.48	21.33	22.08
pH	2.91	2.99	3.01	3.03
TA (g/L)	11.13	10.18	11.12	10.08
Ammonium (mg/L)	125.6	112.2	135.3	123.4
Amino acids (mg/L)	117.5	122.3	148.3	155.2
Total yeast assimilable nitrogen (mg/L)	243.1	234.5	282.3	278.4

Discussion

Sauvignon blanc vines were significantly different for soluble solids, amino acids and total yeast assimilable nitrogen with health vines having higher values. While no significant differences were detected on the Riesling vines the trend was similar to the Sauvignon blanc. The differences observed suggest that trunk diseases may influence fruit quality and vine performance.

Sub-optimal fruit composition caused by trunk diseases may become a problem as an increasing number of vineyards express symptoms in New Zealand. Research is continuing to investigate how trunk pathogens interact with vine physiology and impact on production.

Acknowledgements

This research would not have been possible without funding from the Ministry of Agriculture and Forestry Sustainable Farming Fund (MAF SFF), The Marlborough Research Centre (MRC) and travel funding from the Nelson Marlborough Institute of Technology (NMIT).

2567 Trunk health in New Zealand vineyards

Page 8

HortResearch
Rangahau Ahumāra

Preliminary results of grapevine trunk disease monitoring in two vineyards in Marlborough, New Zealand

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Introduction

The New Zealand wine industry has been expanding since 1995 and has grown to become New Zealand's second largest horticultural export crop by value. With the investment required in establishing new vineyards, vineyard managers need to ensure long-term productivity and profitability from the plantings. This study examines the hypothesis that in a vineyard block affected by trunk disease, the numbers of affected plants will increase over time with a consequent reduction in vineyard profitability. The results presented are for the first three years of a five-year programme.

Grapevine trunk disease in a Blenheim vineyard.

Methods

A Sauvignon blanc and a Riesling vineyard were chosen in the Marlborough district to monitor trunk disease development. Trunk core samples were taken from vines within the target blocks to confirm the presence of trunk disease and to identify associated pathogenic fungi. Diseased vines were mapped within each vineyard to observe changes in disease incidence over time...

Results

The fungi most commonly associated with trunk disease in both vineyards were *Botryosphaeria* spp. and *Eutypa lata*. The monitoring of vines over time showed that the number of dead vines increased (Figure 1). Knowledge of the rate of increase in vine death over time will allow modelling of the potential impact of trunk disease on long-term vineyard profitability. Due to the fixed costs of production a 2.8% reduction in productivity resulting from vine death leads to a 5% reduction in profit (Figure 2). Other studies have shown that fruit quality is reduced in vines with sub-lethal trunk disease (Mundy & Ecochi 2007). The figures presented here do not take into account the reduction in the value of fruit on diseased vines.

Figure 1. Percentages of dead vines in monitored blocks of Sauvignon blanc and Riesling in Marlborough in the 2006 and 2008 seasons.

	2006 % Dead vines	2008 % dead	Total number of vines in block
Sauvignon blanc	0.7	1.8	3772
Riesling	3.2	7.8	1870

Figure 2. Summary of estimated effect on productivity of a 2.8% loss of vines for an 'average' Sauvignon blanc vineyard in Marlborough.

Marlborough model vineyard	Block with no vine death	Block with 2.8% vine death
Producing area (ha)	27.0	27.0
Total production (t)	398	387.7
Average return ($/t)	2 465	2 465
Net cash income ($)	987 270	957 466
Vineyard working expenses ($)	380 571	380 571
Profit before tax ($)	606 155	584 565
Surplus for reinvestment ($)	334 670	319 512
Percentage of normal Surplus	100%	95%

[illegible]

Discussion

As a result of productivity losses, from vine death, vines have to be replaced. Until these vines come into production, a reduction in income will reduce tax paid, but the fixed costs of interest, drawings and vineyard operational expenses remain the same as for a fully healthy vineyard. Hence when vines die the effect on profit for the vineyard is greater than the percentage of vines that have died. Data on the rate of vine death obtained in this programme will be used to develop an initial model of the potential economic impact of trunk disease.

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Acknowledgements

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Abstract for Australasian Plant Protection Society conference

INCIDENCE OF FUNGI ISOLATED FROM GRAPE TRUNKS IN NEW ZEALAND VINEYARDS

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INTRODUCTION

With the growth of the New Zealand wine industry in size and geographic distribution, the number of observations of grape vine trunk disease symptoms has increased. Within the industry, identification of fungi present in trunks of unthrifty vines has been a low priority. Previous studies have often focused on a single genus (1) or regional record of disease (2).

In order to reduce the impact of trunk diseases in New Zealand vineyards, it is important first to establish which fungi are present. This survey is a preliminary investigation of the range and incidence of fungi isolated from trunk wood across a number of vineyard sites in New Zealand.

MATERIALS AND METHODS

Field survey A survey was conducted on vines from 37 vineyard blocks in the North and South Islands of New Zealand. Core samples were taken from the trunks of five vines at each site, using a MATTSON N° 4333 forestry corer. This device removed a 5-mm core approximately 80 cm up the trunk, passing directly through the wood until the bark was ruptured on the far side. The corer was cleaned between samples with 70% ethanol to prevent cross contamination. The entire core sample was transferred in a sterile tube to the laboratory.

Isolations Each core was surface sterilised for 30 sec in 70% ethanol, 2 min in 3.5% w/v sodium hypochlorite and 30 sec in 70% ethanol. Samples were cut into 5-10 mm pieces and placed on potato dextrose agar (PDA; DIFCO) amended with 100 µg/mL streptomycin sulphate and 100 µg/mL Penicillin G potassium salts and incubated at 20°C with lights (12 h photoperiod).

Identification After one week, fungi were identified by morphological features and confirmed by amplifying the internal transcribed spacer regions of the rDNA using the polymerase chain reaction (PCR) primers ITS1-F and ITS-4. PCR products were sequenced using the BigDye Terminator V. 3.1 cycle sequencing kit (Applied Biosystems, UK). The resultant sequences were characterised by Basic Local Alignment Search Tool analysis from the most closely related sequences on GenBank. Fungal morphological characteristics were re-examined after a month to confirm identification further and to allow time for slower growing fungi to be isolated and identified. Not all fungi were identified to the species level so results are given as a summary by genera.

RESULTS

The most commonly isolated fungi were species of the genera *Botryosphaeria*, *Phaeomoniella* and *Eutypa* at multiple sites (Table 1). Less commonly, *Phaeoacremonium spp.* and *Cylindrocarpon* spp. isolates were also found. The same genera were not isolated from all 37 sites sampled. *Phaeoacremonium* sp. were found only in Hawke's Bay, although the other fungal isolates were not confined to a single region. Other fungi isolated during the survey included species of *Acremonium, Alternaria, Cadophora, Cladosporium, Epicoccum, Gliocladium, Mucor, Penicillium, Phoma, Trichoderma, Ulocladium* and *Xylaria*.

Table 1. Recoveries of fungal genera regarded as wood pathogens from a survey of thirty seven vineyard blocks. The survey of incidence of fungi was conducted in the North and South Islands of New Zealand during 2007 and 2008.

Genus	North Is.	South Is.
	n=24	n=13
Botryosphaeria	20	5
Phaeomoniella	19	3
Phaeoacremonium	3	0

Phomopsis	8	3
Cylindrocarpon	2	3
Eutypa	12	8

DISCUSSION

The incidence of species of *Botryosphaeria*, *Phaeomoniella* and *Eutypa* in many of the vineyard blocks surveyed suggests that these fungi should be the focus of more detailed research to establish their importance to the industry. The isolation of a fungus from a block does not prove that it is the organism responsible for the disease symptoms. If multiple fungi are present, the incidence does not allow the determination of which fungi are the most likely to be causing symptoms at that site.

As the sample size in each vineyard block was limited, we cannot be certain that failure to detect a particular species indicates that these fungi were not present. For example additional isolations will be needed to determine if *Phaeoacremonium* is restricted to Hawke's Bay only.

ACKNOWLEDGEMENTS

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Abstract for the New Zealand Plant Protection Conference poster to be presented in August 2009

SAMPLING TECHNIQUES FOR ISOLATING TRUNK DISEASE FUNGI FROM A NELSON VINEYARD

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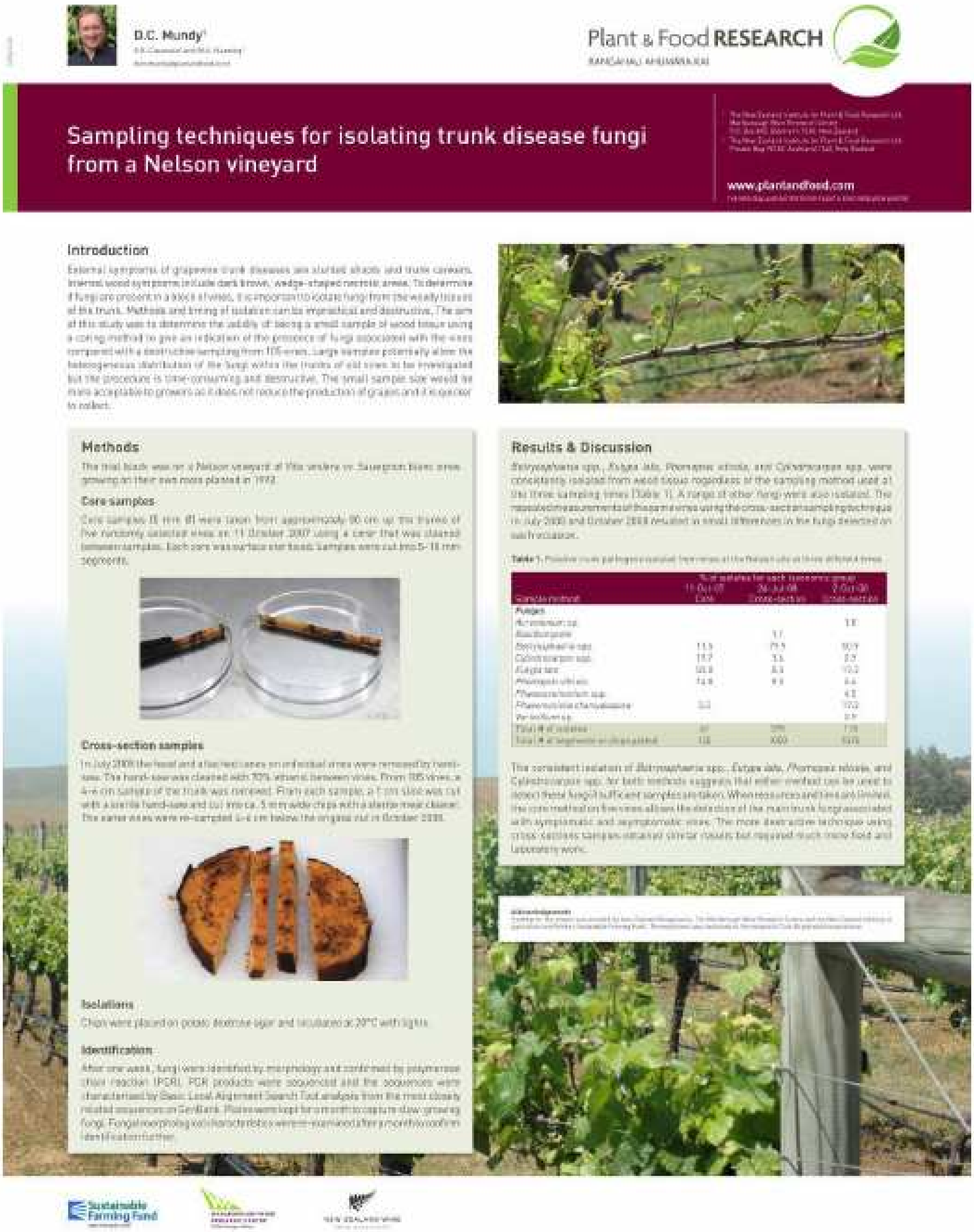
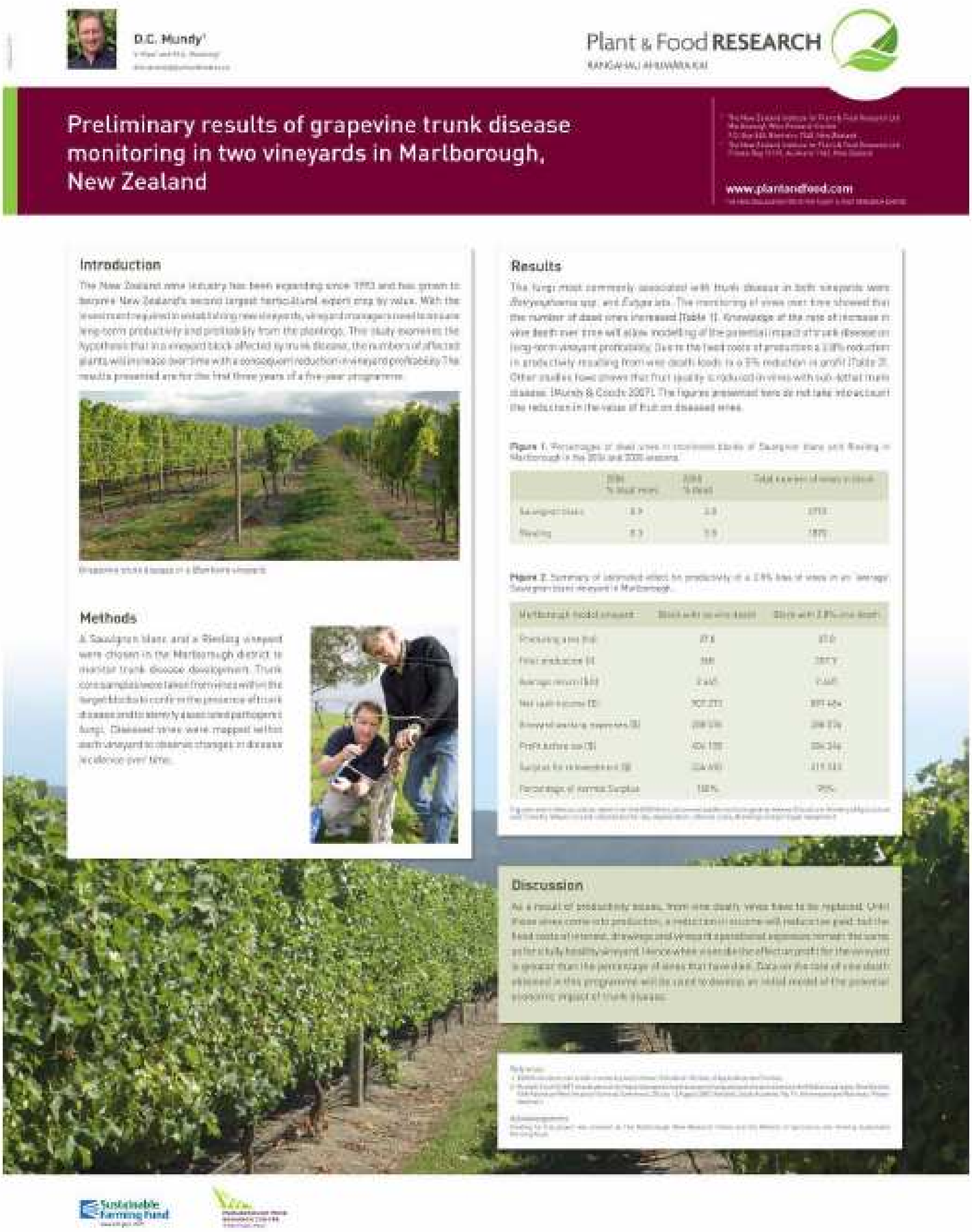
ABSTRACT

We conducted a trial of two different sampling techniques undertaken at three different times using a destructive and a non-destructive method to ascertain the fungal population associated with trunks of grapevines. A Nelson vineyard was surveyed in October 2007 using a coring method on 5 vines, and 105 vines were subsequently sampled in July and October 2008 using a cross-section sampling method. *Botryosphaeria, Cylindrocarpon, Eutypa* and *Phomopsis* were isolated on all occasions, regardless of method. The detection of other fungi varied with sampling technique and time taken. Differences in isolations between methods and timings of sample collection reflect the heterogeneous distribution of the fungi within the trunks of old vines. The core sampling technique was sufficient to determine fungi associated with symptomatic and asymptomatic vines. The more destructive technique, where cross-section samples were taken, gave similar results but required more resources. If isolations are to be collected from vines, then the method, timing and sample size need to be considered and standardised.

Poster for the New Zealand Plant Protection Conference poster to be presented in August 2009



Appendix 4. Poster for the 2009 wine industry conference



2567 Trunk health in New Zealand vineyards Page 12

Draft paper for NZPP August 2010 (Confidential)

Ecology and management of grapevine trunk diseases in New Zealand: a review

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Abstract Grapevine trunk diseases threaten the longevity of vineyard production in New Zealand. This paper provides a summary of the knowledge of the most common fungal grapevine trunk diseases, as well as identifying gaps that require further research. Current knowledge of symptoms, causal organisms, etiology and disease control of botryosphaeria die-back, esca, eutypa die-back and Petri disease are discussed. Additional information about how these diseases may be influenced by different vineyard practices common in New Zealand viticulture is provided.

Keywords grape, ecology, symptoms, integrated management, trunk disease.

INTRODUCTION

With an increased awareness of grapevine trunk diseases that may affect the longevity of vineyards in New Zealand, it was considered timely to present a summary of the current knowledge of the diseases and the methods of control. Selected diseases covered are botryosphaeria dieback, esca, eutypa dieback and Petri disease. While esca has not yet been recorded in New Zealand, this disease has been included as it is a major disease in other grape-growing regions of the world and some of the fungi involved in this complex are present in New Zealand.

BOTRYOSPHAERIA DIEBACK

In some early reports on botryosphaeria dieback (also known as black dead arm) mixed isolations of *Phomopsis viticola* and *Sphaeropsis malorum* (syn. *Botryosphaeria stevensii*) were reported. *Phomopsis viticola* was initially described as the pathogen responsible for symptoms (Chamberlain et al. 1964). *Botryosphaeria* species associated with the dieback disease have a wide host range, can be both saprophytic or endophytic and have been isolated from a number of symptomatic grapevine tissues (Amponsah et al. 2008).

Symptoms

Early signs of infection include mild leaf chlorosis or leaf wilt as the water transport system becomes blocked. Following invasion of the xylem by pathogens, vascular occlusions form (Sun et al. 2008) resulting in vessel blockage. In vines with botryosphaeria dieback the blocked xylem often results in black stains forming in the necrotic xylem tissue. The stains expand longitudinally and laterally within the wood. The cambium over the non-functional xylem also dies, resulting in a canker that is visible on the exterior of the trunk or arm. Affected vines wilt suddenly during the growing season or fail to break dormancy (Pearson & Goheen 1988). Bunch rot symptoms of shrivelled brown berries with small black spore-bearing structures (Nicholas et al. 2003) have also been reported in South Africa (Pearson & Goheen 1988) and New Zealand (Buchanan & Beever 1987).

Causal organism

Field diagnosis of the causal organism, *Botryosphaeria* spp., is often difficult, as both phomopsis cane and leaf spot and eutypa dieback can have similar symptoms. The causal agent for black dead arm in Hungary has been reported as *Botryosphaeria stevensii* (Pearson & Goheen 1988). In New Zealand, *Botryosphaeria* spp. reported as the causal agent of bunch rots in Auckland and Te Kauwhata (Buchanan & Beever 1987) were later confirmed as *Botryosphaeria lutea* (*Neofusicoccum luteum*) (Phillips et al. 2002). New Zealand isolates of *B. lutea, B. australis* and *B. parva* are reported as infecting wounded green shoots of Pinot noir, Chardonnay, Riesling, Cabernet Sauvignon and Sauvignon blanc varieties (Amponsah et al. 2009a).

Disease cycle and epidemiology

Botryosphaeria stevensii overwinters in diseased woody parts of vines, with pycnidia developing during rainy periods in spring and autumn (Pearson & Goheen 1988). Mechanical injuries such as pruning wounds are the suspected entry points for tissue infection (Pearson & Goheen 1988). Experiments conducted on potted vines using New Zealand isolates show that wound age is important for infection, with a greatly reduced incidence of vine infection 30 days following wounding, compared with the infection incidence up to 3 days after wounding (Amponsah et al. 2009a). Timing of wounding may also be important, with the presence of sap in spring keeping the wounds wet – potentially a factor that increases the risk of infection (Pearson & Goheen 1988). Rainwater run-off may be important in the release and dispersal of conidia under New Zealand vineyard conditions (Amponsah et al. 2009b). Year-round trapping of conidia in rainwater traps has been reported in Canterbury, with the highest recorded trap catches during December, January and February when high mean daily temperatures (15 to 20°C) were recorded (Amponsah et al. 2009b). Optimal temperature for infection is between 23 and 26°C, but infection can occur at a range from 15 to 26°C (Pearson & Goheen 1988).

Control

In the absence of effective chemical control, removal and destruction of diseased vine parts is recommended (Pearson & Goheen 1988).

ESCA

Esca (also known as black measles) is the disease complex that results in a trunk rot of older grapevines. The disease has been widely reported in viticultural regions throughout the world (Rooney-Latham et al. 2005). The symptoms that characterise this disease have not been described in New Zealand, although some of the fungi involved have been reported (Clearwater et al. 2000; Whiteman et al. 2002; Mundy et al. 2009a). The disease has been highly destructive in vineyards in California (Gubler et al. 2005; Rooney-Latham et al. 2005) and Europe (Surico et al. 2008), so the New Zealand industry needs to remain vigilant.

Symptoms

The name esca describes the soft white rotted fibres in the trunk of the grapevine that were used for tinder, a characteristic symptom of this disease (Surico 2008). Other symptoms include "apoplexy" or sudden wilting of the vine with the shedding of some or all leaves and fruit, superficial brown to purple spots on the berry surface (measles), vascular discolouration of wood, typical tiger-striped patterns on leaves and tip die back of shoots (Eskalen et al. 2007).

Causal organism

The various fungi associated with the esca complex (Table 1) can be grouped into two classes, wood staining and white rotting. In some cases leaf symptoms are expressed when only the wood-staining fungi are present. No esca symptoms have been reported in the field when only the white rot fungi are present.

Table 1. Fungi associated with the esca disease of older grapevines.

Grouping	Genus (and species where known)	Present in New Zealand[2]
Wood staining[1]		
	Phaeomoniella chlamydospora	Yes
	Phaeoacremonium species including *aleophilum, angustius, iranianum, mortoniae,*	*P. aleophilum, P. armeniacum, P.*

	parasiticum, subulatum, venezelense	*globosum,* *P. occidentale*
White rots		
	Fomitiporia australiensis	No
	Fomitiporia mediterranea	No
	Fomitiporia polymorpha	No
	Fomitiporella vitis	No
	Inocutis jamaicensis	No
	Stereum hirsutum	Yes

[1]Summary of wood-staining *Phaeoacremonium* species taken from Surico et al. (2008).

[2]Presence in New Zealand according to Landcare Research (2010).

Disease cycle and epidemiology

In California, propagules of *Phaeoacremonium* species were detected in soil and standing water, as well as in the air of infected vineyards (Rooney-Latham et al. 2005). *Togninia minima* (the teleomorph of *Ph. aleophilum*) was detected in both laboratory mating experiments and on moist incubated grapevine pieces from naturally infected vineyards, suggesting that in California at least this is the fungus associated with symptom expression (Rooney-Latham et al. 2005). The correlation between trapped propagule numbers and rainfall events suggests that the pathogen moves as airborne inoculum during rainfall. The complete life cycle and hence the importance of propagule dispersal for the fungus is still unknown.

Phaeoacremonium species are detected in wood of vines with either Petri disease (described below) or esca. Vines that do not show symptoms of the diseases can have the fungi growing in the wood and transfer of these pathogens can occur during propagation.

Control

In Europe, esca is a considerable disease for which no chemical control is available. Identification will be important if Esca establishes in New Zealand so that the best possible control measures can be implemented. One of the main methods of control currently recommended is to control the nursery process carefully so that *Phaeoacremonium* species do not establish in the vineyard via infected planting material (Surico et al. 2008).

EUTYPA DIEBACK

Eutypa dieback (also known as dying arm or dead arm) occurs in most grape-growing regions of the world where rainfall exceeds 600 mm annually (Pearson & Goheen 1988). Within New Zealand, the disease is distributed in both the North and South Islands (Mundy & Manning 2007; Mundy et al. 2009b).

Symptoms

According to Pearson & Goheen (1988), symptoms include deformed and discoloured shoots in spring whilst cupped, small and chlorotic leaves are normally the first symptoms on vines older than 8 years. In cordon-pruned vines, symptoms become more extreme in successive years until part or all of the arm fails to produce shoots in spring. Close examination of symptomatic cordons will often reveal cankers. Removal of bark is required to determine the extent of the canker. In New Zealand cane-pruned vines may show a lack of shoot growth from one side of the head or no dieback symptoms before vine death. In the field, cross sections of necrotic sapwood may be found to extend from the origin of the canker in the trunk or arm (Pearson & Goheen 1988) often in a wedge-shaped lesion. Culturing of fungi is required to determine if lesions result from eutypa dieback or from botryosphaeria dieback.

Causal organism

The casual organism of eutypa dieback is *Eutypa lata* (anamorph *Libertella blepharis*). *Eutypa* can be cultured from colonised wood chips placed on agar media and conidiomata may develop from the culture after 6–8 weeks (Pearson & Goheen 1988). However, identification based only on morphological features in culture can be insufficient to distinguish *E. lata* from other ascomycetes possessing *Libertella* anamorphs, including *Eutypella*, *Diatrypella*, *Diatrype*, *Cryptosphaeria* and *Cryptovalsa* (Pitt et al. 2010). Cultures produce a white mycelium growth from infected wood chips after 3 or more days at 20–25°C. A 12-h light-dark regime promotes formation of conidiomata and sporulation (Pearson & Goheen 1988). Cultures of the Diatrypaceae collected from New Zealand have been identified as *Eutypella vitis* or *Eutypa* sp., based on sequences of the internal transcribed spacer (ITS) regions (Mike Manning, Plant & Food Research, unpublished data). Continued studies in New Zealand will be required to determine the presence and importance of other *Libertella* in symptomatic grapevines.

Disease cycle and epidemiology

According to Nicholas et al. (2003), perithecia develop on infected wood and can form 2 or more years after the tissue is killed. Infections of apricots, almonds, plums, apples, pears and a range of other fruit and ornamental trees can also be sources of spores. Spores are released during rainfall and splashed or blown via air currents onto recent pruning wounds. The fungus grows into the xylem and blocks the water-conducting vessels. Infections move at a rate of 10–12 cm/year. Foliage symptoms do not normally occur until at least 4 years after the initial infection occurs. Following infection of fresh pruning wounds, *E. lata* colonises the xylem, cambium and phloem (wood). On infected wood, perithecial stromata are produced firstly at the site of initial infection and then spread on dead wood with the canker development (Pearson & Goheen 1988). The pathogen is disseminated solely by the pale yellow and allantoid ascospores that are released from the perithecia (Pitt et al. 2010).

Control

Current control practices are focused on pruning, with remedial cuts to remove infected wood, timing to avoid the most susceptible period of wounds in early winter, avoiding pruning during or directly after rainfall, and the use of wound protection paints (Pitt et al. 2010). In New Zealand two products are currently registered with label claims for the use as a wound protectant against *E. lata*; these are VineVax™ and Greenseal™.

PETRI DISEASE

Petri disease (also known as young esca, young vine decline or black goo) is a concern in the wine industry because of the damage the disease can cause to young plantings. Petri disease is also a concern as it may lead to the establishment in vineyards of fungi that may later be involved in expression of esca.

Symptoms

With Petri disease, growth slows with a reduction in trunk growth, shortened internodes, reduced foliage and reduced leaf size (Scheck et al. 1998). Vines may grow normally in the first year but decline in subsequent seasons, with leaf chlorosis and early defoliation. Vines with symptoms generally have dark-brown to black staining of the vascular tissue, observed when the trunks are cut in cross or longitudinal section (Whiteman et al. 2007). The symptoms may result in vine death or poor establishment of new plantings.

Causal organism

Phaeomoniella chlamydospora, Phaeoacremonium species and other pathogens can all be isolated from young vines, often from the same tissue, complicating determination of which fungi are responsible for symptoms. In Australia, *P. chlamydospora* was the fungus predominately isolated from vines with Petri disease (Edwards & Pascoe 2004) and New Zealand studies have also indicated a regular occurrence of this pathogen (Clearwater et al. 2000). While *Phaeoacremonium* species may not be as commonly isolated, they are detected in symptomatic plants and their relative importance is yet to be determined.

Disease cycle and epidemiology

Many of the staining fungi isolated in Petri disease vines are the same as those associated with esca, and it is likely that the infection cycle for these pathogens is the same as that described above for esca. In 2009, three new *Phaeoacremonium* species on grapevines in New Zealand were confirmed from non-symptomatic grape rootstock mother-vines (Graham et al. 2009). This report is consistent with the conclusion that rootstock mother-vines were the primary source of *P. chlamydospora* for grafted vines (Whiteman et al. 2007). These records are further supported by findings in Spain (Giménez-Jaime et al. 2006) and South Africa (Fourie & Halleen 2004).

In New Zealand, reported pathways of infection by *P. chlamydospora* include propagules in the soil and infection during grafting due to nursery practices involving repeated exposure to cutting and hydration processes (Whiteman et al. 2002). Therefore the production of young vines and the soils used for nursery plantings have been investigated (Ridgway et al. 2002).

Control

The use of clean planting material without *P. chlamydospora* and *Phaeoacremonium* species would be ideal. However, detection of the fungus in mother-vines is difficult, and identification based on visual symptoms such as black staining has been reported to have a high proportion of false positives (Whiteman et al. 2007). Molecular methods of detection and identification have been investigated (Pottinger et al. 2001; Ridgway et al. 2002; Whiteman et al. 2002; Weir & Graham 2009) but, to date, no commercial service has been provided to allow certification of planting material free of Petri disease-related fungi. Therefore, current control activities are focused on reducing the risk of producing infected grafted plants. Hot water treatment to reduce the chance of fungal infection of new planting material has been investigated as a possible method of control (Graham 2007), but caution has been advised before widespread adoption of this practice (Whiteman et al. 2007). No effective chemical control for the field or nursery has yet been established.

CONCLUSIONS

Knowledge of the fungi responsible for grapevine trunk diseases has increased since the first international workshop on grapevine trunk diseases, but control options remain limited. Good cultural practices, such as removing infected wood and protecting pruning wounds from infection, are still the best advice for the industry to reduce the spread of trunk diseases.

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The Impact of Grapevine Trunk Disease

The cost of botrytis on production has been well documented through research in recent years. But another project, undertaken originally in Marlborough is showing that grape growers also need to be aware of how serious grapevine trunk disease can be, especially to the financial bottom line.

Which is why Sustainable Farming Fund has financed a further three years of study into this issue that could have a serious impact on the performance and productivity of grape vines. Dion Mundy and Mike Manning from HortResearch are the two conducting the research, which has already thrown up some interesting findings. While Marlborough's vineyard area is the largest in the country and continually expanding, it is still a young region with very few vines older than 25 years, Dion says.

"Many of the trunk fungi that cause diseases in other wine growing regions around the world do not show symptoms until vines are at least 10 years old, probably due to the slow growth habit of the fungi. The older vines that do exist may provide some information on the type and level of trunk fungi that might be expected in these younger vines as they age."

Fly over Marlborough and you can't help but notice gaps amongst large tracts of vines. Dion says these gaps may be due to pruning mistakes, or accidents within the vineyard from machinery. But he has to wonder if a large percentage of them are also suffering from trunk disease which is killing the vine from the ground up.

During the past two years, Mike and Dion have been surveying vines in three separate vineyards in the region, concentrating on Sauvignon Blanc and Riesling. It's shown there are a number of fungal species affecting vines, including: Botryosphaeria, Eutypa, Phomopsis and Cylindrocarpon. All affect the vascular system of the plant.

"Initial studies have shown that some vines can have more than one trunk disease fungus present," Dion says. "The fungi associated with the trunk disease have many different pathways to infection or colonisation of trunk wood. They can enter the vascular system of young plants through surface wounds of mother plants in the nursery or during subsequent pruning during establishment in the vineyard, and often symptoms do not appear until the vines are older."

Having discovered the presence of trunk fungi, the next part of the research involved determining whether the infected vines had an influence on productivity and the profitability of the vineyard. Yields decreases were not significant in any of the three vineyards monitored, but in one there was a significant difference in soluble solids. Dion says this could cause some concern, as there could be financial implications if the fruit was to be harvested at the normal time, or an increased disease risk if the fruit was harvested later.

"Of interest to winemakers are the concentrations of primary amino acids and ammonium that are added together to determine the total YAN. At Site 3, both primary amino acid and total YAN concentration were significantly lower on vines with trunk disease. Low total YAN can lead to problems in winemaking, as the yeast needs the primary amino acids and ammonium to grow and complete the winemaking process.

"While a viticulturist will aim to provide a balanced nutrient budget, other factors such as disease can interfere with this. The viticulturist will try to provide a balance in the vineyard with the correct amount of nitrogen to provide the YAN the winemaker wants, without adding too much, that could lead to excessive vegetative growth or leaching into the soil. In the case of trunk diseases, the nitrogen that the roots are providing for the fruit may be intercepted by the fungus. Alternatively the fruit may not receive the nitrogen, as the whole process of nutrient uptake within the vine may be damaged by the blockages to the vascular system."

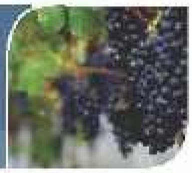
There are no accurate figures that show the financial impact of trunk vine disease. But Dion and Mike have established a desktop costing, of the possible losses in Sauvignon Blanc, based on observed

You can see the gaps caused in this vineyard by trunk disease. Note the remainder of a vine in the background. Because it has been left, the disease spores will continue to multiply and spread.

Fact Sheets

HortResearch
Rangahau Ahumāra

Grapevine trunk diseases in older New Zealand vines



KEY STAFF INVOLVED:

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HortResearch, Marlborough

Mike Manning
HortResearch, Auckland

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Lincoln University

WHY ARE TRUNK DISEASES IMPORTANT IN OLDER VINES?

Trunk disease refers to a disease syndrome in which fungi of various kinds colonise the trunk, particularly in the region of the crown (often via pruning wounds). These infections kill varying amounts of xylem (wood) and phloem tissue, limiting water and nutrient flow between roots and canopy. Symptoms range from general poor growth to complete vine death (Figure 1).

As vineyards age, the number of affected vines can increase, resulting in a general decline in productivity of the vineyard. Trunk diseases can also affect wine quality as a consequence of the fruit having lower sugar levels and reduced nitrogen compounds needed for complete fermentation. Vineyard managers are faced with carrying out a cost/benefit analysis on either replacing vines when they die, or removing vines that are still producing but with reduced fruit quality and yield. The current and potential economic impact of trunk diseases in New Zealand has not been quantified, making management decisions difficult for growers.

WHAT ARE THE COMMON DISEASES?

Common name	Fungus	Distribution
Eutypa die-back (also Dying dead arm or Dead arm)	*Eutypa lata*	New Zealand and world wide
Botryosphaeria die-back (also Black dead arm)	*Botryosphaeria* spp.	New Zealand, Italy, North America
Petri disease	*Phaeomoniella chlamydospora*	New Zealand and world wide
Esca	A complex of fungi including *Phaeomoniella chlamydospora* and *Phaeoacremonium* species, *Fomitiporia* and others	Europe, North America
Phomopsis Dead Arm	*Phomopsis viticola*	New Zealand and world wide

WHERE CAN I GET MORE INFORMATION?

Further details on the grapevine trunk disease research is available on **http://www.wineresearch.org.nz/projects/trunk%20health.htm** or by contacting Dion Mundy at **dmundy@hortresearch.co.nz**

SUGGESTED READING

Nicholas P, Magarey P, Wachtel M 2003. *Diseases and Pests*. Grape production series Number 1, Winetitles, Adelaide 2003.

Gubler WD, Rolshausen P, Trouillase F, Urbez J, Voegel T 2005. *Grapevine trunk diseases in California*. Practical Winery & Vineyard. 6–25 Pp. http://www.practicalwinery.com/janfeb05/janfeb05p6.htm

Balasubramaniam R 1993. *HortFACT – Grapevine Diseases in New Zealand* http://www.hortnet.co.nz/publications/hortfacts/hf905020.htm#E2AE3

WHAT ARE THE COMMON SYMPTOMS?

- Poor growth of an arm or side of the head (Figure 2)
- Stained or brown tissue when the vine is cut in cross section (Figure 3)
- Vine death.

HOW CAN THEY BE CONTROLLED?

Current recommended best practice for controlling all of these diseases is:

- Protect large wounds with pruning paste
- Do not make large pruning cuts during wet weather
- Remove and burn dead wood from the vineyard as part of good hygiene measures (Figures 1 and 4)
- Remedial pruning to remove infected wood.

Figure 1. Dead wood not removed from vineyard (poor hygiene) and producing *Eutypa lata* spores.

Figure 2. Poor grapevine shoot growth as a result of *Eutypa lata* infection of the vine.

Figure 3. Brown staining of the grapevine wood when cut in cross section is a common symptom of trunk disease fungi. Wedge-shaped areas of brown staining are common with *Eutypa* and *Botryosphaeria* infections.

Figure 4. Leaving large piles of dead vines in the vineyard is not good vineyard practice and can lead to the spread of trunk diseases.

WINEGROWING FACT SHEET NO. 3
Version 1 : January 2010

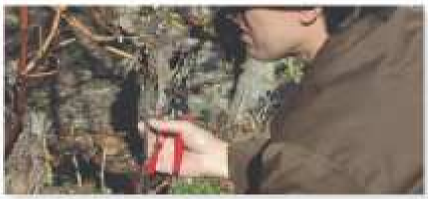
Written by Dion Mundy[1]

Plant & Food RESEARCH
RANGAHAU AHUMĀRA KAI

www.plantandfood.com

Identification of bleached canes and other diseases at pruning

This fact sheet provides basic identification of, and suggested treatment for, some of the common diseases that may be observed in vineyards during winter. Removal of infected wood during pruning can be one of the most effective ways of breaking the disease cycle. The correct identification and treatment of these diseases can reduce disease pressure during the season.



Common disease symptoms

Table 1 contains a summary of the most common visual or disease symptoms observed on grapevine canes. Both *Botrytis* and *Phomopsis* can occur on dead or damaged canes and both can result in bleached canes. Canes infected by Phomopsis have a large number of small brown/black dots between larger black sunken fissures and cracks on the cane (Figure 1). The black resting bodies of *Botrytis* tend to be larger than the black dots of *Phomopsis* and are more irregular in shape. Both diseases should be controlled by cutting out infected canes whenever possible and using chemical control agents when available for the coming season, to reduce spread.

Various other diseases and disorders may also be detected in the vineyard during pruning. Canes with red or brown spider web patterns (Figure 2) should be removed, as they have been infected with powdery mildew in the past and are likely to have infected buds that may result in flag shoots in spring. During pruning, it is also useful to remove black spot (Figure 3) and other cankers if they are observed. Die-back on the end of canes can be the result of trunk disease fungi such as *Eutypa* (Figure 4). If possible, canes that do not have die-back should always be selected for tying down. Canes that are discoloured or marked by physical damage such as wind (Figure 5) do not pose a disease risk, but still should not be selected for pruning, as the damage may provide a weak spot that results in breakage during tying down.

Table 1. Common vine diseases and visual symptoms.

Disease	Symptoms	Figure
Cane botrytis	Bleached canes (can have black resting bodies on the bleached canes)	
Phomopsis (also see Winegrowing fact sheet 4)	Bleached canes and black dots on surface	1
Powdery Mildew	Red/brown spider web pattern on canes	2
Black spot	Cankers and blackening on canes	3
Eutypa die-back	Die-back of shoots and cordons	4
Other causes		
Wind Rub	Damaged cane	5

Managing disease problems of the canes

The spread of diseases described in this fact sheet can be reduced by pruning out the infected wood and either mulching the prunings or removing them from the vineyard during winter. Mulching of pruning residues will reduce the chances of diseases over-wintering on the vineyard floor. If disease continues to spread, then more targeted disease control for the individual disease may be required.

Figure 1. Phomopsis bleaching and damage on cane.

Figure 2. Powdery mildew webbed discolouration of canes.

Figure 3. Cane showing black spot cracking and damage.

Figure 4. Die-back on cane caused by Eutypa.

Figure 5. Damage from wind rub.

Where can I get more information?

For detailed descriptions of how individual diseases may be dealt with, readers are directed to:

- Nicholas P., Magarey P. and Wachtel M. 2003. Diseases and Pests. Grape production series Number 1, Winetitles, Adelaide 2003.
- Pearson R. C. and Goheen A. C. 1988. Compendium of Grape Diseases. APS Press St. Paul, Minnesota, USA.

Further details on the grapevine trunk disease research is available on http://www.wineresearch.org.nz/publications/MarlboroughTrunkDiseaseWeb.htm

You may also contact:

Dion Mundy at dion.mundy@plantandfood.co.nz or
Marlene Jaspers at Marlene.Jaspers@lincoln.ac.nz

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WINEGROWING FACT SHEET NO. 4
Version 1 : January 2010
Written by Dion Mundy[1]

Plant & Food RESEARCH
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Phomopsis stem and leaf spot

Life cycle

The pathogen *Phomopsis viticola* over-winters on bleached canes (Figures 1 & 2). Wet weather in spring induces spore production (10 hours minimum) and further rainfall or high humidity (8-10 hours) is required for infection by washed or splashed spores. While 23°C is the optimum temperature for infection, only temperatures above 37°C stop growth. Berry infection rarely occurs in New Zealand, as this requires 20-30 hours of wetness and warm weather at flowering. Leaf and shoot infections are generally seen on the first 20 cm of growth (Figure 3). When infection is severe, lesions can coalesce and leaves and bunches may be lost (Figure 4). The pathogen survives for the full season in the infected shoots, the infected areas becoming characteristically bleached. It produces fruiting bodies to start the cycle again the following spring.

Figure 1. Bleached cane with black-edged lesions and fruiting bodies.

Figure 2. Magnified bleached cane and fruiting bodies.

Figure 3. Green shoots with black lesions resulting from splashed spores being released from fruiting bodies onto bleached canes in spring.

Figure 4. In extreme infections, the shoot can become heavily infected (black), resulting in the loss of leaves and bunches, as shown here.

Control/management

The primary control of Phomopsis stem and leaf spot should be the removal of infected wood. Pruning to remove bleached canes with fruiting bodies removes most of the potential spores from the vineyard. If the prunings are mulched or burnt, then the risk of infection the following year will be greatly reduced. If a block has a history of infection, then monitoring should start two weeks after budburst when monitoring for powdery and downy mildew. At the time of publication, products with the active fungicides mancozeb, captan, folpet and fluazinam were available in New Zealand for chemical control of Phomopsis. The current New Zealand Winegrowers export wine grape spray schedule should be consulted before making any chemical applications.

Symptoms and other diseases for which it may be mistaken

Phomopsis on leaves can be mistaken for black spot. Phomopsis leaf symptoms alone may not be diagnostic but in combination with black lesions on the shoots, the disease can normally be easily identified. During the winter, bleached canes can be the result of either *Botrytis* or *Phomopsis*. The fruiting bodies of *Phomopsis* on the bleached canes (Figure 2) can be distinguished from the over-wintering stage of *Botrytis* on canes. If the cane material is incubated under warm damp conditions, *Phomopsis* will ooze a mass of spores, which can be best described as looking like coils of tooth paste. In contrast, *Botrytis* will produce grey mould growing across the cane surface. Regardless of which disease has resulted in the bleaching, the canes should be removed by pruning whenever possible.

Phomopsis staining on a cane.

Where can I get more information?

For detailed descriptions of how individual diseases may be dealt with, readers are directed to:

- Nicholas P., Magarey P. and Wachtel M. 2003. Diseases and Pests. Grape production series Number 1, Winetitles, Adelaide 2003.
- Pearson R. C. and Goheen A. C. 1988. Compendium of Grape Diseases. APS Press St. Paul, Minnesota, USA.

Further details on the grapevine trunk disease research is available on http://www.wineresearch.org.nz/publications/MarlboroughTrunkDiseaseWeb.htm

You may also contact:

Dion Mundy at dion.mundy@plantandfood.co.nz or
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WINEGROWING FACT SHEET NO. 5
Version 1 | January 2010
Written by Dion Mundy[1]

Plant & Food RESEARCH
RANGAHAU AHUMĀRA KAI

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Effects of trunk disease on crop quality

In assessing the cost to the industry of trunk diseases, a number of factors need to be considered (Wicks & Davies 1999).

Researchers have estimated yield reductions caused by trunk diseases, and the replacement costs of vines that are killed. Reworking and management costs of trunk diseases have also been calculated. The losses resulting from uneven berry maturity and consequential reductions in wine quality are also significant and are the focus of this fact sheet.

Changes in fruit composition during ripening and at harvest were monitored on vines with and without symptoms of trunk disease for two varieties Sauvignon blanc and Riesling.

During ripening, the soluble solids content of the Sauvignon blanc fruit was consistently lower (by 0.5-1.0 °Brix) for vines that had trunk disease symptoms than for vines without symptoms (Figure 1). The difference in soluble solids content was less consistent in ripening Riesling fruit. This reduction in soluble solids is consistent with reports for grapes with other vascular disorders (such as leaf roll virus) and indicates that these diseases are affecting fruit composition.

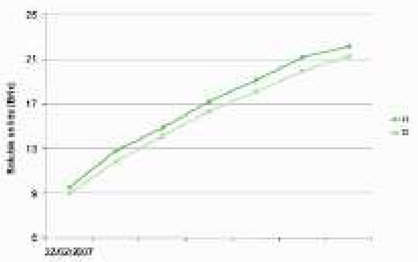

Figure 1. The development of soluble solids content in vines with (diseases (D)) and without (healthy (H)) grapevine trunk disease symptoms in 2007.

At harvest, significant differences were observed in soluble solids, amino acid concentrations, and total yeast assimilable nitrogen (YAN) only of Sauvignon blanc vines. A delay in soluble solids may result in an additional risk of disease or fruit not achieving a target sugar concentration. Symptoms also resulted in lower values of other characteristics (Table 1).

Table 1. Summary of physiological measurements of grapevines at harvest 2007 with and without trunk disease symptoms.

	Diseased vines		Healthy vines	
	Riesling	Sauv. blanc	Riesling	Sauv. blanc
32-berry weight (g)	45.3	58.0	44.5	56.7
Bunch number	54.6	55.0	48.6	59.0
Total yield per vine (kg)	3.70	4.27	2.90	3.78
Soluble solids (Brix°)	20.70	**21.40**	21.30	**22.30**
pH	2.99	2.99	3.01	3.05
TA (g/L)	11.13	10.10	11.12	10.00
Ammonium (mg/L)	125.6	112.2	135.0	123.4
Amino acids (mg/L)	117.5	**122.3**	146.0	**155.2**
Total yeast assimilable nitrogen (mg/L)	243.1	**234.5**	282.8	**278.6**

Values within a row in bold are significantly different from each other ($p=0.05$).

Sub-optimal fruit composition caused by trunk diseases will lower wine quality. This problem will rise as increasing numbers of New Zealand vineyards reach the critical age for expression of trunk disease symptoms. It may have a significant economic impact on the New Zealand wine industry in the longer term.

Acknowledgements

This research could not have been conducted without the help of Matua Valley Wines and Pernod Ricard New Zealand.

Where can I get more information?

For more information, readers are directed to:

- Mundy D, Cocchi C 2007. An evaluation of the impact of grapevine trunk disease on fruit quality and vine performance in the Marlborough region, New Zealand. 13th Australian Wine Industry Technical Conference, Adelaide, South Australia, 28 July – 2 August 2007. Pp. 327.
- Wicks T, Davies K 1999. Effect of Eutypa on grapevine Yield. The Australian & New Zealand Grapegrower & Winemaker (Annual Technical Issue): 15-16.

Further details on the grapevine trunk disease research is available on http://www.wineresearch.org.nz/publications/MarlboroughTrunkDiseaseWeb.htm

You may also contact:

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Marlene Jaspers at Marlene.Jaspers@lincoln.ac.nz

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WINEGROWING FACT SHEET NO. 6
Version 1 : January 2010
Written by Dion Mundy[1]

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Retrunking of old vines

If grapevines are starting to show symptoms of grapevine trunk diseases, retrunking is one management option. The method may restore productivity to infected vines and will remove infected wood that could otherwise contribute to the continued infection of vines within the block.

Key steps for retrunking of grapevines

The "train and cut" method of retrunking requires the selection of one or more water shoots (from above the graft union), which are trained to form a new canopy (Figure 1). The following year, the trunk above the new shoot is removed and the stump is painted with wound dressing (Figure 2). The renewed vine continues to grow and returns to production (Figure 3). A diagrammatic summary of the process is provided in Figure 4.

Figure 1. A vine with a water shoot trained to form a new trunk.

Figure 2. When the new canopy is established, the old trunk is removed and the wound is painted.

Figure 3. Renewed vine in production following 'retrunking'.

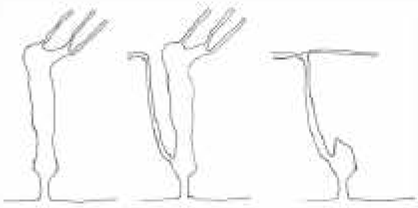

Figure 4. A simplified diagrammatic representation of the retrunking process.
1. Vine identified with visual trunk disease symptoms.
2. Water shoot trained to form new canopy.
3. Old infected trunk removed.

Considerations when planning retrunking for vines

Retrunking to renew vines infected with trunk diseases is labour intensive and costly [Sosnowski et al. 2004]. However, it is one of the few options available to restore productivity in severely infected grapevines. If retrunking is to be successful, then as much infected wood as possible should be removed. Ideally, the cordon or trunk should be cut so that no staining can be seen in the wood [Figure 5]. Greatest success with retrunking has been reported where 30 cm or more of unstained wood has been removed with the final cut.

Wound dressing is also important for the success of the operation. As the removal of cordons or sections of trunk generates large wounds, these should be painted with a registered wound dressing product [Sosnowski et al. 2009]. The angle of the cut should also be sloped to allow rain to run off the surface and not to pool. Major cuts should be made in late winter, when the wounds heal more quickly, and should not be made before or during large rainfall events.

Figure 5. Cross section of trunk with large amount of stained wood and small area of unstained wood.

Where can I get more information?

For detailed descriptions of how individual diseases may be dealt with, readers are directed to:

- Nicholas P., Magarey P. and Wachtel M. 2003. Diseases and Pests. Grape production series Number 1, Winetitles, Adelaide 2003.
- Pearson R. C. and Goheen A. C. 1988. Compendium of Grape Diseases. APS Press St. Paul, Minnesota, USA.

For information on retrunking of vines with eutypa die-back, readers are directed to:

- http://www.sardi.sa.gov.au/pestsdiseases/horticulture/horticulture_pathology/eutypa_dieback/eutypa_dieback_disease_management
- http://www.phylloxera.com.au/phylloxera/pdfs/Trunkdiseases.pdf
- Sosnowski M, Creaser M, Wicks T 2004. Managing eutypa dieback of grapevines by remedial surgery. The Australian & New Zealand Grapegrower & Winemaker: September 36-39.
- Sosnowski M, Loschiavo A, Wicks T, Scott E 2009. Managing eutypa dieback in grapevines. The Australian & New Zealand Grapegrower & Winemaker (Annual Technical Issue): 13-16.

Further details on the grapevine trunk disease research is available on http://www.wineresearch.org.nz/publications/MarlboroughTrunkDiseaseWeb.htm

You may also contact:

Dion Mundy at dion.mundy@plantandfood.co.nz or Marlene Jaspers at Marlene.Jaspers@lincoln.ac.nz

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WINEGROWING FACT SHEET NO. 7
Version 1 : January 2010
Written by Dion Mundy*

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Fungi associated with trunk diseases in the New Zealand wine-growing regions

Why are trunk diseases important?

Trunk disease refers to a disease syndrome with a loss of vigour and express cane dieback following colonisation of the trunk by various species of fungi. Infection is particularly common in the region of the crown, often via pruning wounds. These infections kill varying amounts of xylem (wood) and phloem tissue, limiting water and nutrient flow between roots and canopy. Symptoms range from general poor growth to complete vine death (Figure 1).

As vineyards age, the number of affected vines can increase, resulting in a general decline in productivity of the vineyard. Trunk diseases can also affect wine quality as a consequence of the fruit having lower sugar levels and reduced nitrogen compounds needed for complete fermentation. Vineyard managers are faced with having to make a decision on whether to replace vines only after they die, or whether to replace them while they are still producing but with reduced fruit quality and yield. The current and potential economic impacts of trunk diseases in New Zealand have not been quantified, making management decisions difficult for growers (however information on the cost of vine replacement due to virus has been completed and may be useful to growers faced with this problem).

What are the common symptoms?

- Poor growth of an arm or side of the head (Figure 1).
- Staining or browning of trunk tissue when the vine is cut in cross section (Figure 2).
- Vine death.

What are the common diseases?

Table 1. Common grapevine trunk diseases and the fungi associated with them.

Common name	Fungus	Distribution
Eutypa die-back (also Dying dead arm or Dead arm)	*Eutypa lata*	New Zealand and worldwide
Botryosphaeria die-back (also Black dead arm)	*Botryosphaeria* spp.	New Zealand, Italy, North America
Petri disease	*Phaeomoniella chlamydospora*	New Zealand and worldwide
Esca	A complex of fungi including *Phaeomoniella chlamydospora*, *Phaeoacremonium* species, *Fomitiporia* and others	Europe, North America
Phomopsis Dead Arm (Phomopsis stem and leaf spot)	*Phomopsis viticola*	New Zealand and worldwide

Are these fungi present in my region?

With the growth of the New Zealand wine industry in size and geographic distribution, the number of observations of grapevine trunk disease symptoms has increased. Within the industry, the identification of fungi in trunks of unthrifty vines has been a low priority. Previous studies have often focused on a single genus or regional record of disease.

In order to reduce the impact of trunk diseases in New Zealand vineyards, it is important first to establish which fungi are present. A preliminary investigation of the incidence of fungi isolated from trunk wood across a number of vineyard sites in New Zealand was conducted from 2007 to 2009 and a summary is provided. The samples were collected from 41 vineyard blocks across the North and South Islands of New Zealand. Core samples were taken from the trunks of five vines at each block, using a *forestry corer*. The entire core sample was transferred to the laboratory and the fungi present in the core identified.

The most commonly isolated fungi were species of the genera *Botryosphaeria*, *Phaeomoniella* and *Eutypa* (Table 2). Less commonly identified were *Phaeoacremonium* and *Phomopsis* spp.

The general trend was for all the fungi to be present in higher percentages in North Island vineyards. This may reflect the higher average age of the vines from these regions. The results are also only an indication of the presence of the fungi and do not confirm disease symptoms. As the sample size in each vineyard block was limited, we cannot be certain that failure to detect a particular genus indicates that these fungi were not present. For example, additional isolations will be needed to determine if Phaeoacremonium is more widely distributed.

Figure 1: Vine with symptoms of poor shoot growth resulting from trunk infection by *Eutypa*.

Table 2. Recoveries of fungal genera regarded as wood pathogens from a survey of thirty-seven vineyard blocks.
The survey of incidence of fungi was conducted in the North and South Islands of New Zealand during 2007, 2008 and 2009.

Genus	% North Island vineyards with fungi detected1 (n=24)	% South Island vineyards with fungi detected (n=17)
Botryosphaeria	83	41
Phaeomoniella	79	35
Eutypa	58	12
Phomopsis	33	29
Phaeoacremonium	13	6

[1] Some vineyards had all five fungi present, while others did not have any of the five listed fungi detected during the sampling.

How can these diseases be controlled?

Current recommendations for controlling all of these diseases are:

- Protect large pruning wounds with pruning paste.
- Do not make large pruning cuts during wet weather.
- Remove and burn dead wood from the vineyard as part of good hygiene measures (see WINEGROWING FACT SHEET NO. 9 FOR MORE DETAILS).
- Remedial pruning to remove infected wood (see WINEGROWING FACT SHEET NO. 6 FOR MORE DETAILS).

Figure 2. Wedge of dead stained grapevine wood that could be the result of infection by either *Botryosphaeria* sp. or *Eutypa lata*.

Where can I get more information?

Further details on the grapevine trunk disease research is available on http://www.wineresearch.org.nz/publications/MarlboroughTrunkDiseaseWeb.htm

You may also contact:

Dion Mundy at dion.mundy@plantandfood.co.nz or Marlene Jaspers at Marlene.Jaspers@lincoln.ac.nz

Suggested reading

- Nicholas P, Magarey P, Wachtel M 2003. Diseases and Pests. Grape production series Number 1, Winetitles, Adelaide 2003.
- Gubler WD, Rolshausen P, Trouillase F, Urbez J, Voegel T 2005. Grapevine trunk diseases in California. Practical Winery & Vineyard. 6-25 Pp. http://www.practicalwinery.com/janfeb05/janfeb05p6.htm
- Amponsah NT, Jones EE, Ridgway HJ, Jaspers MV 2008. Production of Botryosphaeria species conidia using grapevine green shoots. New Zealand Plant Protection 61: 301-305.
- Mundy DC, Manning MA 2006. Initial investigation of grapevine trunk health in Marlborough, New Zealand. 5th International Workshop on Grapevine Trunk Diseases. Department of Plant Pathology University of California, Davis, CA.
- http://www.phylloxera.com.au/phylloxera/pdfs/Trunkdiseases.pdf

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New Zealand Wine

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WINEGROWING FACT SHEET NO. 8
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Written by Dion Mundy[1]

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Phaeoacremonium spp. in New Zealand vineyards

Phaeoacremonium species are important to the New Zealand wine industry. Species of that genus are associated with two diseases of grapes in other countries. In California *Phaeoacremonium inflatipes* has been described as an aggressive pathogen of grape seedlings responsible for young grapevine decline (Scheck et al. 1998), which is now commonly referred to as Petri disease. *Phaeoacremonium* species are also part of the fungal disease complex of older vines, causing a disease known as Esca.

Current reported distribution in New Zealand

Phaeoacremonium is a genus with 28 species, many of which are associated with discoloured vascular tissue of woody plants (Graham et al. 2009). Some confusion exists over records of *Phaeoacremonium*, because recent taxonomic changes have moved what was known as *Phaeoacremonium chlamydosporum* out of this genus and into the taxonomic grouping *Phaeomoniella chlamydosporoa*. Records of detection in New Zealand of the new grouping of *Phaeomoniella chlamydosporoa* (not *Phaeomoniella chlamydospora*) are limited to: three species have been detected on rootstock plants in Auckland (Graham et al. 2009). There is also one record from Marlborough (Clearwater et al. 2000), three from Hawke's Bay (Mundy et al. 2009), and one from in Nelson unpublished data).

Spread within the vineyard

Work in California has shown that *Phaeoacremonium* spores can be detected in soil and standing water, as well as in the air at infected vineyards (Rooney-Latham et al. 2005). The correlation between trapped spore numbers and rainfall events suggests that these pathogens move as airborne inoculum during rainfall events. However, the complete life cycle and hence the importance of different kinds of spore dispersal for these fungi is still unknown.

Phaeoacremonium species are readily detected in wood of vines with both Petri disease and Esca. However vines that do not show symptoms of these diseases can have the fungi growing within the wood and transfer can occur during propagation. One way to reduce the spread of these diseases is to ensure that only clean mother plants are used to produce new planting material.

Petri disease symptoms

With Petri disease (also known as young vine decline, young esca, black goo), plants express slow growth with a reduction in trunk girth, shortened internodes, reduced foliage and reduced leaf size (Scheck et al. 1998). Vines may grow normally in the first year but decline in subsequent seasons with leaf chlorosis (yellowing) and early defoliation. Vines with symptoms generally have dark-brown to black staining in the vascular tissue when the trunks are cut in cross section (Figure 1). The symptoms may result in vine death or poor establishment of new plantings. Similar symptoms may be observed in vines infected with *Phaeomoniella chlamydosporum*. Often when *Phaeomoniella chlamydospora* is isolated from young vines, Phaeoacremonium species and other pathogens can also be isolated from the same tissue, making it very hard to determine which species are responsible for the symptoms.

Figure 1. Cross sections of young grapevine trunk with vascular staining.

Esca Symptoms

Esca (also known as black measles) is the disease complex that results in a trunk rot of older grapevines. The name Esca describes the soft white rotted fibres in the trunk (Figure 2) of the grapevine that can be used for tinder, a characteristic symptom of this disease (Surico 2008). Other symptoms include "apoplexy", or sudden wilting of the vine, with the shedding of some or all leaves and fruit, superficial brown to purple spots on the berry surface (measles), vascular discolouration of wood, typical tiger-striped patterns on leaves (Figure 3) and tip die-back of shoots (Eskalen et al. 2007). A range of fungi associated with the Esca complex (Table 1) can be grouped into two classes, wood streaking and white rots. In some cases, the leaf symptoms can be detected with just the wood-streaking fungi. No Esca symptoms have been reported in the field with only the white rot fungi present.

Table 1. Fungi associated with the Esca disease of older grapevines.

Grouping	Genus (and species where known)
Wood streaking	*Phaeomoniella chlamydospora* *Phaeoacremonium* species including (*aleophilum, angustius, iranianum, mortoniae, parasiticum, subulatum, venezuelense*)[1]
White rots	*Fomitiporella vitis* *Fomitiporia australiensis* *Fomitiporia polymorpha* *Fomitiporia mediterranea* *Inocutis jamaicensis* *Stereum hirsutum*

[1] Summary of wood-staining *Phaeoacremonium* species taken from Surico et al. (2008).

Figure 2. White rot fungi in the centre of a grapevine trunk within a ring of vascular staining.

Figure 3. Leaf symptoms of Esca including typical "tiger-stripe" leaf.

2567 Trunk health in New Zealand vineyards Page 17

Why should we look for *Phaeoacremonium* species in New Zealand?

The disease Esca has been widely reported in viticultural regions throughout the world (Rooney-Latham et al. 2005) but has not been reported in New Zealand. In Europe Esca is a considerable disease problem, with no chemical control option available. If we detect Esca in New Zealand, it will be important to control the disease quickly before it can spread. One of the main methods of control currently recommended is to control the nursery process so that *Phaeoacremonium* species do not establish in the vineyard with new plantings (Surico et al. 2008). Planting vines without *Phaeoacremonium* species present should also reduce the likelihood of losses due to Petri disease.

Where can I get more information?

Further details on the grapevine trunk disease research is available on http://www.wineresearch.org.nz/publications/MarlboroughTrunkDiseaseWeb.htm

You may also contact:

Dion Mundy at dion.mundy@plantandfood.co.nz or Marlene Jaspers at Marlene.Jaspers@lincoln.ac.nz

Suggested reading

- Clearwater LM, Stewart A, Jasper MV 2000. Incidence of the "black goo" fungus, *Phaeoacremonium chlamydosporum*, in declining grapevines in New Zealand. New Zealand Plant Protection 53: 448.
- Eskalen A, Feliciano AJ, Gubler WD 2007. Susceptibility of Grapevine Pruning Wounds and Symptom Development in Response to Infection by *Phaeoacremonium aleophilum* and *Phaeomoniella chlamydospora*. Plant Disease 91 (9): 1100-1104.
- Graham AB, Johnston PR, Weir BS 2009. Three new *Phaeoacremonium* species on grapevines in New Zealand. Australasian Plant Pathology 38 (5): 505-513.
- Mundy DC, Casonato SG, Manning MA 2009. Incidence of fungi isolated from grape trunks in New Zealand vineyards. The Australasian Plant Pathology Society 2009, Newcastle City Hall NSW Australia. Pp. 86.
- Rooney-Latham S, Eskalen A, Gubler WD 2005. Teleomorph Formation of *Phaeoacremonium aleophilum*, Cause of Esca and Grapevine Decline in California. Plant Disease 89 (2): 177-184.
- Scheck H, Vasquez S, Fogle D, Gubler WD 1998. Grape growers report losses to black-foot and grapevine decline. California Agriculture 52 (4): 19-23.
- Surico G 2008. Towards a more precise definition of esca. 6th International workshop on grapevine trunk diseases: esca and grapevine declines, Florence, Italy, 1-3 September 2008. Pp. 29.
- Surico G, Mugnai L, Marchi G 2008. The Esca Disease Complex. In: Ciancio A, Mukerji KG ed. Integrated Management of diseases Caused by Fungi, Phytoplasma and Bacteria. Springer Science. Pp. 119-136.

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FURTHER INFORMATION //

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Vineyard hygiene and prevention of trunk diseases

One of the simplest and yet most effective ways to reduce the spread of grapevine trunk diseases is to practice good vineyard hygiene (such as removing dead and infected vines).

If dead infected wood is not removed (Figure 1), then spores can be produced in large numbers following rainfall and these will infect new wounds in adjacent vines. High numbers of spores result in a high chance of infection. Removal of the infected wood, followed by burning or burial of the material dramatically reduces the numbers of spores in the vineyard. Pulling out vines and making a pile on the edge of the block (Figure 2) is not a solution, as the pile of vines will still release spores from infected vines.

Dead vines in a block, should be removed as soon as possible (Figure 3). When vines die and dry out, this is often the signal for the fungi in the wood to start producing spore bodies on the outside. If these spore bodies are allowed to mature spores can be spread during wet weather to new wounds on adjacent grapevine trunks, leading to patches of dead vines in the block (Figure 4).

The removal of infected dead wood from the vineyard will not cure vines affected by trunk diseases. However, as part of an integrated system of control, good vineyard hygiene should slow their spread. Conversely, failure to implement good vineyard hygiene will severely restrict the success rate of other management options.

Figure 1. Dead wood, not removed from vineyard (poor hygiene), producing *Eutypa lata* spores.

Figure 2. Leaving large piles of dead vines in the vineyard is not good vineyard practice and can lead to the spread of trunk diseases.

Figure 3. Dead vines should be removed from the canopy to prevent the spread of disease to healthy vines.

Figure 4. Vines adjacent to the first infection die over time, leaving a zone of dead plants.

Where can I get more information?

Further details on the grapevine trunk disease research is available on http://www.wineresearch.org.nz/publications/MarlboroughTrunkDiseaseWeb.htm

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Other publications

http://www.wineresearch.org.nz/publications/MarlboroughTrunkDiseaseWeb.htm

Marlborough Trunk Disease Web

Publications
Our Reports
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Current research areas and contacts
Dion Mundy - Plant and Food Research
- Surveys of Grapevine trunk diseases in New Zealand
- Control and management of diseases
- Plant and disease interaction for grapevine trunks

Marlene Jaspers - Lincoln University
- Petri disease, a cause of young vine decline
- Cylindrocarpon black foot disease, which causes a lot of grapevine roots and stem bases
- Botryosphaeria dieback of grapevines

Basic information about diseases and fungi related to them

Common name	Fungus	Distribution
Botryosphaeria die-back (also Black dead arm)	Botryosphaeria spp.	New Zealand, Italy, North America
Esca	A complex of fungi including *Phaeomoniella chlamydospora* and *Phaeoacremonium* species, *Fomitiporia* and others	Europe, North America
Eutypa die-back (also Dying dead arm or Dead arm)	*Eutypa lata*	New Zealand and world wide
Petri disease	*Phaeomoniella chlamydospora*	New Zealand and world wide
Phomopsis Dead Arm	*Phomopsis viticola*	New Zealand and world wide

Links
International Council on Grapevine Trunk Diseases
Plant & Food Research
Lincoln University
Ministry of Agriculture and Forestry Sustainable Farming Fund
- National vineyard grapevine health project
- Marlborough grapevine trunk disease project

2567 Trunk health in New Zealand vineyards Page 21