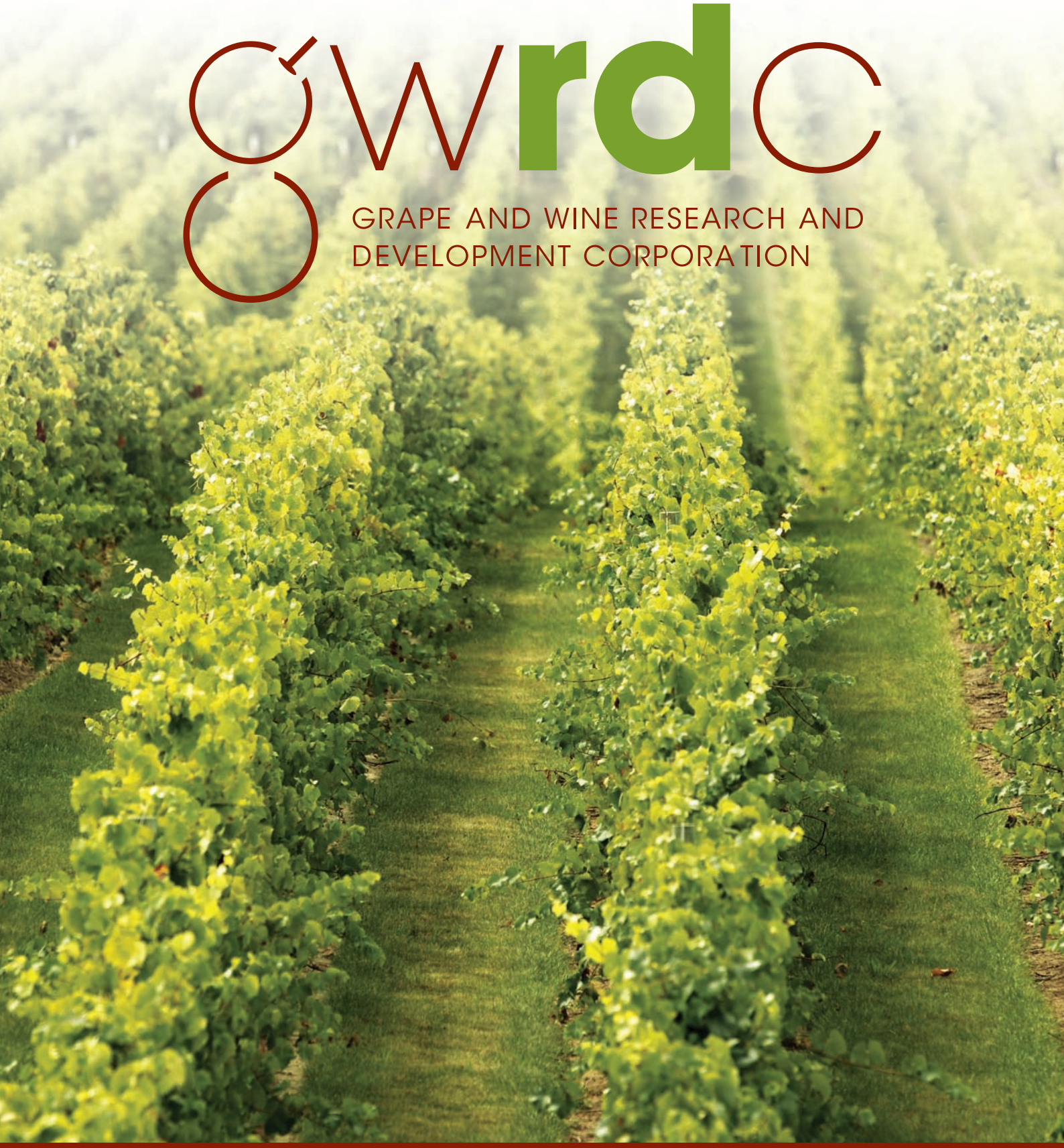
GRAPE AND WINE RESEARCH AND DEVELOPMENT CORPORATION



SMOKE EFFECT IN GRAPES AND WINE

managing quality in a changing climate

1. Introduction (what)

The on-going presence of atmospheric smoke from bushfires through Victoria has caused concern in a number of different wine grape growing regions throughout south-eastern Australia, in particular Victoria. This factsheet has been produced in collaboration with the Grape and Wine Research and Development Corporation (GWRDC), Department of Primary Industries (DPI) Victoria, The Australian Wine Research Institute (AWRI) and the Victorian Wine Industry Association (VWIA) to provide information for those grapegrowers and wineries considering sampling grapes, wine or leaves to assess the likelihood of being negatively impacted upon by the smoke.

Image courtesy of Mark Krstic, GWRDC

2. Assessing potential impact (why)

Since 2003, a number of research programs have been initiated across Australia to better understand how atmospheric bushfire smoke is absorbed by the vine and how this ultimately impacts on reducing overall wine quality. Research in 2007 has suggested that the various smoke compounds, of which there are over 3000, appear to enter the vine through the leaves, and are actively translocated to the fruit (Krstic and Whiting 2007). The chemical composition of bushfire smoke varies greatly depending on the types of native vegetation and actual burning conditions, but guaiacol and 4-methylguaiacol appear to be good 'indicator' compounds in both grapes and wine of potential smoke exposure and relate in a negative way to the likely impact on overall wine quality. Guaiacol (2-methoxyphenol) has aromas described as smoky, phenolic, aromatic, burnt, and burnt bacon and 4-methylguaiacol has smoky, leather, and spicy aromas. However, these are only two of the many potential compounds within the bushfire smoke and current research is investigating other potential 'indicator compounds'. It should also be noted that guaiacol and 4-methylguaiacol are compounds normally imparted to wine from oak and this needs to be taken into account when wine samples are being collected for analysis.

How much exposure to smoke is required to create a smoke taint effect in grapes and wine? Although research is ongoing in this area, it is interesting to note that a single heavy exposure of smoke to grapevines is sufficient to result in smoke taint in wine, assuming that the exposure occurs sometime between fruitset and harvest. Vines and grapes are highly sensitive to uptake of smoke from veraison to harvest. Research has also shown that repeated smoke applications to the same vines has resulted in a cumulative effect on the levels of smoke compounds and smoke aromas in wine (Kennison et al. 2008). Therefore, grapes that have repeated smoke exposures or smoke exposures for a long period of time produce wines with an accumulation of smoke aromas and compounds.

3. When and where to sample

Samples can be collected from grapes, leaves, un-fermented juice or wine and submitted for testing. What samples are submitted for testing depends on the point in time in the growing season when samples are collected, and the particular party interested in assessing likely smoke impact.

Grapevine leaf and fruit samples should be collected in the morning prior to 10 am. This ensures that samples are collected at times of low temperature and moisture stress, and ensures consistency between different sampling dates.

The most effective time to test levels of guaiacol and 4-methylguaiacol in grapes is as close to harvest date as possible. It should be noted, however, that a finding of low concentrations in grapes at harvest is not a guarantee that any wine made from those grapes will be free from smoke taint. Guaiacol can be released from precursors and bound forms during fermentation. Research is currently underway to identify these precursors and to develop diagnostic or predictive assays to quantify the potential for release of guaiacol during fermentation, however such assays are not currently available.

For growers and wineries with a number of vineyards that may require sampling and testing, a strategic approach should be adopted. All vineyards do not need to be sampled at the same time. Sample those varieties which ripen the earliest first (e.g. Pinot Noir and

Chardonnay). It is important to note that for lighter style varieties such as Pinot Noir, smoke taint characters might be perceived as more pronounced than full bodied styles such as Cabernet Sauvignon and Shiraz. It is important to sample in a procedure that provides the most useful information first. For example for a number of vineyards of the same grape variety, sample the vines considered to be first exposed to smoke . This is likely to provide an idea of the worst case scenario.

In terms of the different types of samples being submitted for analysis, the following is provided as a guide:

3.1 Grapes:

Previous research has indicated that the variability of guaiacol and 4-methylguaiacol smoke effect 'indicator' compounds in an individual vineyard is high. Therefore it is important to ensure that a representative sample be collected from the entire vineyard. It is recommended that a random 30 bunch sample from across the entire vineyard is collected and only 1 bunch collected per vine. Once all 30 bunches have been collected, strip approximately half the berries off each bunch and place into a large container. Mix the berries and from this container collect, bag and label a sample of berries weighing approximately 500 grams.

Image (c) Bryan Coombe. Image supplied courtesy of the AWRI Online Image Collection.

3.2 Leaves and canes:

While entry of these smoke compounds appears to be via the leaves of a grapevine, it is thought that measurement of levels of guaiacol and 4-methylguaiacol in leaves might provide a better indicator of smoke taint potential in both grapes and wine. This is still a research hypothesis being tested this season. However, for those who wish to submit leaf samples for analysis please collect at least 100 grams of approximately 50 leaves (blade and petiole, select fully functioning leaves from the middle of the shoot, avoid old basal and young distal leaves). Ensure that samples are collected from across the entire vineyard and only collect 1 leaf per vine). Collect, bag and label a sample and submit for analysis. Cane samples can also be analysed if required. Please discuss any leaf or cane sampling with experts from the AWRI.

Image (c) P. May and E.A. Lawton. Image supplied courtesy of the AWRI Online Image Collection.

3.3 Unfermented juice:

A 50 mL centrifigued or settled juice can be submitted in labeled plastic containers. Juice samples will need to be frozen prior to despatch and it is advisable to add a protective amount of SO2 (~200 mg/L) to prevent fermentation.

Image (c) The Australian Wine Research Institute. Image supplied courtesy of the AWRI Online Image Collection.

3.4 Wine:

A 50 mL sample of finished wine in either a plastic or glass labeled container can be submitted for analysis. Also, in response to issues associated with the release of bound forms of guaiacol and 4-methylguaiacol during winemaking, a number of winemakers are opting to conduct laboratory-scale ferments in an attempt to better understand the actual impact on final wine. This could give a good indication of a presence of taint and

its likely severity. The AWRI has proposed the following protocol. A basic fermentation protocol has been proposed by the AWRI in the 2009 season. This includes:

(i) Sampling

This procedure should be followed for both white and red grapes. A sub-sample of 1 kg of loose berries from the 30 bunch grape sample should be used.

(ii) Crushing, pressing and fermentation

Crush grapes by hand in a clean sealable container using a potato masher. Add potassium metabisulphite (PMS) 50 ppm, Pectic enzyme at twice the recommended rate and diammonium phosphate (DAP) 200 ppm. Prepare and add an active dried wine yeast such as EC1118, 300 mg/L, ferment at 20-25°C, mixing a few times per day. It is ideal to maintain a management regime that matches actual large-scale production conditions and ensure the fermentation does not stick or develop reduced characters. Aim for a five day ferment if possible. The majority of guaiacol is usually released during the first four days of fermentation or within the first 8°Bé.

(iii) Post fermentation analysis

Dryness of fermentation can be verified using clinitest tablets. Hand press through a strainer and aim to extract at least →550 mLs of finished wine. It is preferable to add 60 ppm PMS, cold settle overnight or centrifuge. Submit wine to an experienced sensory panel that is familiar with the identification of smoke taint characters. A 50 mL sample of finished wine in either a plastic of glass labeled container can be submitted for analysis. Wines that are originating from a Phylloxera Infested Zone (PIZ)/Phylloxera Exclusion Zone (PEZ) areas do not need a plant health declaration and can be shipped direct. Use a clean plastic drink size bottle if wines have a high CO_2 content.

Steve Lowe (King Valley Vignerons) and Wendy Cameron (Brown Brothers winemaker) assessing smoke tainted wines and grape juices in 2007. Photo courtesy of Mark Krstic.

4. Sending samples for analysis in Victoria

DPI Victoria's Farm Services Victoria - Grapes Team, has established a single permit for Plant Health Certificates to assist growers or wineries wanting to send fruit to the AWRI, Vintessential or Chemical Analysis for testing. Growers or wineries who wish to sample their fruit for testing levels of smoke taint 'indicator' compounds guaiacol and 4-methylguaiacol, and who might need assistance with the preparation, processing and transport of these samples should contact either Ricky James or Kieran Murphy from DPI Victoria for instructions and further assistance (contact details below). As the the AWRI is located in Adelaide, South Australia all grape samples that are sent are bound by Phylloxera protocols and must be accompanied by a Plant Health Certificate as issued by the Plant Standards branch of the Victorian DPI. A Plant Health Certificate can only be issued if the samples have been frozen at -18°C for a period of 24 hours in an approved facility. Depending on demand, the DPI Grapes Team will take delivery of fresh samples at a number of central locations for processing as per Plant Standards requirements and shipped in bulk to the AWRI,Vintessential or Chemical Analysis.

There are three facilities where growers or wineries can leave samples: Punt Road Wines in the Yarra Valley, Mitchelton Wines at Nagambie and the DPI Victoria offices at Rutherglen. Growers and wineries must complete the paperwork provided detailing name, address, variety, block, fax, email, etc. The procedure for the collection of samples is outlined below.

At this stage, shipments to the AWRI/Vintessential/ Chemical Analysis will be on Tuesday and Thursday evenings. Be mindful that fruit needs to be frozen for 24 hours prior to shipping, so samples due for shipment on Tuesday or Thursday for example, will need to be in freezer by 12.00 pm (midday) the previous day at the latest. The delivery of chilled or already frozen samples will ensure the samples are dispatched ASAP.

4.1 Delivery procedure:

Yarra Valley- Punt Road Wines- Delivery of samples is strictly from 9:00 am to 5:00 pm. Samples are to be taken directly to the freezer and signed in with all information recorded. Samples left in the laboratory will not be accepted. For further details contact Kieran Murphy on 0408 591 858.

Nagambie- Mitchelton Wines- Delivery of samples is strictly by appointment only. Please contact Ricky James on 0447 341 373 to arrange a time to deliver samples.

North East- DPI Rutherglen- Delivery of samples is strictly between 9:00 am and 12:00 midday on Mondays and Wednesdays. For further details contact Ricky James on 0447 341 373.

Samples from Phylloxera Exclusion Zones and Phylloxera Restricted Zones areas can be delivered into these areas for collection.

Please ensure that each sample to be tested is double bagged in the appropriately sized clip-lock bags. Both the inner and outer bag will need to be labeled with adhesive labels stating the grower's name, address,variety and block details. The contact details and address for each sample submitted is required to facilitate invoicing from the AWRI/Vintessential/ Chemical Analysis for the service.

5. Sending samples for analysis in NSW

For those growers or wineries in NSW wanting to submit samples to the AWRI for analysis, the NSW Department of Primary Industries (DPI) has established a 'Movement conditions of wine grape samples from NSW to South Australia for smoke taint testing' protocol. The protocol can be downloaded from the National Wine Grape Industry Centre (NWGIC) website www.nwgic.org or by contacting Duncan Farquhar on 0418 427 789 or email duncan.farquhar@dpi.nsw.gov.au.

6. Payment details

DPI Victoria and GWRDC will cover the costs of the Plant Health Certificate and transport to the appropriate laboratory. Laboratories will directly invoice growers or wineries for any testing done. Please contact the laboratory prior to despatch of samples (contact details below) to notify them of pending analysis required and to arrange payment details. It is advised that growers or wineries contact the AWRI/Vintessential/Chemical Analysis to arrange payment facilities.

7. Laboratory contact details

7.1 The AWRI:

Contact the Analytical Service, Customer Service on telephone (08) 8303 6600, fax (08) 8303 6621 or email analyticalservice@awri.com.au

For information regarding analytical result interpretation please contact Con Simos, Winemaking & Extension Services on (08) 8303 6600, 044 888 9432 or email con.simos@awri.com.au

Analytical Service
The Australian Wine Research Institute
PO Box 197
Glen Osmond SA 5064

The AWRI have committed to a fast turnaround time of three working days on receipt of the sample to be tested. For more information and pricing, go to the AWRI website: http://www.awri.com.au/analytical_service/analyses/smoke_taint/

7.2 Vintessentials:

Contact Stephen Byrne on telephone 03 5987 2242, fax 03 5987 3303 or email info@vintessential.com.au

Vintessentials
13/143 Point Nepean Rd
PO Box 2244
Dromana VIC 3936

For more information and pricing visit www.vintessential.com.au/

7.3 Chemical Analysis:

Contact Russell Kinghorn on telephone 03 8850 5000, fax 03 9852 0772 or email info@chemicalanalysis.com.au

Chemical Analysis
41 Greenaway Street
Bulleen VIC 3105

For more information visit www.chemicalanalysis.com.au/

8. Results and interpretation

Results from laboratory analysis of guaiacol and 4-methylguaiacol are typically reported back in terms of micrograms per litre (µg/L) for each compound. The limit of detection is set at 1 µg/L in grapes and wine, with an uncertainty of ±1.0 µg/L or ±10% (whichever was greater). For samples where the laboratory has reported 'not detected' or 'below the limit of detection' this means that the compounds in the samples have not exceeded the 1 µg/L level. The sensory threshold (that is, the level under which the compounds are unlikely to be smelt) in sparkling juice base is approximated at 6 µg/L. For finished wine, the sensory threshold largely depends on the wine's structure; winemakers have observed smoke taint levels, in lighter red wine styles, of 12-15 µg/L.

Grapes and leaf samples are recorded in units of micrograms per kilogram fresh weight (µg/kg). The limit of detection is set at 1 µg/L in both grapes and wine, with an uncertainty of ±1.0 µg/L or ±10% (whichever was greater).

It should be noted, however, that a finding of low concentrations in grapes at harvest is not a guarantee that any wine made from those grapes will be free from smoke taint. Also, low concentrations in young wine is not a guarantee that wine will not exhibit 'smoke taint' sensory characters as the wine ages.

What can winemakers do to mitigate the impact of smoke taint in the final wine? Processing at cool temperatures, hand harvesting, bunch pressing and shorter skin contact during are beneficial. Carbon has proven to be effective at removing smoke taint characters in white juices, although its action is non selective and care should be taken. Carbon will also remove grape characters. Refer to the Winemaking and Extension services team at the AWRI for more information. Post fermentation techniques such as reverse osmosis have also shown shown positive results in reducing guaiacol and 4-methylguaiacol in wines (Wilkinson, 2009). There have also been some early indications that exogenous tannin additions may also aid in the management of the problem in wines. However, this last point is still very much under investigation.

9. Key references

- Kuchel, J. (2003). Trials to extract smoke compounds from grape berries before harvest. Technical report produced for the Alpine Valleys Winemakers and Grapegrower Association. Conducted by Vignoble Monitoring Services, 23 pages.
- The Australian Wine Research Institute (2003). Annual report 2003. Glen Osmond, South Australia.
- Krstic M.P. and Whiting J. Understanding the sensitivity to timing and management options to mitigate the negative impacts of bush fire smoke on grape and wine quality – Scoping study. Victorian Department of Primary Industries, 2007, 59 pages.
- Kennison K.R., Wilkinson K.L., Williams H.J., Smith J.H. and Gibberd M.R. (2007) Smoke-derived taint in wine: Effect of postharvest smoke exposure of grapes on the chemical composition and sensory characteristics of wine. J. Agric. Food Chem. 2007, 55, 10897-10901.
- Kennison, K.R., Gibberd, M.R., Pollnitz, A.P. and Wilkinson, K.L. (2008) Smoke derived taint in wine: the release of smoke-derived volatile phenols during fermentation of merlot juice following grapevine exposure to smoke. Journal of Agricultural and Food Chemistry 56, pp. 7379-7383.
- Krstic, M.P. (2008) Smoke taint workshop. Proceedings of the 2nd smoke taint technical workshop. Final report to the GWRDC for project number GWR 07/07, 44 pages.
- Kennison, K., Wilkinson, K. and Gibberd, M. (2009) Latest Developments in the Investigation of Smoke Derived Taint in Grapes and Wine. Factsheet produced by Department of Agriculture and Food Western Australia, University of Adelaide and Curtin University, 7 pages
- Wilkinson, K. (2009) Amelioration of smoke taint derived taint in wine by membrane filtration and solid phase adsorption. Final report to the GWRDC for project number RD 06/04-2, 28 pages.
- Kennison, K., Wilkinson, K., Pollnitz, A., Williams, H. and Gibberd, M. (2009) Effect of timing and duration of grapevine exposure to smoke on the composition and sensory properties of wine. Australian Journal of Grape and Wine Research (in press).

GWRDC
GRAPE AND WINE RESEARCH AND DEVELOPMENT CORPORATION

- Kennison, K. (2009) Bushfire generated smoke taint in grapes and wine. Final report to the GWRDC for project number RD05/02-3, 50 pages.
- Downey, M. O., Pitt, K. and Lowe, S. (2009). Impacts of Smoke on Grapes and Wine in Victoria. Factsheet produced by the Victorian Department of Primary Industries, 2 pages.
- Articles that are or have been published in Australian Viticulture (Winetitles):
  - o Krstic, M.; Martin, S. and Lowe, S. (2007) Influence of bushfires in north-east Victoria on smoke taint issues, Australian Viticulture, 11 (2), 31-33
  - o Anon. (2008); Workshop discussion guides the future of smoke taint research, Australian Viticulture, 12 (5), 58-59
  - o Jones, L. (2008) Smoke taint study aims to understand more about the impacts on grape and wine quality, Australian Viticulture, 12 (3), 102-103
  - o Logan, S. (2008) Lessons from a fiery day in February, Australian Viticulture, 12 (1), 74-76
  - o Simos, C. (2008) The implications of smoke taint and management practices, Australian Viticulture, 12 (1), 77-80
  - o Turner, B.; Wilkinson, K. and Simos, C. (2008) Smoke taint research under way to assist growers in the future, Australian Viticulture , 12 (3), 100-101
  - o Ward, G.; Kennison, K. and Gibberd, M (2008) Decision making enhanced by smoke taint research, Australian Viticulture, 12 (3), 98-99
- Articles that are or have been published in the Australian & New Zealand Grapegrower & Winemaker (Winetitles):Smith, F. (2006) The taint of smoke, Australian & New Zealand Grapegrower & Winemaker, 510: 45-46
  - o Smith, F. (2006) Tainted wine is commercial death, Australian & New Zealand Grapegrower & Winemaker, 508: 56-58
  - o Vallesi, M. and Howell, G. (2007) The ashes we didn't want – smoke taint in vintage 2007, Australian & New Zealand Grapegrower & Winemaker, 520: 66-77
  - o White, T. (2007) Smoke taints perception on exact characteristics, Australian & New Zealand Grapegrower & Winemaker, 521: 65-66
  - o Smith, F. (2008) What to do if smoke gets in the wine, Australian & New Zealand Grapegrower & Winemaker, 530: 20

Note that some of these references are currently available from the GWRDC website on the homepage, visit www.gwrdc.com.au for downloadable copies of these.

Visit the AWRI website for more information about guaicol as a wine taint, or to obtain a copy of the paper: Simos, C. (2008) The implications of smoke taint and management practices, Australian Viticulture, 12 (1), 77-80. All Australian wine and grape levy payers have password access to these sections of the AWRI website. To apply for a password go to the AWRI website (www.awri.com.au) and click on 'Levy payer new account' on the home page and follow the prompts.

AWRI Online Image Collection (http://www.awri.com.au/information_services/medialibrary)

A webcast presentation is also available to wine and grape levy payers via the AWRI website on smoke taint management practices.

On 12 February 2009, the Department of Primary Industry Victoria issued an email bulletin entitled 'Bushfire and Smoke – wine industry' which contains links to further information on research undertaken into smoke taint by the Department of Agriculture and Food WA, Curtin University of Technology and the University of Adelaide, and also to a fact sheet produced by the Victorian Department of Primary Industries in conjunction with the King Valley Vignerons, as a part of the 'Strategies to manage the impact of smoke taint in Australian vineyards' project. The email bulletin contains other important information with regard to mitigation strategies in dealing with smoke taint.

A DVD has been produced by DPI Farm Services Victoria (FSV) from a Grape and Wine Research Development Corporation funded workshop on the effect of smoke on wine grape quality. For a copy of the DVD, please contact Kieran Murphy on 03 92964658 or kieran.murphy@dpi.vic.gov.au

An online video provides a summary of the DVD and is available to view on the DPI Victoria Website, to view go to www.dpi.vic.gov.au/horticulture.

10. Key contacts for further technical information (who)

Con Simos – Group Manager – Industry Development and Support at the AWRI

Phone 08 8303 6600

Mobile 0448 889 432

Email: con.simos@awri.com.au

Ricky James – DPI Victoria – Grapes Industry Development Officer (Central and North Eastern Victoria)

Phone 02 6030 4611

Mobile 0447 341 373

Email: Ricky.James@dpi.vic.gov.au

Kieran Murphy – DPI Victoria – Grapes Industry Development Officer (Yarra Valley, Mornington Peninsula and Port Philip regions)

Phone 03 9296 4458

Mobile 0408 591 858

Email: Kieran.Murphy@dpi.vic.gov.au

Authors:

Con Simos & Sarah Ballantine (AWRI)

Mark Krstic (GWRDC)

Joanne Butterworth-Gray (VWIA)

Ricky James, Kieran Murphy and Pam Strange (DPI Victoria)

Kristen Kennison and Glynn Ward (DAFWA)

Kerry Wilkinson (University of Adelaide)

Duncan Farquhar (NWGIC)

Disclaimer

This publication may be of assistance to you but the State of Victoria and other agencies associated in the development of this information and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

This factsheet has been produced in partnership with a number of key research agencies (AWRI, DPI Victoria, Department of Agriculture and Food WA, The University of Adelaide and the National Wine Grape Industry Centre), in association with the GWRDC and the Victorian Wine Industry Association.