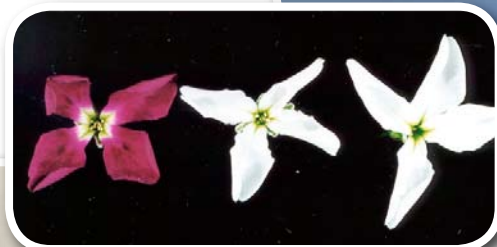
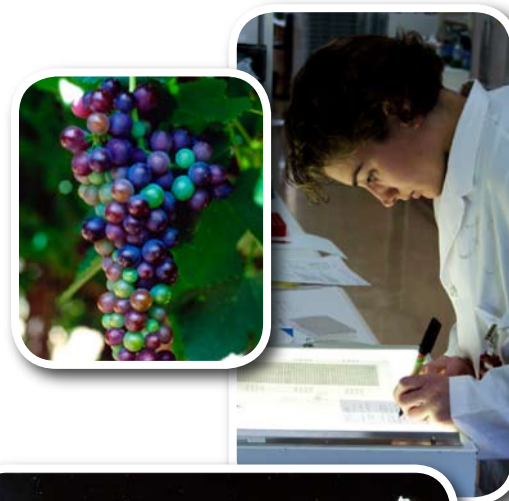


PhD Projects 2007

ADELAIDE LABORATORY
WAITE PRECINCT
URRBRAE SA



This booklet contains general information about undertaking a PhD at CSIRO Plant Industry (Adelaide Laboratory) in collaboration with a University Department. If you require any further information please contact our postgraduate co-ordinator Dr Mandy Walker (mandy.walker@csiro.au, ph:08 8303 8600) or go to the CSIRO PI postgraduate website at: www.pi.csiro.au/careers/phd/doingphd.htm

Where are we?

Nestled in the Adelaide foothills on the picturesque Waite Precinct of the University of Adelaide.

The Waite Precinct in Adelaide is Australia's leading research, education and commercialisation cluster set in the beautiful Adelaide foothills, with views of the sea and the city centre only 7km away. It includes the internationally renowned Waite Arboretum, Urrbrae House Historic Precinct and the Waite Conservation Reserve. It has the largest concentration of expertise in the southern hemisphere in the areas of plant biotechnology, cereal breeding, sustainable agriculture, wine and horticulture and land management.

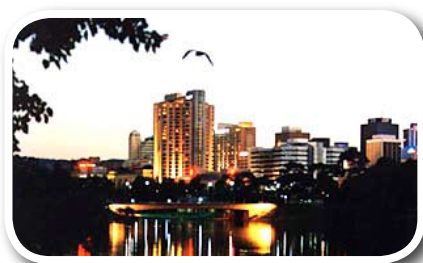


The Waite is home to a number of Schools within the Faculty of Sciences of the University of Adelaide, and a number of research partners including the CSIRO, Primary Industries and Resources South Australia (PIRSA), the South Australian Research and Development Institute (SARDI), the Australian Wine Research Institute (AWRI) and the Australian Centre for Plant Functional Genomics (ACPGF).

More info on the Waite Campus:

www.adelaide.edu.au/campuses/waite/

Adelaide as a place to live:



dynamic World leaders in wine technology and marketing, software developer Ratbag games, the emerging film support industry

glamorous The Festival of Arts, Tour Down Under, Adelaide Cup

trendy Rundle Street East, Adelaide Hills, Fleurieu Peninsula, the Fringe, the West End

creative The Jam Factory, our film industry, research centres, Adelaide International Film Festival and performing arts companies

contemporary The emerging bioscience industry, the city's broadband infrastructure, environmental initiatives

progressive Live music, Hip Hop, Adelaide's tradition of social reform, the Festival of Ideas, Thinkers in Residence, Writers Week

fun Festivals (Womad, Cabaret, Feast, the Fringe), food, wine

innovative Wine research, Adelaide's leadership in business clusters, IT industry

stylish Adelaide's elegance, heritage architecture, Adelaide's proliferation of restaurants.

More info:

www.adelaidecitycouncil.com/discover/visitor/index.asp

Why do a PhD at CSIRO PI?



By doing your PhD with CSIRO Plant Industry you will experience world class facilities and work alongside Australia's leading plant scientists. Plant Industry's world-wide reputation for scientific excellence and achievement is reflected in its ranking in the top three plant scientific institutes in the world.

How to do a PhD at CSIRO PI - Adelaide Laboratory

All students undertaking PhDs with CSIRO Plant Industry are affiliated with a university and have a university supervisor allowing students to maintain and develop their university connections while being exposed to research in a working environment. Prospective students should first contact the relevant CSIRO scientist to discuss the project they are interested in doing. If the student is accepted into the PhD program at CSIRO PI, they will then be assisted in identifying a suitable University supervisor and applying for a postgraduate scholarship at the University of Adelaide (www.adelaide.edu.au/scholarships/) or Flinders University (www.fp.cc.flinders.edu.au/scholarships/). As completed applications for postgraduate scholarships must be submitted to the respective Universities by the 31st October, students are encouraged to contact CSIRO PI regarding possible PhD projects in early October.

But wait ...there's more:

- > Divisional top-up stipends of \$5,000 available to 1st class Honours students with an Australian Postgraduate Award (APA) scholarship
- > High level supervision
- > Modern laboratories with state of the art equipment
- > Personal computer and IT support provided
- > Financial support provided to attend local and international conferences
- > Training courses available e.g. Scientific writing, Media skills etc.
- > Peer support program
- > Free parking!
- > 5 minutes to the famous Edinburgh Hotel!!

More info:

www.pi.csiro.au/careers/phd/doingphd.htm

RECENT CONFERENCES ATTENDED BY OUR PHD STUDENTS

Local

- > 12th Australian Wine Industry Technical Conference, Melbourne, July 2004
- > 6th Australasian Plant Virology Workshop, Gold Coast, August 2004
- > ComBio 2005, Adelaide, September 2005
- > Australian Society of Microbiology Conference, Canberra, September, 2005

International

- > 7th International Symposium on Grapevine Physiology & Biotechnology, University of California, Davis, USA, June 2004
- > 13th International Workshop on Plant Membrane Biology, Montpellier, France. July 2004
- > 11th International Cereal Rust and Powdery Mildew Conference, John Innes Centre, Norwich, UK, August 2004
- > IUMS2005 - Microbes in a Changing World, San Francisco USA, July 2005
- > 4th International Workshop on Anthocyanins, Rotorua, New Zealand February 2006
- > 8th International Congress of Plant Molecular Biology, Adelaide, August 2006

Publications BY SOME OF OUR RECENT PHD STUDENTS

- > Tucker MR *et al.* (2004) Sexual and apomictic reproduction in *Hieracium* subgenus *pilosella* are closely interrelated developmental pathways.
Plant Cell 15: 1524-1537
- > Downey MO *et al.* (2004) The effect of bunch shading on berry development and flavonoid accumulation in Shiraz grapes.
Aust J Grape & Wine Res 10: 55-73
- > Rodrigues J and Koltunow AMG (2005) Epigenetic aspects of sexual and asexual seed development.
Acta Biologica Cracoviensia, Series Botanica 47: 37-49
- > Selth LA *et al.* (2005) A novel NAC domain protein interacts with geminivirus replication accessory protein to enhance viral replication.
Plant Cell 17: 311-325
- > Selth LA *et al.* (2006) Identification and characterisation of a host reversibly glycosylated peptide that interacts with the Tomato leaf curl virus V1 protein.
Plant Mol Biology 61: 297-310

current CSIRO PI PHD STUDENTS IN THE ADELAIDE LAB

Nicole Cordon

The accumulation of flavonoid compounds in grapes and their contribution to wine quality
University of Adelaide

Omid Eini Gandomani

Geminivirus DNA β satellite for heritable gene silencing in plants
University of Adelaide

Julio Macedo Rodrigues

Is apomixis epigenetically regulated? A case in the model plant hieracium sp
University of Adelaide

Muhammad Saeed

Control of geminiviral diseases of cotton and tomato in Pakistan and Australia
University of the Punjab, Pakistan

Susan Wheeler

The role of ABA in grape berry ripening
University of Adelaide

Examples OF WHERE OUR RECENT PHD GRADUATES HAVE GONE

- > Postdoctoral fellow at Institut Biologie Moléculaire des Plantes, Strasbourg, France (commenced Jul 2003)
- > EMBO fellowship at University of Freiburg, Germany (commenced Jan 2004)
- > EMBO fellowship at the Cancer Research UK London Research Institute (commenced Sept 2005)
- > Postdoctoral fellowship at Risø National Laboratory, Roskilde, Denmark (commenced Sept 2005)
- > Postdoctoral fellow, School of Agriculture, Wine & Food, Uni of Adelaide (commenced Oct 2006)



Adelaide Laboratory

The major research goal of our program is to improve the performance of horticultural crops in the production, processing and marketing chain using improved genetic material from molecular and conventional breeding, and generating better plant management techniques. An important focus is research for the Australian Grape & Wine Industry targeting areas involving quality characteristics such as berry colour and flavour and production characteristics such as disease control, flowering and fruit set and sustainability issues such as water and nutrient use.

MOLECULAR BASIS OF SEED AND FRUIT FORMATION



Dr Anna Koltunow

This project seeks to understand the genes and mechanisms involved in seed set and fruit initiation – processes critical in determining the final yield and form of fruits, nuts and grains. For example new seedless cultivars will add to the value of the citrus and table grape industries and aid in expansion of export markets. Apomixis (seed set in the absence of fertilization) fixes hybrid vigour and is of value to repeated production of hybrids of commercial seed, rice and other staple grains in developed and developing countries.



FLAVONOID BIOSYNTHESIS PATHWAYS IN PLANTS



Dr Mandy Walker

We are studying the regulation of the flavonoid biosynthetic pathway which leads to the formation of red and purple anthocyanins, colourless tannins and flavonols, all of which are antioxidants. Information that is gained by studying the model plant *Arabidopsis* is applied to important horticultural crops, winegrapes and apples with the aim of improving colour, flavour and health benefits.



REGULATION OF COLOUR AND TANNIN PRODUCTION IN GRAPES



Dr Simon Robinson

The red/purple colours in red wine are anthocyanins extracted from the skin of dark coloured berries during winemaking. Skin and seed tannins, which are colourless compounds very similar to anthocyanins, also add mouthfeel and texture



to the wine. We are studying the molecular and biochemical regulation of the synthesis of these important compounds and the related flavonols during grape berry development with a view to utilising this information for the improvement of wine grapes and the final product, wine.

GRAPE BERRY DEVELOPMENT AND RIPENING



Dr Chris Davies

To make premium quality wine, producers need to achieve uniform high berry quality. Using molecular and biochemical techniques we are gaining a better understanding of the complex processes in grape berry development leading to ripening. We will target processes that are the most important in terms of managing fruit quality. A current focus of this work is the role played by plant growth regulators in coordinating berry (and vine) development.



FRUIT FLAVOUR AND AROMA



Dr Paul Boss

A major sensory experience the consumer has when eating fruit or drinking wine is the appreciation of flavour and aroma. This project aims to use analytical chemistry, genetics and molecular biology to determine the major contributing compounds and genes to fruit flavour and aroma, with an initial focus on grape and wine. An understanding of flavour and aroma development will lead to objective measures of fruit quality and altered management practices to meet certain flavour and aroma styles in finished wine.

MOLECULAR BREEDING



Dr Mark Thomas

Flowering and fruit development are the focus of this project, as they determine yield and fruit quality. A genomics approach is being used to identify the important

genes and their interactions in grapevines. By studying the function of these genes we can then ascertain how they influence fruit and wine quality. We will also determine how vineyard management practices can be used to influence the activity of these genes to improve quality. Another outcome of this research may be the generation of new varieties with improved yield and superior quality fruit which will benefit both growers and winemakers.



MOLECULAR FUNGAL PATHOLOGY



Dr Ian Dry

This project focuses on the molecular basis of host-pathogen interactions in grapevines with the aim of developing effective resistance strategies to the major fungal diseases.

A better understanding of how plants resist attack by fungal pathogens, and the successful introduction of durable and effective resistance genes into grapevines, will lead to increases in productivity and quality through a reduction in the dependence on chemical inputs for disease control. A major aim of our research is to develop grapevines which are resistant to powdery mildew using natural genes from American grape species without the negative impacts on wine quality associated with traditional breeding techniques.

CONTROL OF PRODUCTIVITY AND QUALITY



Dr Brian Loveys and Dr Jim Speirs

We are carrying out strategic research aimed at gaining an understanding of the hormonal mechanisms controlling plant growth and development. Our results have led to the development of novel methods of

irrigation which significantly improve crop water use efficiency, and maintain crop quality, with no penalty from reduced yield. Methods are being developed for the assessment of grapevine rootstocks based on their physiological responses to water stress. We are also applying these methods to other horticultural crops.

Adelaide Laboratory
Hartley Grove, Urrbrae 5064 SA
Phone: (08) 8303 8600 Fax: (08) 8303 8600



CSIRO PLANT INDUSTRY

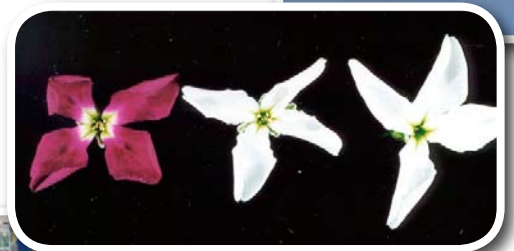
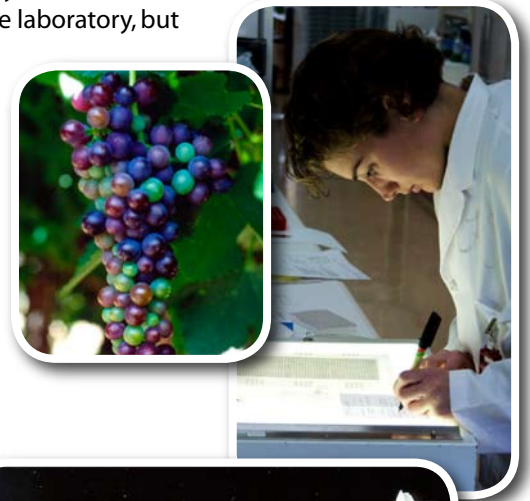
PHD PROJECTS - 2007

The following projects are available to be undertaken in the Adelaide Laboratory of CSIRO Plant Industry. If you are interested in other research areas undertaken in the Adelaide laboratory, but for which PhD projects are not currently listed below, please contact our postgraduate co-ordinator Dr Mandy Walker (mandy.walker@csiro.au) and she will put you in contact with the relevant person to discuss possible projects.

- > *Molecular control of grapevine flowering**
- > *The synthesis and storage of flavour precursors in grape berries**
- > *Defining the role of plant hormones during wine grape berry ripening **
- > *Molecular control of powdery mildew resistance in grapevine**
- > *Discovering new genes affecting the colour of plants*
- > *Wine quality in a changing environment**

*Students undertaking these projects would be eligible to apply to the Grape and Wine Research and Development Corporation PhD Scholarship Program which provides funding for both either **Full scholarships** of \$25,000 stipend and up to \$10,000 operating per annum for 3 years or a **Supplementary scholarships** to bring the total scholarship amount up to industry standard which is assumed at \$25,000 stipend per annum with supplementary operating funds also available. The closing date for GWRDC PhD scholarship applications is the **31 October 2006**. More information is available at <http://www.gwrdc.com.au/applicationForms.asp>

More info on CSIRO scholarships & CSIRO PI projects available in other locations within Australia:
www.pi.csiro.au/careers/phd/doingphd.htm



> Molecular control of grapevine flowering

IDENTIFICATION AND FUNCTIONAL CHARACTERISATION OF GENES INVOLVED IN FLORAL INITIATION AND DEVELOPMENT

SUPERVISOR: Dr Mark Thomas
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phone: (08) 83038624 fax: (08) 83038601

BACKGROUND:

The yield from a vineyard fluctuates significantly (15% -30%) from year to year and is largely determined by the fruitfulness of a vine. However this process is not well understood for grapevine. Fruitfulness is a combination of factors: number of inflorescences per vine, flower number per inflorescence, fruit set and berry development. The process occurs over two seasons with floral initiation occurring in the first season in latent buds followed in the second season after bud burst by inflorescence growth and fruit growth. Management techniques such as pruning level can have an effect on yield but it is largely the interaction of environmental conditions and the genes in the plant that determine the degree of fruitfulness. It is known that inflorescence number per vine is the main component of yield and this is determined by the success of floral initiation.

To gain a better understanding of grapevine fruitfulness we have isolated key genes involved in grapevine flowering during latent bud development and after bud burst. Identifying the key genes in this genetic network and determine how these genes are influenced by the environment are essential first steps in understanding the *in planta* control of fruitfulness. A grapevine gene flowering model has been developed and fourteen flowering pathway genes were separated into 3 groups

based on their roles and include: flowering time genes, inflorescence and floral meristem identity genes, and floral organ identity genes. Evaluation of some of these grapevine genes demonstrated that they either promoted or delayed flowering in other species. A gene involved in grapevine flowering was identified and was found to be associated with the conversion of tendrils to bunches of grapes.



AIMS:

This project will investigate the genes responsible for the early events of floral initiation. Gene information from flowering models developed for *Arabidopsis* will be utilised to clone the corresponding genes from grapevine and the function of these genes investigated. How the environment influences gene expression will also be investigated.

EXPERIMENTAL APPROACH:

New genes will be identified using bioinformatic mining of microarray data, EST and genomic sequence databases. Identified genes will be isolated from existing cDNA or genomic libraries and expression patterns investigated by real-time PCR and RNA *in situ* methods. Transgenic approaches will be used to investigate gene function. Plants grown under controlled conditions in growth rooms will be used to investigate the effect of the environment on the expression of genes involved in floral initiation.

REFERENCES:

- Boss PK, Thomas MR (2002) Association of dwarfism and floral induction with a grape 'green revolution' mutation. *Nature* **416**: 847- 850
- Boss PK, Buckeridge EJ, Poole A, Thomas MR (2003) New insights into grapevine flowering. *Functional Plant Biology* **30**: 593-606
- Boss PK, Sreekantan L, Thomas MR (2006) A grapevine TFL1 homologue can delay flowering and alter floral development when overexpressed in heterologous species. *Functional Plant Biology* **33**: 31-41
- Sreekantan L, Torregrosa L, Fernandez L, Thomas MR (2006) VvMADS9, a class B MADS-box gene involved in grapevine flowering, shows different expression patterns in mutants with abnormal petal and stamen structures. *Functional Plant Biology* **33**: 877-88

> Why does wine taste so good?

THE SYNTHESIS AND STORAGE OF FLAVOUR PRECURSORS IN GRAPE BERRIES

SUPERVISOR: Dr Paul Boss
email: paul.boss@csiro.au
phone: (08) 83038614 fax: (08) 83038601

BACKGROUND:

Wine flavour and aroma perceived by the consumer results from a complex mixture of compounds many of which derive from grape berries. It is thought that free volatiles are most likely lost during fermentation, and so most grape-derived flavour compounds in the wine originate from less volatile precursors in the berries. The precursors are secondary metabolites that have been glycosylated, presumably to make them more water soluble and/or tagged for transport to the vacuole. The targeting is thought to occur via glutathione attachment and transport across the tonoplast membrane by ABC transporters. These glycosylated compounds accumulate during berry development and are then released as volatiles in the wine by the action of microbes and due to the acid nature of wine.

AIMS:

The aims of this project are to characterise the pathway leading to secondary metabolite storage in grape berries and to understand the influence these pathways have on wine flavour and aroma.



EXPERIMENTAL APPROACH:

Molecular techniques will be used to identify and characterize grapevine genes associated with the glycosylation and transport of flavour metabolites into the vacuole. It is envisaged that the candidate will use yeast and Arabidopsis as model systems alongside grape in order to test gene function. The position forms part of a larger team studying and identifying grape-derived wine flavour compounds.

REFERENCES:

Rea PA *et al.* (1998) From vacuolar GS-X pumps to multispecific ABC transporters. *Annual Review of Plant Physiology and Plant Molecular Biology* **49**: 727-760

Bowles D *et al.* (2005) Glycosyltransferases: managers of small molecules. *Current Opinion in Plant Biology* **8**: 254-263.

> Hormones and ripening wine grapes

DEFINING THE ROLE OF THREE PLANT HORMONES DURING WINE GRAPE BERRY RIPENING

SUPERVISOR: Dr Christopher Davies
email: christopher.davies@csiro.au
phone: (08) 83038628 fax: (08) 83038601

BACKGROUND:

This project forms part of a larger program of research aimed at better understanding grape berry development and in particular the involvement of hormones during berry ripening. Plant hormones control plant development through inducing coordinated changes in gene expression and are important in most developmental processes. In grape berries we have evidence that ripening is under the control of endogenous hormones. Both the timing of the initiation, and the rate of ripening, are crucial to the date of commercial ripeness and most likely also to berry composition. Three plant hormones (abscisic acid (ABA), ethylene and brassinosteroids (BRs)) have been identified as involved in ripening but the mechanism of their action, their relative influence and their potential usefulness in manipulating this process are yet to be well characterised. A better understanding of the mechanism of action of these hormones and how they interact to control ripening offers the possibility for manipulating berry ripening to advantage. Control over the timing of harvest through manipulating ripening may improve yield and quality, and reduce loss in cooler climates and allow greater flexibility in winery scheduling during winemaking. The manipulation of ripening via hormones may also increase the synchronicity of ripening and provide flexibility in berry composition and therefore wine style by altering the balance of berry metabolism.

AIMS:

The overall project aim is to gain a better understanding of the action of ABA, ethylene and BRs on grape berry ripening. This will occur through gaining knowledge of the mechanism of hormone action, the changes in gene expression they induce, the potential interactions between them and the effects they exert on berry development and metabolism.



EXPERIMENTAL APPROACH:

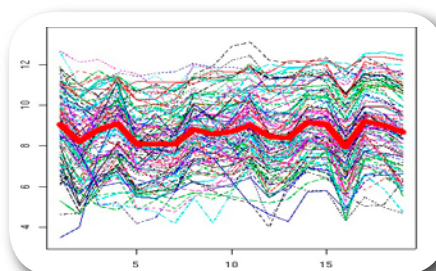
Field, glasshouse and laboratory experiments will be used to further elucidate the action of the three hormones discussed above on grape berry ripening. These hormones (and inhibitors of their biosynthesis and perception) will be used in experiments on tissue culture cells, whole berries and in field experiments on entire bunches to identify their effect on gene expression and metabolism. Gene expression changes will be measured techniques such as real-time PCR and microarray analysis. Differential application of hormones and the use of inhibitors of hormone synthesis and action will be used to investigate the possible interaction between the hormone candidates. Changes in berry metabolism will be measured by biochemical analysis and related to gene expression changes and possible gene function to form a more holistic picture of hormone action during berry development.

REFERENCES:

Davies C *et al.* (1997) Treatment of grape berries, a nonclimacteric fruit with a synthetic auxin, retards ripening and alters the expression of developmentally regulated genes. *Plant Physiology* **115**: 1155-1161.

Davies C and Robinson SP (2000) Differential screening indicates a dramatic change in mRNA profiles during grape berry ripening. Cloning and characterisation of cDNAs encoding putative cell wall and stress response proteins. *Plant Physiology* **122**: 803-812.

Chervin C *et al.* (2004). Ethylene seems required for the berry development and ripening in grape, a non-climacteric fruit. *Plant Sci.* **167**: 1301-1305.



> Molecular control of powdery mildew resistance

FUNCTIONAL CHARACTERISATION OF NBS-LRR GENES INVOLVED POWDERY MILDEW RESISTANCE IN GRAPEVINE

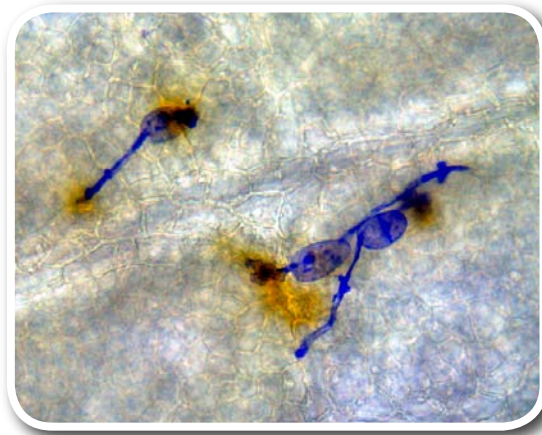
SUPERVISOR: Dr Ian Dry
email: ian.dry@csiro.au
phone: (08) 83038632 fax: (08) 83038601

BACKGROUND:

Plants are protected from disease by specific recognition of diverse effectors presented by invading pathogens. This recognition capacity is encoded by plant resistance (*R*) genes that, in turn, activate a multitude of innate defense responses. The most prevalent class of plant *R* genes encode putative intracellular receptors containing highly conserved motifs including an N-terminal coiled coil (CC) or Toll/Interleukin-1 receptor-like (TIR) domain, a nucleotide binding site (NBS), and C-terminal, leucine-rich repeats (LRR). Typically, one member of a multigene family specifies resistance through direct or indirect recognition of a cognate pathogen avirulence (*Avr*) gene product. However, it has been shown that two functional members of a gene family can confer the same specificity or conversely, that one gene encodes recognition of multiple distinct pathogen signals. In addition, genetic diversity within host-pathogen systems may also exist in the requirements for downstream components of disease response pathways.

Some details of the host components that regulate fundamental aspects of *R* protein triggered responses are now being uncovered. Resistance mediated by the barley *Mla* resistance protein is dependent on the presence of *Rar1*, *Sgt1* and *Hsp90* which appear to be crucial for the formation and activation of *R* protein-containing recognition complexes as well as for regulating downstream signalling processes. More recent results suggest that activation of the *Mla* protein, in the presence of its cognate fungal avirulence (*Avr*) protein, occurs via interaction of the N-terminal CC domain with a specific nuclear WRKY-box transcription factor, which regulates induction of the defense response.

Powdery mildew (*Erysiphe necator*) is the most economically important grapevine disease worldwide. Using a map-based cloning approach, we have identified a major resistance locus (*Run1*) from a wild North American grape species that confers resistance to this obligate biotrophic pathogen. Sequencing of this locus has revealed the presence of up to 6 full-length



TIR-NBS-LRR type proteins that are very similar in structure to the *Mla* powdery mildew resistance genes isolated from barley.

AIMS:

This project aims to study the activation of each of the putative grapevine powdery mildew *R* gene candidates following powdery mildew infection to determine the relative specificities of each family member. It will also investigate the regulation of signal transduction from the *R* gene candidates and identify host proteins which interact with and mediate the induction of the defense response.

EXPERIMENTAL APPROACH:

Full-length transcripts will be isolated from a cDNA library constructed from powdery mildew infected grapevine leaves. Gene-specific primers will then be used in Real time-PCR experiments to study activation of individual *R* gene family members along with induction of *Rar1* and *Sgt1* genes in response to powdery mildew infection. Yeast 2 hybrid techniques will be employed to identify host factors which interact with the grapevine powdery mildew *R* proteins to mediate downstream signal transduction.

REFERENCES:

Barker CB *et al.* (2003) Use of molecular techniques for the transfer of powdery mildew resistance from a wild American grapevine into elite winegrape cultivars. *Australian & New Zealand Grapegrower & Winemaker* **473**: 97-99.

Halterman DA *et al.* (2003) Powdery mildew-induced *Mla* mRNAs are alternatively spliced and contain multiple upstream open reading frames. *Plant Physiology* **131**: 558-67.

Shirasu K and Schulze-Lefert P (2003) Complex formation, promiscuity and multi-functionality: protein interactions in disease-resistance pathways *Trends in Plant Science* **8**: 252-258.

McHale L *et al.* (2006) Plant NBS-LRR proteins: adaptable guards. *Genome Biology* **7**: 212 .

> *Discovering new genes affecting the colour of plants*

SUPERVISORS: Dr Mandy Walker
email: mandy.walker@csiro.au
phone: (08) 83038629 fax: (08) 83038601

Dr Tim Holton, QDPI &
Professor Mark Tester ACPFG, University of Adelaide

BACKGROUND:

Anthocyanins are secondary metabolites present in most higher plants and contributing to the red and purple colours of leaves, flowers and fruit, and to processed products such as red wine, jam and fruit juice. Anthocyanins are synthesised by a well-characterised enzymatic pathway which also gives rise to other flavonoid compounds such as tannins, providing the characteristic astringent taste to fruit and wine. Anthocyanin colour in fruit and flowers (Grotewold, 2006) depends on:

1. vacuolar pH where anthocyanins are stored
 2. anthocyanin modification (addition of sugars, hydroxyl, acyl and methyl groups)
 3. cofactors such as metal ions
 4. cell shape which reflect or magnify the light.
- Vacuolar pH is important because anthocyanins are generally only coloured at acidic pH and uncoloured or yellow/brown at neutral pH. To date only three genes have been identified that alter vacuolar pH thereby affecting flower colour (Fukada-Tanaka *et al.*, 2000). While two of these genes are transcription factors, the third belongs to a class of Na⁺/H⁺ antiporters.

AIMS:

- a) Identify novel genes that alter the hue of transgenic Arabidopsis flower petals.
- b) Test known antiporters for their ability to alter flower colour in transgenic Arabidopsis.
- c) Use transgenic grape roots to further characterise these genes.



EXPERIMENTAL APPROACH:

Transgenic Arabidopsis with purple flowers will be mutagenised and screened for altered flower colour. Candidate genes will be isolated by a positional cloning approach and characterised by altered expression studies using tools such as RNAi constructs and overexpression vectors. A reverse genetic approach will be utilised to examine the role of Na⁺/H⁺ antiporters in maintaining the pH in Arabidopsis flower petals. Arabidopsis with insertions in the genes of interest will be crossed to the purple flowered Arabidopsis to determine the role they play in flower colour. Both approaches will utilise trans-activated promoter trap lines of Arabidopsis (Kiegle *et al.*, 2000) in which the expression of a gene can be controlled specifically in petal tissue. Confocal microscopy can be used to verify the expression pattern of the GFP reporter gene in petal cells. This technique will allow the analysis of genes that might otherwise be essential for normal plant growth. Another method available to test the activity of these genes to alter colour is to use hairy root transformation of transgenic grapevine roots, which synthesise anthocyanins as shown in the picture above. This has the advantage of producing relatively large amounts of material of a single tissue type in a short time for biochemical analysis such as HPLC.

REFERENCES:

Fukada-Tanaka S, Inagaki Y, Yamaguchi T, Saito N and Iida S (2000) Colour-enhancing protein in blue petals - Spectacular morning glory blooms rely on a behind-the-scenes proton exchanger. *Nature* **407**: 581-581.

Grotewold E (2006) The genetics and biochemistry of floral pigments. *Annual Review of Plant Biology* **57**: 761-780.

Kiegle E, Moore CA, Haseloff J, Tester MA and Knight MR (2000) Cell-type-specific calcium responses to drought, salt and cold in the Arabidopsis root. *Plant Journal* **23**: 267-278.

> Wine quality in a changing climate

THE EFFECT OF HEAT STRESS ON GRAPE COMPOSITION

SUPERVISORS: Dr Chris Soar
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phone: (08) 83038649 fax: (08) 83038601

Dr Paul Boss
email: paul.boss@csiro.au
phone: (08) 83038614 fax: (08) 83038601

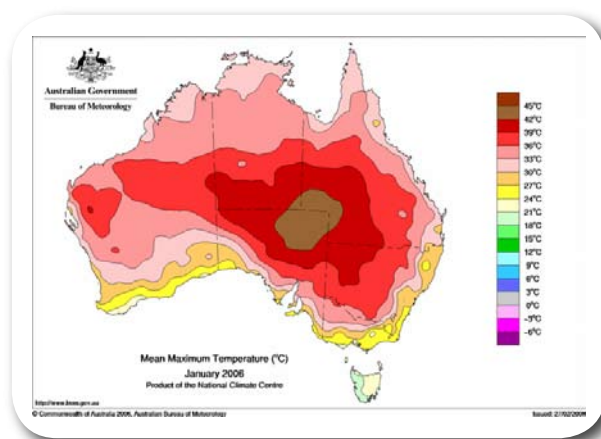
Dr Brian Loveys
email: brian.loveys@csiro.au
phone: (08) 83038615 fax: (08) 83038601

This is a joint project between the South Australian Research & Development Institute and CSIRO Plant Industry.

BACKGROUND:

Climate change has been identified as a significant risk to consistency of quality in global wine production. Increased climate variability, in particular increased occurrence of extreme temperatures and shifting rainfall patterns in wine grape producing regions may result in increased occurrence of heat and water stress on grape bunches. Several aspects of grape berry ripening and juice composition such as colour, acidity and the presence and composition of flavour and aroma compounds are known to be influenced by temperature and stress. Thus predictions for climate change within this century have the potential to substantially shift regions of premium wine production. In addition increased climate variability may result in greater inconsistency in year to year vintage quality at the regional and vineyard level.

At present there is a gap in knowledge as to the specific effects of extreme heat stress on wine composition. This deficiency means it is difficult to model the likely effects of climate change on wine quality and therefore devise management strategies to offset the potential risks.



AIMS:

Specifically this project will analyse the effect of short-duration high-temperature treatments on the formation of colour, flavour and aroma compounds in grapes and wine. This will add to our general understanding of how heat stress at the vine and bunch levels alter wine composition but will also feed into modelling studies that will help predict the risks that climate change poses to wine quality consistency. This project will interact closely with existing projects looking at the effects of extreme heat stress on grapevine performance.

EXPERIMENTAL APPROACH:

The project will utilise gas chromatography, mass spectrometry, HPLC and various analytical protocols to analyse aspects of grape and wine composition from heat stressed material sourced from vineyard, glasshouse and growth chamber experiments.

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