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Cooperative Research Centre *for* Viticulture

Adelaide University

The National Wine and Grape Industry Centre
(Charles Sturt University, NSW Agriculture)

The Australian Wine Research Institute

CSIRO

Department of Natural Resources
and Environment, Victoria

Primary Industries & Resources, SA

The Australian Dried Fruits Association Inc.

Winemakers' Federation of Australia Inc.

Winegrape Growers' Council of Australia Inc.

Grape and Wine Research
and Development Corporation

The Dried Fruits Research and
Development Council

Wine Industry National Education
& Training Advisory Council Inc.

Getting to the root of water use efficiency

A CRCV research project is determining if the amount of water required for each tonne of grapes varies according to the variety or the rootstock on which the variety is grafted.

If it does, it should be possible to make Australia's limited water resource go further through the broader use of the most water efficient varieties and graft combinations with irrigation management that takes their specific water requirements into account.

Project researcher **Rob Stevens**, based at SARDI in Loxton (SA), said little is known about the relative water use efficiency of different grapevine varieties, rootstock and variety-rootstock combinations or how water use efficiency changes as a result of drought or salinity stress.

"If we find there are significant differences in water use efficiency between varieties and/or rootstocks, there is potential to develop advanced irrigation practices that take them into account. This could mean financial savings for growers, further reductions in environmental impacts from irrigated vineyards, and water for further vineyard development," he said.

Trial sites have been established on privately-owned properties at Barmera and Kingston-On-Murray in the Riverland and major winemakers have helped researchers choose the five rootstocks for each of the most widely grown varieties, Shiraz and Chardonnay.

The trial has been established so that two irrigation treatments are used at each property. Vines watered according



to best regional practice are being compared with those irrigated at a water reduction of 30-35 per cent.

The project involves regular monitoring of soil moisture and salinity, ground water heights, water quality, irrigation volumes and weather variables.

Initial vineyard and glasshouse trials conducted by **Dr Mark Gibberd** of CSIRO Plant Industry at Merbein have shown marked differences in the way grapevines use water. Chardonnay leaves for example use less water per unit of dry matter produced than Shiraz. Rootstocks are also known to affect water use efficiency of winegrape varieties. The research is attempting to better understand the processes contributing to these differences.

"The results of this project will assist growers to choose varieties and rootstocks that use water most efficiently, vine breeders will be able to identify traits linked to water use efficiency and incorporate them into their programs, and growers will benefit from better irrigation strategies," Mark said.

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CEO's Report

New initiative

As of today, many more industry people will know about the CRCV's research activities as our newsletter is incorporated into *Australian Viticulture*, the official journal of the Winegrape Growers' Council of Australia. This is an important move in terms of communicating research progress and outcomes and we thank *Australian Viticulture* for the opportunity. The newsletter will still be available on our website at crcv.com.au and posted to those on our mailing list.

Boost to CRC Program

All CRC participants and the users of ACRC-derived technologies can take great reassurance in the Prime Minister's recent announcement that the Cooperative Research Centre program is to receive an additional \$227 million over the next five years to foster world class research and innovation. Increased funding will provide for more Centres and more resources to establish larger Centres and for increased collaboration.

The announcement, part of the Government's Innovation Action Plan, reflects the confidence the Government has in the CRC program as a world's best practice model in collaborative R&D and education.

The investment in CRCs helps to foster greater links between industry and research

and educational institutions and will lead to significant benefits for the Australian economy when research outcomes are applied commercially and in the general interest of the Australian community.

The Commonwealth has accepted the recommendation of the Chief Scientist, that there be specific access to seed funds to foster commercialisation of CRC research. Funds of this nature would play a significant role in encouraging commercial collaboration in the application of some major CRCV research outcomes and release of the guidelines will be followed with great interest.

Second Year Review

Preparations are underway for the CRCV's Second Year Review, a significant review of CRCV progress to be undertaken by the Commonwealth, later this year. Under the guidelines, CRCs are required to undertake their own internal reviews of research as a Stage 1 to the comprehensive Commonwealth review. The CRCV will conduct this review in May with the assistance of external reviewers and the Program Industry Reference Groups.

As most CRCV projects are approaching their third year, it will provide an ideal opportunity to review progress against the Centre's objectives.

Welcome

The CRCV would like to welcome Mary Retallack, who will join the Research to Practice™ team in February. Mary, a former lecturer in Viticulture and Wine Studies at the Onkaparinga Institute of TAFE, will be responsible for development and delivery of the Research to Practice™ Grapevine Nutrition module. She will liaise closely with researchers and growers to ensure that the course remains up to date and meets the high standards of other workshops in this popular series. We wish her all the best and look forward to her contribution to the Centre.

Jim Hardie CEO

Getting to the root of water use efficiency

The key technology being used in this project is called carbon isotope discrimination. Mark said the process allowed scientists to easily measure differences in leaf water use efficiency among varieties. "The technique relies upon the plants ability to discriminate between two naturally occurring, non-radioactive isotopes of carbon. As luck would have it, the processes associated with carbon isotope discrimination are closely associated with the processes that contribute to water use efficiency," he said.

Identifying rootstocks with superior water use efficiency with old methods takes years and is very expensive. The new method is fast and inexpensive. The method has been used to test for water use efficiency in a number of other plants including wheat, peanuts, sunflower and barley, and is now being used to test the samples from the project trial sites.

"Our first priority is to discover variation in transpiration and water use efficiency between rootstocks and varieties in the glasshouse and early indications show it could be quite substantial," Mark said. "The next part of our research is to compare the leaf measures in the glasshouse with water use efficiency in the field, that is, tonnes of fruit produced per megalitre of water applied, and to find out what physiological processes contribute to variation between grapevine scion varieties and rootstocks.

"This project will give us a wealth of information about water use efficiency and which varieties respond best to reduced irrigation. This will enable growers to use less water and decrease problems such as salinity and rising water tables which is vital for the long-term sustainability of the industry."

The project title is 'Application of carbon isotope discrimination technology to understanding and managing wine-grape water use efficiency' (Project 2.1.4).

Newsletter

The Cooperative Research Centre for Viticulture Newsletter is produced bi-monthly. All contributions are welcome, especially reports from conferences, seminars and international trips.

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Phylloxera season a busy time for researchers

The CRCV is working on developing a rapid early detection test and alternative management procedures for phylloxera on ungrafted vines.

CRCV PhD student **Karen Herbert** is part of the team conducting this important research and says the last few weeks have been extremely busy.

“Phylloxera is only active in the warmer months, so for the past few weeks I have been setting up pot-based trials in the glasshouse and infesting vines with phylloxera populations from Rutherglen and the King Valley,” she said.

Based at the Department of Natural Resources Environment (DNRE) in Rutherglen, Karen will monitor the infested pots for two to three weeks before harvesting the leaves for further testing. The new quarantine glasshouse facility at Rutherglen, which provides a constant temperature ideal for inoculating new vines with phylloxera, will enable Karen to study population dynamics for the rest of the year.

Her project is primarily focused on the early detection of phylloxera, with current methods identifying the insect only when it is active and once phylloxera has caused significant damage to the vines.

“We are aiming to develop a rapid and effective diagnostic test for detecting phylloxera all-year round that could be incorporated into regular analysis of vineyards,” she said.

Karen infesting Cabernet Sauvignon vines with phylloxera leaf galls in the glasshouse. The phylloxera galls were collected from a commercial vineyard near Rutherglen.



Karen is taking three different approaches to early detection tests, which include using diagnostic kits developed by SARDI for other soil-borne diseases, to determine if this technology can be extended to detect low numbers of phylloxera in vineyard soils. Another approach will be leaf-based detection by looking for recognisable changes occurring in the leaves of the vine when phylloxera has attacked the roots.

Karen will be using near infrared spectroscopy (NIR) technology to fingerprint the chemical composition of grapevine leaves and her studies will gauge whether the level of chemical differences between leaves from uninfested and infested vines could be used as an early indicator for phylloxera infestation.

During the year Karen will study the population dynamics of her phylloxera-infested vines in preparation for the second element of her studies to develop interim control strategies for vineyards infested with phylloxera.

“Although the only permanent solution for phylloxera infestations is to graft vines onto phylloxera resistant rootstocks, a control strategy can limit the damage and maintain crop levels, giving growers more time to convert their

vineyards over to rootstocks,” she said. During the phylloxera season next year Karen will be conducting chemical insecticide trials. “Chemicals have not previously been effective in controlling phylloxera in Australia, but some overseas trials have shown some promise and we would like to screen these compounds under Australian conditions,” she said.



The field site for testing population dynamics and chemical insecticide trials. The site is a commercial vineyard in the King Valley, VIC.

“I will be using those chemicals both in the field and the glasshouse to establish how effective they are in the control of phylloxera.”

After working hard to establish her phylloxera studies, Karen said she is looking forward to seeing some results in the next 12 months which will translate into improved detection and management procedures for phylloxera.

Quality assurance for dried grape industry

The Australian Dried Grape Industry has adopted a program to ensure its activities address minimum food safety requirements.

The system is known as the Dried Grape Approved Supplier Program and is a major development for the industry. Dried Fruits Research and Development Council's executive officer, **Ross Skinner** said there had been a push from suppliers and from industry processors for a quality assurance system extending back to the production sector. Ross, who chaired the industry working group that developed the approved supplier program, said the dried grape industry looked at the experiences in other industries and realised many requirements placed on producers with regard to training and maintaining their QA system were both expensive and time consuming. "The dried grape industry wanted a system that complied with future

Government food safety regulations and met the requirements of industry customers without going over the top," he said.

"The industry working group that put the scheme together recognised that many of the quality assurance programs being promoted for producers have hefty training and audit costs and extensive record keeping requirements that our industry wanted to avoid where possible. "Our focus was on tailoring a scheme that met the food safety responsibilities without enforcing time consuming procedures and processes on growers at this base level of QA."

Ross said the working group had received feedback that some schemes generated so much office work and were so costly to maintain that many growers had given up on them.

"Our industry wanted a base level program that was not too time consuming so that we got a high level of compliance.

We wanted a program that was not expensive to implement and only required second party auditing by the processors and not third party auditors," he said.

The Dried Grape Approved Supplier Program has met these requirements with a half-day training course costing growers only \$85 after government training subsidies.

The program is based on the Hazard Analysis Critical Control Points (HACCP) plans produced by **Sue McConnell** of Agriculture Victoria for six producers with various production systems. This study provided the information necessary for developing the industry's Food Safety Plan that lies at the heart of the approved supplier program.

"The industry has focused on food safety in this program rather than every facet of product quality. In doing so not every element of the HACCP plans has been

Chemical Use Database Established

The dried fruit industry will monitor vineyard chemical usage as part of its Approved Supplier Program by entering grower spray diaries onto a database developed by Agriculture Victoria with DFRDC funding support.

The diary information is being entered onto the database system maintained at the Dried Fruit Quality Centre. The computer program will search the grower entries to ensure compliance with registered chemical use, use at correct rate and adherence to industry withholding periods. The spray diary

clearance is also linked to the chemical residue clearance testing program also undertaken at the Quality Centre.

The Quality Centre will provide an information report to growers highlighting spray date comparisons with Agriculture Victoria's "ideals based weather-station-data" and pest and disease computer models.

It will also include;

- The cost per acre of the grower's chemical spray program compared with the average of all the growers in his/her region.
- A warning on spray practices that may lead to a chemical resistance build-up in diseases.
- A warning on the tank mixing of incompatible chemicals that will reduce the effectiveness of spray programs.

"We're also benchmarking information on spray costs so a grower can compare costs with others in the industry and whether his spray use meets protocols for pest and disease resistance build up," said **Debra Thompson**, Laboratory Manager at the Dried Fruits Quality Centre.

This feedback will be given to growers for the first time early this year and then carried out annually.

Debra Thompson inputs grower spray diary information into the chemical use database.



incorporated into the program," said Ross.

"The dried grape approved supplier program is an entry level QA scheme and growers are encouraged to undertake higher level training if they wish. These other programs are recognised for the purposes of approving suppliers as long as the requirements of the industry food safety plan have been addressed."

The industry has 1,500 production enterprises and it is mandatory for training to be undertaken by the 2002 harvest if a producer is to be an accredited approved supplier to the industry's processors.

The dried grape approved supplier program has the support of the industry processors and marketers and is endorsed by the grower body, the Australian Dried Fruits Association. Ross said the Dried Fruits Quality Centre, managed by the Australian Dried Fruits Board, is responsible for maintaining the program's grower accreditation database and for organising the audit process.

He said the Australian industry saw adoption of this program as an important way of giving it a marketing edge by differentiating its product from that produced overseas.

"If we can prove that fruit grown in Australian vineyards and processed here is done so under quality assurance systems with food safety in mind then we are more likely to obtain preferred supplier status over imported product produced under unknown conditions," said Ross.

To date 200 growers have undertaken the approved supplier training since its introduction in November and the response from growers has been favourable.

Crop estimation programme commences

By Ross Skinner, Executive Officer of the Dried Fruits Research and Development Council

The introduction of processors buying fruit from growers rather than providing pooled market returns has heightened interest in the development of accurate crop estimation methods to provide an early indication of the effect of supply on likely market returns. This challenge has seen the industry develop a program to provide crop estimate information at three points during crop development.

The first is made in mid-December, 14 months out from harvest, using the CSIRO Plant Industry's model for predicting sultana fruitfulness based on the weather conditions in November/December that influence bunch initiation.

It is interesting that the model indicates the 2000 weather produced the best conditions for bunch initiation for 50 years, since the data was first sourced. The industry has been informed that the 2002 crop could be a bumper as the model predicts higher fruitfulness than the large 1992 crop.

The second estimate is made, when the shoots are about 10 cm long and the inflorescence are clear, to confirm the fruitfulness prediction. At this time the field staff mark the canes that will be tracked in collecting samples for the final prediction, made following fruit set.

The final estimate is conducted following the collection of cane numbers, bunch numbers, bunch weight and berry numbers from 15 vines on 30 vineyard sites scattered throughout the Sunraysia region.

Based on this information an estimate of yield per hectare can be made and, as the data is developed over time, compared with the previous production histories of



Growers Karl Sommer (above) and Tony Martin.



the vineyards and the district averages to ascertain the crop rating.

In future years it is intended to link the yield estimates to the industry production database held at the Dried Fruits Quality Centre to account for such variables as different rootstocks, trellises, irrigation, and soil types to obtain a highly accurate predictive model.

The effects of rain in February and winery demand will still add a degree of uncertainty to the predictions but the industry is confident that its planning processes will benefit from work undertaken between growers, processors and the CSIRO Plant Industry Horticulture Unit to develop this program.

Investigating flower genes in grapevines

CRCV researchers working on improving the viticulture industry's knowledge of grapevine flowering and fruitfulness are making progress. One significant hurdle that has been overcome is getting young potted grapevines, regenerated using tissue culture techniques rather than from cuttings, to flower and produce fruit in the glasshouse, a common problem encountered when working with woody perennial plants.

Success in achieving early flower and fruit development speeds up research by avoiding the two-three year wait until vines normally bear fruit.

By manipulating the glasshouse environment, altering the temperature and extending day length with artificial light, the research team has had success with Chardonnay, Cabernet Sauvignon and Shiraz vines—achieving flowering within one-two years.

This step forward will enable scientists to investigate the flowering process and analyse fruit characteristics, particularly in vines that have been genetically transformed.

The research, being carried out by Dr **Paul Boss**, as part of project 3.4.1 'Rapid floral induction and fruit set for transgene evaluation', is now focused on looking at the genes involved in the flowering process.

"We're looking at both the genes involved in the early stages of flower development, which occurs in buds, through to the later stages that occur after bud burst that lead to the formation of fruit," he said.

"We've isolated a number of genes from grapevines which we suspect have a role to play in flowering."

Paul is particularly interested in determining the genes involved in producing a tendril, an undeveloped flower structure, and an inflorescence, or a flower cluster. "Research has shown that under certain conditions a tendril may be converted to an inflorescence. We need to understand the genetic control of that process," he said.

As part of this project, Paul is keen to gain an insight into which genes are expressed during bud development and what the important stages of flower



CRCV researcher Paul Boss and visiting scholar Elisabetta Sensi looking at a transgenic vine.

development are.

"We want to understand the regulation of fruitfulness on a molecular scale," he said.

This knowledge could well lead to better understanding and prediction of seasonal variation in grape production.

Paul was assisted for six months by **Elisabetta Sensi**, a visiting scholar from the University of Padova in Italy who returned last December.



Mary Retallack

The CRCV's Research to Practice™ project has been boosted by the appointment of **Mary Retallack**, a vine nutrition specialist.

New appointment for Research to Practice™

Mary will start work at the CRCV in early February and is based in Adelaide. She has most recently worked at the Onkaparinga Institute of TAFE as a lecturer in Viticulture and Wine Studies. Her teaching skills and expertise in vine nutrition and sustainable viticultural practices will be put to good use in the Research to Practice™ project. Her role includes liaising with researchers and growers to ensure the streamlined uptake of new research and technology. Mary said she is looking forward to the challenge of her new position with the CRCV and is aiming to develop new educational tools and products to give

growers all the support they need to use new technology in their vineyards. Program 4 Education and Training Manager **Libby Boschen** said Mary's passion for viticultural science and environmental sustainability issues would be obvious to everyone who meets her in the coming months.

"Her role will be pivotal in developing new products, reaching new target groups, and taking the Research to Practice™ program through the current transition period to gaining self-sustaining status," Libby said.

Growers benefit from spray application research

CRCV research is helping growers take the guesswork out of chemical spray applications.

In the past growers have not known how much chemical spray has actually been deposited on the vines and, most importantly, if the spray has been effective.

Michelle Warren from Project 1.5.1, 'Rapid tests for quantifying chemical spray application on vines' said this project would give growers the information and the tools needed to protect their vines against powdery mildew, downy

mildew, botrytis and lightbrown apple moth.

"The project is two-pronged with scientists at CSIRO in Canberra fine-tuning ELISA kits which test the effectiveness of spray applications and we are conducting trials to determine how growers need to use the kits to get an accurate reading for their vineyards," Michelle said.

ELISA kits were originally developed for measuring chemical residues in wine and grape juice and are being modified to

test the amount of chemical deposited on the vine. The kits are being developed as an economical and fast way for growers to test the effectiveness of their spraying.

It is important that growers have the right information to use the kits effectively when they are released and CRCV researchers will be conducting trials this season on growers' properties after they have sprayed to develop a guide for maximising the efficiency of the kits.

"We need to determine how many of these tests need to be used to give a true indication for the entire vineyard because variability can be a problem," she said.

"We will be able to advise growers where to conduct the tests in their vineyards, how many tests and which parts of the vine to test. They will basically be getting an instruction guide with the ELISA kits as a result of this research."

The CRCV's Research to Practice™ offers workshops on spray application. For more information about the workshops please contact **Bronwyn Clarke** or **David Braybrook** on (03) 9210 9222.

CRCV research will help take the guesswork out of chemical spray applications.



CRCV role at technical conference

The CRCV will be a major contributor to this year's Eleventh Australian Wine Industry Technical Conference at the Adelaide Convention Centre, from 7-11 October.

Nearly 80 workshops will be offered at the Conference and many CRCV projects will be featured.

They include: Botrytis, phylloxera management, precision viticulture, Viticare, Near Infrared Spectroscopy, powdery and downy mildew, pest and disease identification, evaluating R&D outcomes in a vineyard, Environmental Management Systems, objective measures of grape and wine quality, mouthfeel

characteristics, berry maturation and tannins.

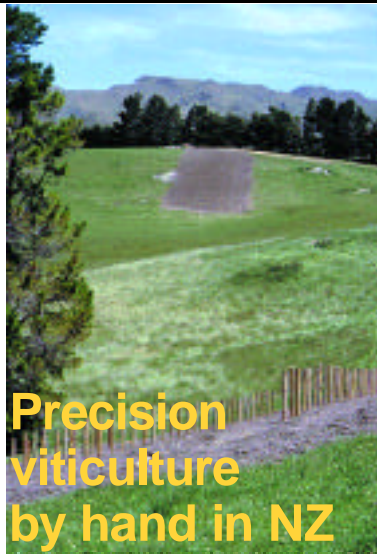
Viticare coordinator **Noel Ainsworth** said the workshops would be limited to only 30 participants and presenters would be encouraged to make them as interactive as possible. They will be held at venues close to the Adelaide Convention Centre: the Waite Campus of Adelaide University and in the Barossa, McLaren Vale, Langhorne Creek and the Adelaide Hills.

Noel said most of the workshops would be held Sunday morning, Monday and Tuesday afternoons and all day Thursday. The majority of workshops will not clash

with other session times at the Conference.

"As there's a limit of 30 people per workshop it will be a case of first in best dressed but most people will be asked to only choose one, possibly two workshops each to ensure that every Conference delegate has a chance of attending at least one workshop," said Noel.

A registration brochure for the Conference will be distributed in April. To add your name to the mailing list or for further information, contact the **Conference Manager Ms Rae Blair** on (08) 8303 6611 or email awitc@awri.adelaide.edu.au.



Precision viticulture by hand in NZ

A tour to a Canterbury property being developed by an American winemaker trained in Burgundy, was one of the major highlights of a recent trip to New Zealand for CRCV researcher **Rob Bramley**. Rob, a Senior Research Scientist with CSIRO Land and Water, was in NZ to present a paper reporting on aspects of precision viticulture at Soil 2000, the second joint conference of the Australian and New Zealand Soil Science Societies.

The Canterbury property is to be known as Pyramid Valley Vineyards and is being developed by **Michael and Claudia Weersing**.

“Michael is currently the winemaker for Neudorf in the Nelson area of NZ, but has for some time been looking for a site approximating the conditions of Burgundy and has used Lincoln University soil scien-

Industry comment sought on environment paper

A discussion paper has been prepared by the CRCV outlining a potential national framework for environmental management for the wine and grape industry. The discussion paper seeks to raise awareness of the concepts of formal environmental management, in particular the potential use of Environmental Management Systems throughout the industry. It also includes potential methods for implementation of best environmental practice.

The CRCV is now seeking comment from industry participants on the contents of this paper and in particular the

Site development at Pyramid Valley Wines, North Canterbury, New Zealand.

tists to assist in his search,” said Rob. “Having been trained in Burgundy Michael, an American, is aiming to produce top quality Pinot Noir and Chardonnay ‘in which the soil and site speak louder than the winemaking.’”

Rob said the site was still under development with barely a vine to be seen but what fascinated him was the degree to which prior planning and detailed soil surveying in particular had been carried out before the property was established.

“The site was being planted in small parcels about the same size as a couple of tennis courts so as to account for the site variability,” said Rob. Three different soil types occurred within 100 m of each other. He said the vineyard was to be managed organically and not mechanised due mainly to the small block sizes, the slope of the terrain and the row spacing (1 m rows planted at 10,000 vines ha), otherwise, “this was very much precision viticulture by hand”.

He said Michael had certainly thought carefully about what he was doing and it would be fascinating to see the results in a few years time.

For further information about Soil 2000 or precision viticulture, contact Rob Bramley on (08) 8303 8594.

draft environmental management framework.

The paper has been developed under the CRCV's Viticare initiative - a national, regionally-based network of groups comprising grape growers, winemakers, consultants, training providers and service providers.

If you would like a copy of the discussion paper please visit the CRCV website crcv.com.au/viticareprog2.html or contact: **David Baker, EMS Officer, phone/fax (08) 8340 0506 or e-mail: dbaker@senet.com.au.**

Recent CRCV Publications

Scientific Reports

Grape quality

Canopy microclimate and berry composition
Haselgrove, L., Botting, D.G., Iland, P.G., van Heeswijck, R., Hoj, P., Dry, P.R. and Ford, C.
Australian Journal of Grape and Wine Research 6, 141-149, 2000

Viticultural sustainability

Canopy management for fruitfulness
Dry, P.R.
Australian Journal of Grape and Wine Research 6, 109-115, 2000

Partial drying of the root-zone of grape 1. Transient changes in shoot growth and gas exchange
Dry, P.R., Loveys, B.R. and Düring, H.
Vitis 39, 3-8, 2000

Partial drying of the root-zone of grape. 2. Changes in the pattern of root development
Dry, P.R., Loveys, B.R. and Düring, H.
Vitis 39, 9-12, 2000

Hormonal changes induced by partial rootzone drying of irrigated grapevines
Stoll, M., Loveys, B.R. and Dry, P.R.
J. Exp. Bot. 51: 1627-1634, 2000

The use of qualitative airborne multispectral imaging for managing agricultural crops - A case study in south eastern Australia
Lamb, D. W.
Aust.J.Exp.Ag. 40 (5) 725-738, 2000

Technical Reports

Education and Training

CRCV seeks industry views on education and training
Cope, A.
Australian and New Zealand Wine Industry Journal, May/June, 2000

Viticultural Sustainability

Partial rootzone drying - an update
Dry P.R., Loveys, B.R., Stoll, M., Stewart, D. and McCarthy, M.G.
Australian Grapegrower and Winemaker 438a, 35-39, 2000

Esca or not?
Pascoe, I. and Edwards, J.
National Grapegrowers, August, 2000

Slow decline with trunk diseases, Learning about black goo decline, esca and esca-like syndromes and national trunk disease project
Pascoe, I., Edwards, J., and Cottrel, E.
National Grapegrowers, September, 2000

Partial rootzone drying: effects on root distribution and commercial application of a new irrigation technique
Stoll, M., Dry, P.R., Loveys, B.R., Stewart, D. and McCarthy, M.G.
Australian and New Zealand Wine Industry Journal. 15, 74-77, 2000

Nutrition and irrigation strategies for sustainability and grape quality
Wade, J., Holzappel, B., Keller, M., Tesic, D.
Australian Grapegrower and Winemaker, November, 2000

Grapevine Improvement

Gene Technology and Viticulture - in the mainstream
Gackle, A.G., Scott, N.S. and Robinson, S.P.
Australian and New Zealand Wine Industry Journal, Vol 15, No 4, 2000

A Toast to Biotechnology...with GM Wine?
Robinson, S.P.
Innovate Australia Issue 3, February, 2000

Gene Technology and Viticulture Research
Robinson, S.P.
The Wine Contact, August, 2000