Cooperative Research Centre for Viticulture

Australian Government
Grape and Wine Research and Development Corporation

ENHANCING ADOPTION OF SPRAY APPLICATION BEST PRACTICE IN VITICULTURE



FINAL REPORT to

GRAPE AND WINE RESEARCH & DEVELOPMENT

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Abstract

Over recent years CRCV program 4 through WINETAC in collaboration with other organisations has developed a variety of methods of technology transfer that are readily accessible, practical and cost-effective to meet viticulture industry requirements for increased flexibility in training delivery of pesticide application information. The main objective of this project was to continue development of pesticide application extension packages for the viticulture industry based on the Research to Practice® program to meet these changing needs while also providing a focus for industry consultation and feedback.

As a result the Research to Practice® extension package for pesticide application now includes updated presentations, manuals and support materials for the three-day workshop and comprehensive short course materials including a workbook and presentations. Ten pesticide fact sheets have also been developed covering important pesticide application topics such as resistance management, adjuvant use, interpreting chemical label rates and spray equipment set up. As part of the extension component of this project short course training was conducted for two grower groups in Victoria and dilute volume spray trials were conducted during a field session with Mornington Peninsula wine grape growers.

The extension products developed in this project will contribute to the range of training and education options that can be accessed by growers, sprayer operators, students and allied industry personnel. Broader adoption of improved pesticide application practices is likely as a result this information becoming more accessible to a greater proportion of the viticulture industry.

Executive Summary

With the changing extension needs of the viticulture industry over recent years there has been a move towards increased flexibility in training delivery of pesticide application information. This has resulted in a focus on developing training products that are cost and time effective, relevant to each viticulture region and, that can be combined with other forms of training or advice. Over recent years CRCV program 4 through WINETAC in collaboration with other organisations has developed a variety of methods of technology transfer that are readily accessible, practical and cost-effective to meet these changing needs.

The main objective of this project was to continue development of pesticide application extension packages for the viticulture industry while also providing a focus for industry consultation and feedback. Other outputs included training of grower groups utilising the short course package developed during the project as well as pesticide fact sheets that will be freely available to industry via the WINETAC and CRCV. As a result of current and previous projects the Research to Practice® extension package for pesticide application now includes:

- Updated presentations, manuals and support materials for the three-day workshop that over the past six years has successfully delivered the latest information to over 750 participants
- A comprehensive short course package including a workbook and presentations with a focus on specific topics targeted at viticulturists who require practical training in the most critical pesticide application areas
- Training modules with a focus on a particular regional issue such as powdery mildew control
- Five pesticide fact sheets covering important pesticide application topics including resistance management, adjuvant use and spray equipment set up
- A series of five pesticide fact sheets describing the procedure and methods available to interpret pesticide labels and calculate chemical rates (these will be developed into Vitinotes in the near future)
- The Spray Smart CD - a practical, decision-making tool designed to increase industry access to pesticide application and provide this information in multimedia format (CRCV Project 02/05)

Two spray application half-day workshops have been conducted in the King Valley and Henty wine regions in Victoria (using the short course package) as part of the extension component of this project. Another half-day workshop for viticulturists was held in the Yarra Valley in conjunction with Bayer CropScience. Course notes and presentations were also prepared for a 2004 AWITC one-day workshop "Advances in spray application in viticulture" to be held in the Yarra Valley in July 2004. Information on the outcomes of the Research to Practice® program were presented to the wine grape industry and researchers at the Cool Climate Viticulture Forum held in Melbourne during August 2003.

In collaboration with David Braybrook from Swinburne TAFE dilute volume spray trials were conducted during a field session with Mornington Peninsula wine grape growers. The major outcome from this work was a better industry understanding of chemical label interpretation as well as more accurate dilute volume recommendations.

The extension products developed in this project will contribute to the range of training and education options that can be accessed by growers, sprayer operators, students and allied industry personnel. They will make information previously only available in three-day workshops more accessible to a greater proportion of the viticulture industry. This should assist in broader adoption of improved management practices by making it easier for viticulturists to access and implement research outcomes. Potential benefits as a result of this extension strategy are likely to include better targeting of sprays, reduction in chemical usage, more consistent pest and disease control, reduced off-target impacts and lower spraying costs.

Future research and extension should continue to be aligned with relevant objectives of CRCV program 4 and include industry evaluation to improve the understanding of extension client needs and impact of extension activities. Development of strategies for more effective use of information and multimedia technology including the Internet should also be considered. The viticulture industry may also benefit from continuing to fund service providers involved in developing extension packages ensuring that extension information remains relevant and up-to-date.

Introduction

Project background

Effective pesticide application remains an essential component of improved pest and disease management in viticulture, but inefficient use of pesticides can increase chemical usage and production costs, reduce yield and quality, impact on residue levels and the environment, and increase the potential for pesticide resistance. The wine grape industry is under increasing pressure from customers, regulatory authorities and the wider community to reduce chemical inputs so as to meet stringent export market MRLs and minimise spray drift and off-target contamination.

In the past six years the Research to Practice® spray application program has successfully delivered pesticide application research outcomes to over 750 growers, vineyard managers, extension staff from wine companies, consultants and educators nationally. This has resulted in the adoption of more efficient spray application practices by providing a sound base for growers to improve their knowledge and implement more strategic and effective pest management practices.

It is important that the Research to Practice® spray application package is constantly updated to ensure that industry receives the most recent information, and so that the high quality and reputation of the extension program is maintained. The major value of Research to Practice® lies in the intellectual content contained in the manual and presentations and this needs continuous updating as new knowledge becomes available (GWRDC Viticulture Gap Analysis - Peter Read, 2002). Due to the nature of the program, access to the workshops has been limited to a few sectors of the wine and grape industry. It has been estimated that the maximum audience for delivery via workshops in their current format is unlikely to exceed more than 10% of growers in the industry (GWRDC Viticulture Gap Analysis - Peter Read, 2002).

The viticulture industry is looking for increased flexibility in training delivery, with an increased emphasis on training that is cost and time effective, relevant to a region and possibly combined with other forms of training or advice. Over recent years the CRCV and WINETAC in collaboration with other organisations have developed a variety of methods of technology transfer that are readily accessible, practical and cost-effective to meet these changing needs. In the pesticide application area these have included sub-licensing of Research to Practice® spray application workshops to registered training providers and development of training modules on specific topics such as powdery mildew control.

Further extension products to be developed in this project such as a spray application short course package as well as stand alone 'Fact' sheets will contribute to the range of training and education options that can be accessed by growers, sprayer operators and allied industry personnel. These new products will make information previously only available in three-day workshops more accessible to a greater proportion of the viticulture industry and is likely to result in broader adoption of improved management practices.

Project objectives

1. Update Research to Practice® spray application 'Tool Kit' including presentations, manual and support materials to ensure that the winegrape industry has continued access to the latest information, technologies and R&D outcomes.

2. Repackage Research to Practice® spray application materials into a suitable format for use during various extension activities including short courses, field days, seminars and grower meetings.

3. Update and produce 2nd edition of SpraySmart CDROM containing new information for the 2004/05 season.

4. Develop spray application 'Fact Sheets' and guidelines, summarising relevant research outcomes and best practices that will increase industry access to information on improving production practices.

5. Develop and package a licensee workshop delivery 'kit' for sub-licence by wine companies, crop consultants and resellers.

6. Maintain and extend network of international and local researchers, and industry personnel who can contribute to the continued development and delivery of the program content.

Project aims & Performance targets

Outputs and Performance Targets 2003-04

Outputs	Performance Targets
1. Research to Practice 'Tool kit' update	Updated spray application package including manual, presentations and workshop materials developed and produced in hardcopy and CDROM format by 30 September 2003
2. Spray application information repackaged for short courses	Manual, presentations and workshop materials produced by 31 October 2003
3. Fact Sheet development	Ten 'Fact Sheets' produced and promoted in industry publications and other media by 31 January 2004
4. Licensee Kit	Licensee workshop delivery package prepared for sub-licence by 30 April 2004
5. SpraySmart CDROM update	2nd edition of SpraySmart CDROM produced for distribution by 30 June 2004
6. Project report completed	Final project report received by GWRDC by 30 June 2004

Methodology

Technical information from previous and current GWRDC-funded spray application research was prepared and repackaged to suit industry delivery and extension requirements. Content included in information packages developed in this project was sourced from textbooks, published papers, reference books, as well as from the Research to Practice® spray application manual. Searching for new information and recent research outcomes was an important but time-consuming task.

Written material and presentations were prepared in a comprehensive and clear fashion, using as little technical 'jargon' as possible, aiming to provide an appropriate knowledge base in a format that was accessible to users. Bullet points were used in written material where appropriate to enhance user understanding while diagrams were used to illustrate complex processes or ideas.

Ten fact sheets were developed to summarise the key practices for important spray application topics such as sprayer set up, resistance management and interpreting chemical labels. They were designed to provide clear, practical and relevant advice to vineyard managers and growers in a relatively brief document. These were produced in an easy to read and standardised one to four-page format and were based on existing information and recent research outcomes in pesticide application. Other topics of interest covered in the fact sheets included adjuvant selection and use, and spray targets. Five fact sheets were also specifically developed to meet viticulture industry needs for practical information on calculating pesticide rates. This series will also be published as Vitinotes in August 2004.

Research results included in spray application information were drawn together from available published data and from research-in-progress. Much of this research has only recently become available in the public domain and was obtained through links developed with researchers and industry contacts including:

- Dr. David Manktelow (HortResearch) who developed spray coverage assessment techniques, as well as calibration and work rates spreadsheets
- Geoff Furness (SARDI) who developed the Unit Canopy Row calibration method
- Alison MacGregor (PIRVic) who is project leader for the GWRDC "Adjuvant use in viticulture" research project
- AVCARE who have developed spray volume recommendations for use with the new chemical label recommendations

Research to Practice® spray application materials were also developed into a suitable format for use during various extension activities including short courses, field days, seminars and grower meetings. This involved selecting out relevant topics, preparing new presentations and manuals for the target audience and organising field sessions.

Results and Discussion

1. Research to Practice® spray application 'Tool Kit'

The Research to Practice® extension package including presentations, manuals and support materials has been updated to include recent information on adjuvant selection and use, chemical label changes and calculating dilute spray volumes, spraying equipment set up and selection, and spray evaluation. The 'tool kit' also includes calibration calculation sheets, spray evaluation recording sheets, a work rates calculator and several spray application check lists.

Much of this new information is contained in the comprehensive short course materials developed during this project. These are now available on CDROM through WINETAC and CRCV (a CD copy of short course materials is attached to this report). A short course spray application program with descriptions of each topic is provided in Appendix 4.

2. Workshops and seminars

Two spray application half-day workshops were conducted in the King Valley and Henty wine regions in Victoria (using the short course package) as part of the extension component of this project. Another half-day workshop for viticulturists was held in the Yarra Valley in conjunction with Bayer CropScience. Participant evaluation of this seminar is presented in Appendix 5.

As another extension component of this project course notes and presentations were prepared for a 2004 AWITC one-day workshop "Advances in spray application in viticulture" to be held in the Yarra Valley in July 2004 that will consider future technologies and new techniques to optimise pesticide application. The workshop program and topic descriptions are contained in Appendix 6.

A three-hour spray application training course was also conducted for Diploma of Viticulture students from Swinburne TAFE at PIRVic Knoxfield requiring the development of course materials and presentations.

3. Other extension activities

- Meetings were held with Glenn Geitz (QDPI), Bayer CropScience, David Manktelow (HortResearch), Geoff Furness (PIRSA) and Alison MacGregor (SHC, PIRVic) to discuss the latest developments in pesticide application research and technology and plan for future research projects and field trials.

- In collaboration with David Braybrook from Swinburne TAFE dilute volume spray trials were conducted during a field session with Mornington Peninsula wine grape growers. The major outcome from this work was a better industry understanding of chemical label interpretation as well as more accurate dilute volume recommendations. Trial background information and results are provided in Appendix 3.

- As part of increasing adoption of better pesticide application practices the project leader provided verbal and written advice to five vineyard managers from NSW, Victoria and South Australia on various aspects of spray application techniques. Advice and information was also provided to Chemcert during the development of a Chemcert refresher course specifically designed for the viticulture industry.

- Information on the outcomes of the Research to Practice program were presented to the wine grape industry and researchers at the Cool Climate Viticulture Forum held in Melbourne during August 2003 (Presentation slides are provided on the attached CD).

4. Pesticide fact sheets

The front page of each pesticide fact sheet listed below has been included in Appendix 1.

Full copies of fact sheets are provided as Adobe® Acrobat® PDF files on the attached CD.

1. Targeting sprays for vineyard pests and diseases
2. Maintaining pesticide performance in spray mixes
3. Selecting and using spray adjuvants
4. Managing pesticide resistance in the vineyard
5. Equipment adjustment and evaluation to maximise spray coverage

<u>'Calculating pesticide rates' fact sheet series</u>

6. A single rate per hectare – why it shouldn't be used
7. How to determine chemical rates in viticulture
8. Dilute and concentrate spraying
9. Determining dilute water volumes in viticulture
10. Calculating chemical rates for vines

Outcomes

This project has continued to provide industry access to pesticide application research outcomes in viticulture via the development of 'application-ready' information and support tools. Information developed in it's various formats will continue to reinforce innovation by providing new knowledge and skills that give growers confidence to change practices by adopting the best available management methods. It has also continued maximising adoption of R&D outcomes resulting from research projects utilising the successful Research to Practice® model as well as other technology transfer methods. Extension activities continued to address the key concerns of viticulturists including:

- Pest and disease life cycles and appropriate spray timing for effective control
- Optimising spray equipment set up to effectively target the vine canopy
- The effects of the tank mix on pesticide performance and appropriate use of adjuvants
- Correctly interpreting chemical labels and using the right pesticide rate
- Matching water volumes and chemical rates to a growing vine canopy to achieve the correct coverage and dose
- Determining appropriate spray volumes and chemical rates when concentrate spraying
- Assessing spray application results to determine if a biologically effective coverage has been achieved

The extension materials developed in this project should also continue to assist development of production systems requiring less resource inputs by improving the efficacy and efficiency of agrochemical application.

Some of the positive benefits to industry and the community arising from this project are likely to include:

- A potential reduction in production costs and chemical usage
- Improved pest and disease management, yield and quality
- Minimisation of off-target impacts and residue levels in line with industry priorities regarding sustainable production

Evaluation of spray application practices of previous participants before and after attending a spray workshop has demonstrated that over 90% changed at least one significant production practice (Lopresti, 2003). This was primarily due to the standardised, practical 'Tool kit' approach that gave growers a better chance of success in implementing new management strategies. A continuing high level of adoption would be expected as a result of information packages developed in this project and extension conducted. The knowledge and skills gained by viticulturists during spray application extension activities are also likely to be transferred to other growers, employees, customers and students and this should increase the rate of adoption even further.

Performance against planned objectives

Although some of the objectives changed during the course of this project the main project objective to "improve viticulture industry access to spray application information" was met through a combination of extension activities and information development. Changing industry needs and requests required some flexibility in objectives and outputs during the project and as a result some of the original milestones were amended. New outputs as a result of changing objectives are discussed below.

1. Update Research to Practice® spray application 'Tool Kit' including presentations, manual and support materials to ensure that the wine grape industry has continued access to the latest information, technologies and R&D outcomes.

The Research to Practice® spray application manual and presentations were updated to include the most recent research outcomes in the areas of pest and disease management, adjuvant technology, improving pesticide performance and sprayer set up. During this process new resources and support tools were sourced and this information will be provided during spray application workshops and seminars in the future.

2. Repackage Research to Practice® spray application materials into a suitable format for use during various extension activities including short courses, field days, seminars and grower meetings.

Short course and seminar packages were developed as part of this extension project designed to assist viticulturists in improving pesticide application practices via cost and time-effective extension activities.

3. Update and produce 2nd edition of Spray Smart CDROM containing new information for the 2004/05 season.

As the Spray Smart CD development project (CRV 02/05) was delayed a 2nd edition of this product was not be produced as part of this project. Instead the first edition of the CD will contain the latest information obtained and developed during this project that would not have been on the "original" CD intended for release in February 2004.

4. Develop spray application 'Fact Sheets' and guidelines, summarising relevant research outcomes and best practices that will increase industry access to information on improving production practices.

Ten spray application fact sheets were developed to assist viticulturists in effectively applying pesticides. These will be available at workshops, seminars and from WINETAC and CRCV. A series of five fact sheets focussing on interpreting label rates will also be made available as Vitinotes.

5. Develop and package a licensee workshop delivery 'kit' for sub-licence by wine companies, crop consultants and resellers.

A licensee spray application workshop delivery 'kit' for sub-licence by wine companies, crop consultants and resellers had already been developed before the commencement of this project.

(The budget for the current project was reduced by approximately $9,000 to take this fact into account).

6. Maintain and extend network of international and local researchers, and industry personnel who can contribute to the continued development and delivery of the program content.

This project closely linked in with the current projects below while the project leader continued networking with key researchers in the fields of spray application and pest and disease management as well as chemical resellers and vineyard managers:

- CRV 02/05 SpraySmart - Interactive spray application CD-ROM for viticulture
- CRV 01/04 Retaining the 'clean & green' image of Australian viticulture by minimising the effect of agrochemicals in the environment
- CSU 02/01 The surface wax of the grape berry: interactions with chemical sprays and subsequent susceptibility to *Botrytis* infection
- GWRDC Better disease control by using adjuvants

Guidelines and tools were developed in collaboration with these researchers in areas such as matching water and chemical rates to different vine canopies and growth stages, defining bunches as spraying targets and set up protocols for different sprayers and trellising systems.

Additional project outputs

- Dilute volume spray trials were conducted during a field session with Mornington Peninsula wine grape growers. Trial background and results were provided to participants.

- Two spray application half-day workshops were conducted in the King Valley and Henty wine regions in Victoria as part of the extension component of this project.

- A half-day workshop for viticulturists was held in the Yarra Valley in conjunction with Bayer CropScience.

- Course notes and presentations were prepared for a 2004 AWITC one-day workshop "Advances in spray application in viticulture" to be held in the Yarra Valley in July 2004.

- A spray application training course was conducted for Diploma of Viticulture students from Swinburne TAFE at PIRVic Knoxfield requiring the development of course materials and presentations.

- As part of increasing adoption of better pesticide application practices the project leader provided verbal and written advice to five vineyard managers from NSW, Victoria and South Australia on various aspects of spray application techniques.

- Information on the outcomes of the Research to Practice® program were presented to the wine grape industry and researchers at the Cool Climate Viticulture Forum held in Melbourne during August 2003.

Recommendations

Future work and extension should continue to be aligned with relevant objectives of CRCV program 4 and should build on current extension strategies and information related to pesticide application in viticulture.

Objective 4: Improved understanding of skill gaps and industry learning requirements

- Evaluate current knowledge and skills of viticulturists involved in pesticide application to further fine-tune extension strategies and information packages

Objective 6: Improved relevance and responsiveness of learning and skill development solutions

- Continue to regularly update Research to Practice® pesticide application packages and information to include latest research outcomes and outputs
- Consider developing new extension packages for specific target groups including viticulturists at a regional level, VET and tertiary students
- Evaluate the relevance of extension packages and their impact on economic, environmental and social outcomes in the viticulture industry

Objective 7: Improved accessibility of learning and skill development solutions

- Evaluate the accessibility and success of extension packages to determine what other extension strategies and formats are required to ensure that the viticulture industry has access to relevant and up-to-date pesticide application information

The following general recommendations and needs have also been identified:

- Industry evaluation to improve the understanding of extension client needs and characteristics
- Improved training of intermediate audiences such as chemical resellers and consultants including development of quality assurance and accreditation programs
- More effective use of information and multimedia technology including the Internet, email and industry databases to more effectively disseminate information to specific industry groups
- Continued funding support for service providers and technical specialists who develop extension packages to maintain their involvement and contribution to extension – a benefit of this approach is that in return they can provide feedback to CRCV on industry requirements, regional issues and continue their role as an industry contact

References

Drew C.M. (2002). *Review of grape and wine industry extension*. GWRDC final report GWR 01/04, Scholefield Robinson Horticultural Services, 43pp.

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Read P. (2002). *Research gaps and potential project areas for the GWRDC five year plan.* GWRDC, March, 13pp.

*Research to Practice® Model Back Up Bo*ok (1998). Australian National Training Authority.

Viticulture Research to Practice®: Spray application manual (2002). Agriculture Victoria Services (licensed to CRCV).

Appendices

Appendix 1. Pesticide application fact sheets

CRC for Viticulture
Pesticide application fact sheet 1

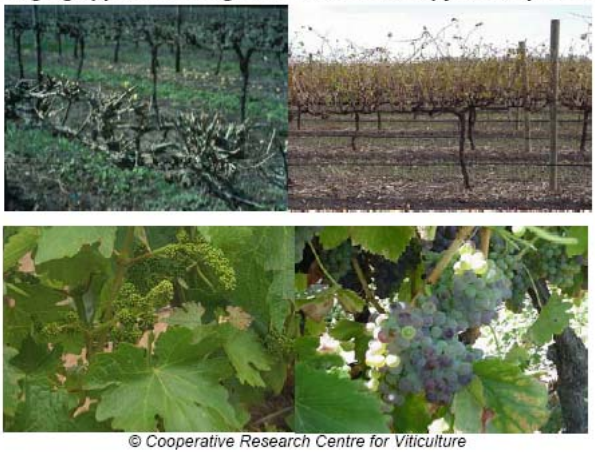
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Targeting sprays for vineyard pests and diseases

An important first step in achieving effective pest and disease control is correctly timing and targeting pesticide applications. Determining where and when a chemical should be applied requires an understanding of what the biological and application target is and how it influences the application process.

- The **biological target** refers to the pest that is to be controlled, for example botrytis, lightbrown apple moth or weeds.
- The **application target** is the place where the pesticide spray must be deposited in order to work on the biological target, for example, the flowers or bunches for botrytis control or the soil for pre-emergent herbicides.

Examples of changing application targets as the vine canopy develops through the season



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These targets will determine the timing of pesticide applications (to coincide with the most vulnerable or most destructive life cycle stages of the target pest), selection of the most appropriate chemical and, application method and sprayer adjustments required to achieve adequate coverage and dose. The following questions should be considered to correctly determine (or define) a spray target.

Has the pest or disease been correctly identified?
Accurately identifying the pest or disease causing vine damage or yield loss will enable the correct control strategy to be implemented, for example:

- Misdiagnosis of pest mites can lead to inappropriate chemical application and a reduction in predatory mite populations. Crinkled, distorted leaves resulting from early season rust mite damage may be mistakenly attributed to cold damage, phomopsis, bud mite, herbicides or 'restricted spring growth'.
- The decision to apply chemicals for phomopsis depends on whether Type 1 (Disporthe) or Type 2 is present in the vineyard. Chemical control is only required for Type 2 infections as no obvious link has been found between Disporthe infection and abnormal budburst or reduced grapevine productivity.

CRC for Viticulture
Pesticide application fact sheet 2

Cooperative Research Centre for Viticulture

Maintaining pesticide performance in spray mixes

The selection and, safe and effective use of agrochemicals is a complex area, with many products registered as pesticides for use in vineyards, and many factors influencing their effectiveness in the field.

Spray tank mixes can contain a variety of chemicals and adjuvants that may interact and change the effectiveness of one or more of the pesticides. Incompatibility, poor water quality and insufficient tank agitation can lead to reduced effectiveness of sprays, phytotoxicity and can affect equipment performance eg. clogging of nozzles and filters in sprayers.

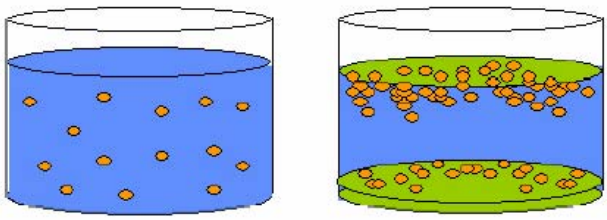
The main issues when mixing pesticides in the spray tank are briefly outlined below including pesticide compatibility problems, tank agitation and mixing, and water quality effects on pesticides. Further information is available from the references listed at the end of the fact sheet. Selection and use of chemical additives such as adjuvants is discussed in *Pesticide application fact sheet 3*.

Pesticide compatibility

Two or more pesticides are frequently combined to control different pests and diseases with a single application. This reduces application costs (labour, fuel and equipment) and time spent spraying in the vineyard. Ideally pesticide mixtures should be avoided but this is usually not practical on a commercial vineyard due to time and cost constraints. When combining two pesticides the following application and efficacy problems can occur:

- Effectiveness of one or both pesticides may be reduced ie. biological incompatibility
- Physical incompatibility resulting in precipitation or clumping ie. physical incompatibility
- Grapevine phytotoxicity (plant injury)
- Excessive run-off due to a high concentration of wetters in the tank mix
- Excessive residues

Physical incompatibility



Source: Research to Practice (CRCV)

A pesticide label will indicate if two products can be mixed together and provide guidance as to the proper order in which they need to be mixed. Generally, only compatibilities between pesticides produced by that manufacturer are listed. Some labels will also contain directions for mixing the product with certain other pesticide formulations. The safest method of assessing compatibility is to ask the manufacturer.

If possible don't use pesticide mixtures unless the chemical label allows their use, the manufacturers recommend the combination, or the mixture has been shown to be compatible through extended use over a range of conditions. Always check the chemical label carefully for incompatibility warnings from the manufacturer.

A pesticide can be tank mixed if the label does not prohibit its application with other products, and if the pesticides in the mix must are registered individually for grapes. **But under this situation the user assumes all responsibility for the application.**

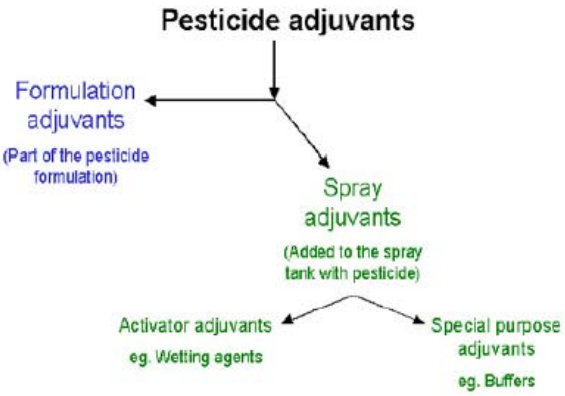
CRC for Viticulture
Pesticide application fact sheet 3

Selecting and using spray adjuvants

An adjuvant is any ingredient that modifies or enhances the performance of the active ingredient in a pesticide. The two categories of adjuvant are:

- **Formulation adjuvants** are added to the active ingredient during manufacture of the pesticide. These are used to improve mixing and handling, increase safety and effectiveness of the pesticide and improve distribution over the target.
- **Spray adjuvants** are added to the tank with pesticides to improve the performance of the active ingredients. There are many additives available for application of fungicides, insecticides and herbicides. These can be grouped into two broad classes - activator and special purpose adjuvants.

Activator adjuvants can include surfactants, wetters, oils, stickers and penetrants. They are commonly used to increase droplet spread, improve pesticide rain fastness and increase pesticide uptake by plants. They enhance pesticide performance by modifying the physical and chemical characteristics of the spray solution including density, surface tension and solubility.

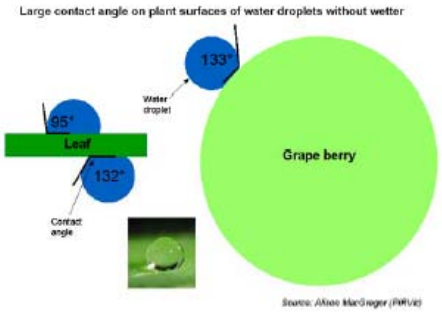


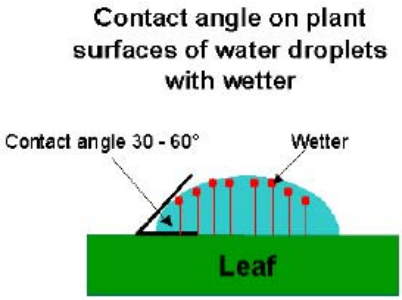
Special purpose adjuvants can include buffering agents, acidifiers, drift control agents and feeding attractants. They are commonly used to modify the spray solution or application conditions so that a pesticide formulation can function effectively. Sometimes they may also alter the physical characteristics of the spray solution.

Surfactants

A broad category of surface-acting adjuvants that improve the absorbing, emulsifying, dispersing, spreading, sticking, wetting or penetrating properties of pesticides. Water-repellent wax (cuticle) on a plant surface is the major barrier to the spreading, retention and penetration of pesticides. Surfactants are mostly used to overcome this barrier by, for example, forming bridges between water and wax on a leaf surface, or altering the permeability of the leaf cuticle.

Wetting agents and spreaders improve the wetting and coverage of foliage and grape bunches by reducing the surface tension between spray droplets and plant surfaces. They can be non-ionic, cationic or anionic. A non-ionic wetter has no charge when dispersed in water. A cationic wetter is positively charged while an anionic wetter has a negative charge on the surface-active portion. Phenol-based non-ionic wetters are most commonly used in viticulture and are generally compatible with most pesticides.





CRC for Viticulture
Pesticide application fact sheet 4

Cooperative Research Centre for Viticulture

Managing pesticide resistance in the vineyard

The way in which a pesticide works on the structure or metabolism of a pest in order to kill that pest is known as its **mode of action**. Understanding the modes of action of pesticides can help in deciding which is the best one to use for a particular situation and also for managing resistance in the target pest or disease.

Once a pesticide has made its way inside a pest or disease, whether this occurs by contact or systemic activity, it will disrupt the structure or physiology of the fungus, insect or weeds in one or many ways. This is the mode of action of the pesticide. For example some fungicides such as the DMI's can be used as eradicants or curatives because they are capable of destroying fungi that have already invaded and begun to damage plant tissue. Their mode of action is to inhibit the metabolic processes of the growing fungi. Protectants have a mode of action that prevents fungal infection through acting as a physical barrier or slowing growth of fungi.

Pesticides are divided into **activity groups** or families of related chemical compounds that:

- Have a similar chemical structure
- The same **mode of action**
- A different mode of action from pesticides in another group

Example – DMI fungicide mode of action

- The DMI's (Demethylation Inhibitors) have been one of the most important groups of fungicides for powdery mildew control over the last decade.
- They are a chemically diverse group and include penconazole (Topas®), triadimenol (Bayfidan®) and myclobutanil (Mycloss®).
- BUT they all inhibit the same demethylation step in the biosynthesis of ergosterol, a vital component of cell walls in many fungi.
- All DMI's kill fungi in this way, this is the **mode of action** of this group of fungicides.
- As all DMI's work at the same single site in fungi they belong to the same activity group ie. Group C

The activity group of a pesticide is classified by a letter code on the chemical label. For example, a fungicide belonging to activity group C will have the following code on the product label:

GROUP	C	FUNGICIDE

Resistance management involves restricting the use of high-risk (single-site) pesticides, and not overusing fungicides from the same activity group that have the **same mode of action**. This applies whether spraying for weeds, pests or diseases.

How resistance develops

Broad-spectrum fungicides such as copper, captan and sulphur act by interfering with several of a fungus' vital life functions. Their multi-site activity allows little chance for development of resistance since the fungus must undergo multiple changes to counteract the fungicide. On the other hand translaminar fungicides usually interfere with one vital life function, so only a single genetic change is needed for the fungus to become resistant to this type of chemical.

The majority of systemic and translaminar pesticides appear to be single-site inhibitors while the majority of conventional protectant fungicides such as sulphur are classified as multi-site inhibitors.

Pesticide application fact sheet 4 (Ver.1, June 2004) - John Lopresti (ed.)

CRC for Viticulture
Pesticide application fact sheet 5

Equipment adjustment and evaluation to maximise spray coverage

Correctly setting up a sprayer and evaluating spray coverage are necessary procedures to ensure that enough chemical is delivered to the vine and target pest or disease. When spraying we are attempting to achieve even coverage throughout the vine canopy while minimising off-target impacts and excessive run-off.

Sprayer set up and evaluation should be carried out at least three or four times during the season for each trellising system. Sprayer adjustment will be necessary each time the vine canopy or target changes, for example, at budburst, 20 cm shoots, flowering, pre-bunch closure and veraison. Correctly targeting sprays is particularly important for late season grape bunch applications.

Sprayer set up is the process of matching the sprayer to the canopy, weather and target to maximise spray coverage and minimise chemical waste by adjusting and optimising:

- Tractor speed
- Air volume, velocity and direction
- Nozzle size, number and direction

Calibration refers to measurement of travel speed and volume output per minute from the sprayer from which is calculated the volume leaving the sprayer per 100 metres of vine row or per hectare. But this tells you nothing about what is required for:

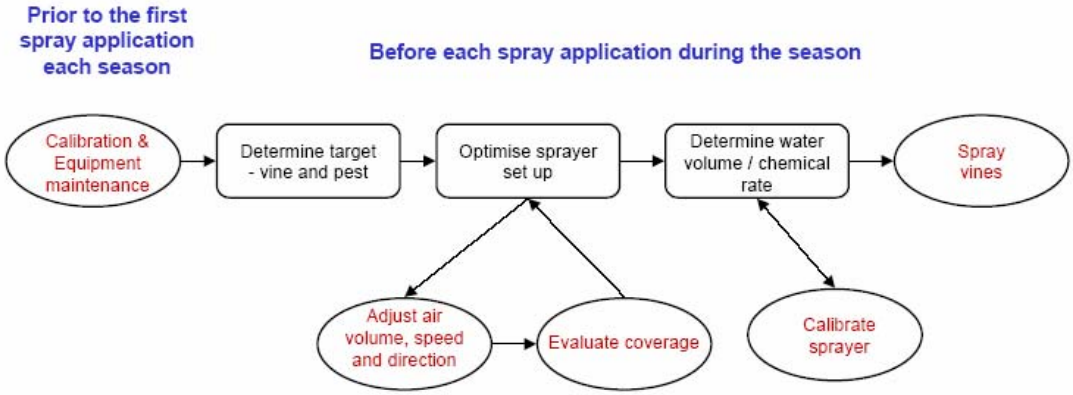
- A particular canopy
- A specific pest or disease
- The weather conditions on the day
- The application target ie. Where on the vine the spray needs to reach

The three factors to consider during sprayer set up are:

1. *Vine canopy* - Identifying the pest or disease and the appropriate pesticide for effective control. Also determining where the spray has to reach ie. What is the application target?

2. *Air quality* - The vine canopy and application target determines the air quality required from the sprayer

3. *Application volume* - The vine canopy, air quality and application target determine the volume of liquid and the amount of chemical needed.



CRC for Viticulture
Pesticide application fact sheet 6

COOPERATIVE RESEARCH CENTRE for VITICULTURE

A single rate per hectare – why it shouldn't be used

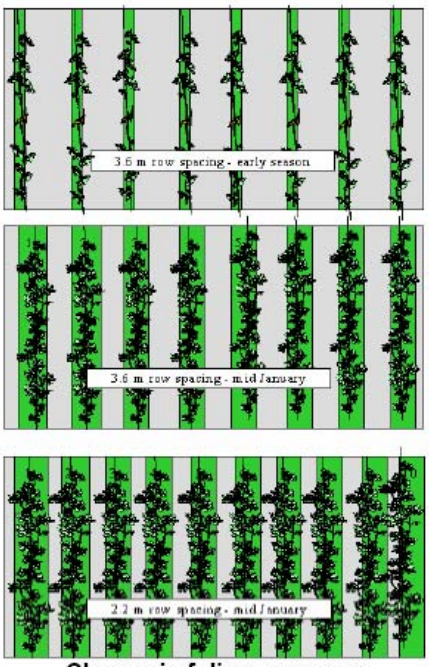
A single chemical rate per hectare is unsuitable for vine spraying where canopies change through the season, and may vary in size and row spacing. Chemical application based on ground area (eg. 2 Litres/hectare) has some appeal because it is easy to use but can result in applying either too little or too much pesticide to vines. Chemical rates should be varied according to the amount of foliage present to make sure that the right amount of chemical is applied to the target.

How much vine canopy is in a hectare?

The amount of vine canopy in a hectare will vary because of:

- Changes in canopy size as the vine grows
- Differences in foliage density due to canopy type, irrigation practices, canopy management, rootstock, planting density etc.
- Changes in amount of foliage per hectare due to different row spacings

In fact during the season leaf surface area per hectare of ground can increase by a factor of ten while foliage area in different canopies can vary by up to twenty-five times. As an example 2 kg/hectare of sulphur may be an appropriate chemical rate at 10cm shoots but 3 kg/hectare may be needed when berries are pea-size to ensure that the same dose is applied to the canopy at both growth stages. In another example, at the same growth stage, a hectare of small, non-irrigated VSP vines in southern Victoria will not need as much chemical as a hectare of large minimally pruned vines grown in the Riverland.



Change in foliage area per hectare due to canopy growth and row spacing

Moving away from a single rate per hectare

Using a single rate per hectare is comparable to painting different sized houses with a single quantity of paint, and not taking into account the differences in surface area that must be covered. In the vineyard there is a risk of under-dosing large canopies or over-dosing small canopies with a single chemical rate.

The single rate per hectare has mostly disappeared from pesticide labels for viticulture. Instead of a chemical rate per hectare (eg. 3 kg/hectare) chemical labels will have a rate per 100 litres of water (eg. 300 g/100 L). As a result growers need to determine the amount of water (Litres/hectare) needed to spray their vines to the point of run-off. Viticulturists can now use the new chemical labels to match chemical rates to the size of their vine canopies. This will result in increasing chemical rates as the canopy grows over the season. Using the 'rate per 100 litres' together with good targeting of the spray should result in a constant dose being applied as the vine grows.

Definitions

Dose: Amount of chemical deposited on a target surface such as a leaf or berry measured in $\mu g/cm^2$ ("Lethal dose" is the amount of chemical required to kill a pest or disease).

Point of run-off ("Thoroughly wet"): Situation where most of the vine canopy is covered in spray droplets so that some join together and begin to run over a leaf or berry – in dense, late-season canopies it generally occurs on outer leaves well before inner leaves are wet.

Further information

- *Spray Application Viticulture: Research to Practice*® is a training package that can be fine-tuned to suit regional requirements and includes workshops, short courses and a comprehensive manual.
- *Label Directions for Spraying Vine Canopies*. Bayer CropScience August 2003.

A single rate per hectare – why it shouldn't be used

Pesticide application fact sheet 6 (Ver.1, June 2004) - John Lopresti (ed.)

CRC for Viticulture
Pesticide application fact sheet 7

Cooperative Research Centre for Viticulture

How to determine chemical rates in viticulture

With the move towards concentrate (low volume) spraying and a new chemical label format it has become clear that there can be some difficulty in determining chemical rates and water volumes required for spraying vines. In this fact sheet the procedure that should be followed to determine water volumes and chemical rates is briefly outlined beginning with definitions of spray application terminology.

Terminology used in spray application

Dilute label rate
The product concentration given on the label for dilute spraying - expressed as grams or millilitres per 100 litres of spray - **A *lethal dose* is applied if the dilute label rate is used in a volume that thoroughly wets the vine canopy**

Application rate
The amount sprayed out per hectare or per 100 metres of vine but it is not the amount of chemical deposited on the vine - Application rate = label rate X water volume eg. 200 g/100L x1000 L/ha = 2 kg/ha

Coverage
Percentage (%) of target surface covered by deposits

Dilute water volume
Volume of water required to 'thoroughly wet' a particular vine canopy

Dose
The amount of chemical deposited on a target surface such as a leaf or berry but it is not the amount of chemical sprayed out per hectare - *Lethal dose* is the amount of chemical that needs to be deposited to control a pest or disease

Point of run off
Also known as 'thoroughly wet' and refers to coverage achieved where the majority of the canopy is covered in droplets so that some join together and run off foliage or bunches

Effective pesticide application - coverage and dose
Effective pest and disease control requires both:

- Adequate **coverage** of the vine canopy
- Sufficient **dose** of the chemical to effectively control the pest or disease

The critical steps in achieving spray coverage and dose required are:

1. Identifying the spray target (biological and application target)
2. Adjusting the sprayer set up to match air output to the canopy being sprayed
3. Selection of spray water volumes
4. Determination of the dilute water volume for the canopy being sprayed
5. Calculating chemical rates required based on the dilute volume

If each one of these steps is performed correctly then the chemical spray program being implemented should be effective. Although it is important to apply the right water volumes and chemical rates to a canopy it should be remembered that this will not control a disease unless good coverage has been achieved.

Increasing spray volumes and chemical rates will not improve coverage unless the sprayer set up is correct

CRC for Viticulture
Pesticide application fact sheet 8

Cooperative Research Centre for Viticulture

Dilute and concentrate spraying

When using new chemical label directions that only provide a 'rate per 100 litres' the water volume required to spray a vine canopy to run off, or dilute volume, **must always be determined** before a chemical rate can be calculated (See *Pesticide fact sheet 9*).

This is the cornerstone of the new label directions because it sets the amount of product that must be applied to a particular canopy whether by dilute or concentrate spraying.

Dilute spraying (high volume): the vine is sprayed to the point of run-off (thoroughly wet), using the dilute chemical rate of g or mL/100 L from the label.

Concentrate spraying (low volume): the vine is sprayed with a water volume that is less than that required for dilute spraying to the point of run-off, while applying the same amount of chemical (kg/ha) that would have been applied if dilute spraying.

Dilute spraying
When dilute spraying, the ml or g per 100 L chemical rate from the label is mixed in the spray tank and the foliage is sprayed to the point of run-off. Application should be to a level of coverage just before the point at which the spray starts to run off the plant surface. Spraying to this point will maximise the amount of product applied, avoid wastage and reduce possible unwanted contamination to the environment.

When dilute spraying higher water volumes are used during the season in comparison to concentrate spraying and a wider range of droplet sizes are produced by spray equipment. Spray volumes are also increased through the season to closely match vine canopy growth.

What is the 'point of run off'?
The term 'to the point of run off' or 'thoroughly wet' is actually quite difficult to describe. It is usually defined as the point at which spray starts to run off the surface of a leaf or bunch but this point can be difficult to identify. Further complications arise because not all parts of the canopy being sprayed will have the same coverage at any one time. In most cases outer leaves closest to the sprayer nozzles will capture more droplets than leaves in the centre of the vine and the aim of setting up the sprayer is to even out the coverage throughout the canopy.

It is clear that we are not talking about a specific point but rather an overall level of wetness throughout a particular canopy and some estimation will be required.

The 'point of run off' can most simply be defined as the point where most droplets on outer foliage of a vine canopy begin to join together with 'some' pooling at the edge of leaves and run off. But this point has only been reached once the sprayer has been set up to ensure even coverage of inner foliage and bunches ie. an even coverage of droplets should be visible inside the canopy.

In estimating the point of run off and level of wetness in a vine canopy the following factors should be considered:

- The point of run-off should be estimated based on the evenness of canopy wetness ie. a balance between different levels of coverage across the canopy
- Leaves near the sprayer will usually show signs of run off before the inner parts of the vine canopy that may never reach this point
- Aim to adequately cover the inner canopy before run off begins on outer canopy by correctly adjusting spray equipment
- Run off has not been reached if spray is dripping from outer leaves but the inner canopy is mostly dry

CRC for Viticulture
Pesticide application fact sheet 9

Cooperative Research Centre for Viticulture

Determining dilute water volumes in viticulture

The water volume that produces coverage to the 'point of run off' where the vine canopy is thoroughly wet is termed the dilute volume. This spray volume is the key in determining the amount of chemical that should be applied to a vine canopy to deposit a lethal dose (See *Pesticide fact sheet 8*).

The dilute volume sets the amount of product that must be applied to a particular canopy **whether by dilute or concentrate spraying**.

Currently there are four options for estimating the dilute volume required for a particular vine canopy:

- Measure in-field dilute volumes by test spraying to run-off
- Estimates based on past experience or regional practices ie. What has worked before?
- Vine-Row-Volume methods such as Unit Canopy Row (UCR)
- AVCARE recommendations

Determining the point of run off for a vine canopy can be difficult and quite subjective. Any of these methods can be used to estimate the dilute volume although in-field measurement of will probably provide the most accurate result. Remember that if a sprayer has been optimised to achieve good coverage throughout a vine canopy then the estimated dilute volume need only be within 10% to 15% of the 'true' value to achieve effective application.

Measuring in-field dilute volumes

Test spraying to run-off
When spray equipment is available that can be used for dilute spraying (regardless of whether dilute or concentrate spraying is conducted) test spraying to run off is the most accurate method to determine the dilute water volume. For a particular vine canopy the sprayer is firstly set up to provide maximum spray coverage and this remains unchanged during dilute volume determination. Correctly setting up the sprayer will ensure that droplets cover all parts of the canopy as evenly as possible. If wetting agent will be used for spraying then it should be added to the water before test runs begin. During test spraying water volumes are increased or decreased until a point is reached where the spray liquid is considered to cover all parts of the canopy more or less to the point of run off (See *Pesticide fact sheet 8*). Observe the vine canopy immediately after test spraying both sides of the row at the best sprayer set up.

When using spray equipment designed to achieve coverage at low spray volumes such as air shear equipment difficulties arise in attempting to use the above method, as this type of sprayer cannot be adjusted easily to spray to run-off. On some relatively small vine canopies it may be possible to determine an approximate dilute volume using a concentrate sprayer as test water volumes used will be within the normal operating range of the equipment.

Using a knapsack sprayer
A knapsack sprayer can be used to spray a vine canopy to run off to estimate the dilute volume and early season it can be a relatively accurate method. Care should be taken though as this method can overestimate the dilute volume on larger canopies. Studies have shown that a high-pressure hand lance that is not introduced into the centre of the canopy appears to give results similar to those achieved using a sprayer. This method should be practiced before it is used to measure the dilute volume.

District knowledge or past experience may allow growers to estimate the dilute volume a particular canopy requires at a specific growth stage during the season. A neighbour with a similar trellising system who uses dilute spraying may be able to provide information on dilute volumes being used for similar canopies. If no information is available then a possibility is to continue using concentrate spray volumes and chemical rates that have provided consistent control in difficult canopies or varieties.

CRC for Viticulture
Pesticide application fact sheet 10

Calculating chemical rates for vines

Once the dilute spray volume has been determined (See *Pesticide fact sheet 9*) then it is relatively simple to calculate the amount of chemical to put in the spray tank to ensure a sufficient dose is achieved.

Sample calculation

Vine canopy:	Dense late season VSP
Dilute label rate:	10 ml/100L (from the chemical label)
Spray tank volume:	2,000 litres
Dilute spray volume to 'thoroughly wet' the canopy being sprayed:	1,500 L/ha

For **dilute spraying** the amount of product specified on the label is added for each 100 L of water ensuring then that the tank mix is sprayed to run off.

Amount of chemical added to the tank = 10 ml/100L X 2,000 L = 200 mL

This tank mix is now sprayed to run off with a spray volume of 1,500 L/ha

The chemical application rate can also be calculated:

Application rate = 10 ml/100L X 1,500 L/ha = 150 ml/ha

For **concentrate spraying** the appropriate dilute volume for the vine canopy being sprayed is used to calculate the concentrate mixing rate that determines how much chemical to put into the spray tank.

Using another sprayer on your vineyard that produces fine droplets you select a concentrate spray volume of 500 L/ha that provides good coverage as well as reasonable work rates.

The concentration factor is the dilute spray volume divided by the concentrate spray volume:

1500 L ÷ 500 L = 3 ie. 3X

The dilute label rate from the chemical label is 10 mL/100 L then the concentrate mixing rate becomes

3 x 10 mL/100 L = 30 mL/100 L

This then becomes the chemical rate per 100 L that is added to the tank.

Amount of chemical added to the tank = 30 mL/100L X 2000 L = 600 mL

The chemical application rate can also be calculated:

Application rate = 30 ml/100L X 500 L/ha = 150 ml/ha

Using both dilute and concentrate spraying results in the same chemical application rate of 150 ml/ha. By concentrating the chemical and utilising the coverage potential of fine droplets when concentrate spraying we are able to put out the required application rate in 500 L/ha instead 1500 L/ha.

Appendix 2. Communication

Research Conference, Seminars, Workshop Presentations and Technical Reports (non-refereed)

Publications

- Spray application in viticulture short course manual (2003). Agriculture Victoria Services (licensed to CRCV)
- *Viticulture Research to Practice®: Spray application manual* (2003). Agriculture Victoria Services (licensed to CRCV), 3rd edition
- AWITC 2004 'Advances in spray application in viticulture' workbook
- CRCV Pesticide application in viticulture "fact sheets" (See Results)

Workshop Presentations

- Spray application short course – King Valley (Vic) wine grape growers, 16th September 2003
- Spray application short course - Great Western (Vic) wine grape growers, 11th November 2003
- Spray application seminar presentation – Yarra Valley wine grape growers, 15th February, 2004

Contributions of Project Staff to Viticultural Education and Training

Total hours spent by project staff in 2003/04 in education and training programs.

Name	Undergraduate Lectures	Postgraduate Supervision	Industry Training*
John Lopresti	5		40

*include seminars, workshops, demonstrations; show annual figure if more applicable.

Appendix 3. Dilute volumes trial report and results

Mornington Peninsula Vignerons Association - Dilute Volume Trials

Background

When using new chemical label directions that don't include a single rate per hectare the water volume required to spray a vine canopy to run off, or dilute volume, must be determined. It is the cornerstone of the new labels because it sets the amount of product that must be applied to a particular canopy whether by dilute or concentrate spraying. This ensures that an adequate amount of chemical, or dose, is applied as the canopy grows and greater water volumes are required.

With the move towards concentrate (low volume) spraying and a new chemical label format it has become clear that there are significant difficulties in determining chemical rates and water volumes required for spraying. These include determining when a canopy has been sprayed to the point of run off and problems in actually achieving this point using equipment designed to put out low spray volumes and fine droplets.

What is the point of run-off?
The term 'to the point of run off' is actually quite difficult to describe. Ideally the level of coverage should be just before the point at which the spray starts to run off the plant surface, but this point can be difficult to identify. Further complications arise because not all parts of the canopy being sprayed will have the same coverage at any one point in time. In most cases outer leaves closest to the sprayer nozzles will capture more droplets than leaves in the centre of the vine and the aim of setting up the sprayer is to even out the coverage throughout the canopy. It is clear that we are not talking about a specific point but rather an overall level of wetness throughout a particular canopy.

How can we measure dilute volumes to determine chemical rates?
Currently there are four methods available to 'estimate' the spray volume required to wet a particular vine canopy:

- Measure in-field dilute volumes using various spray equipment
- District practices and previous experience
- Vine-Row-Volume - 'Unit Canopy Row'
- AVCARE recommendations based on industry, agri-chemical company and researcher experience

Our aim is to estimate the dilute volume required for a vine canopy to within 10-20% of the 'true' value that remains unknown. Chemical rates based on this estimate should be sufficient to control a pest or disease if spraying equipment has been correctly set up to achieve adequate and even coverage throughout a vine canopy.

Objectives

- Estimate dilute volumes required for early season vine canopies using existing techniques and recommendations.
- Compare dilute volumes obtained from field trials using air blast, air shear and hand-gun sprayers with those based on industry recommendations and UCR calculations.
- Develop descriptions and determine measurements that accurately characterise vine canopy traits for use across the Mornington Peninsula region.

Procedure

1. Vine canopy characterisation

Measurements and vine canopy traits are likely to include growth stage, variety, height, width, trellising system, leaf layers (leaf density), shoots per metre, vine spacing, vine age, rootstock, specific pruning styles etc.
Canopy dimensions will include shoots extending beyond general limits of a vine as all vine tissue is usually targeted during commercial spraying operations.

2. Spray equipment set up

Air blast and air shear spray equipment will be calibrated and configured (set up) to maximise spray coverage throughout the vine canopies used for dilute volume trials using water sensitive cards and spray poles.

A non-penetrating hand-gun sprayer will be used in trials and spray coverage maximised by following the procedure described under 'Calculating water volumes for hand-held equipment'.

Dilute volume estimation trials

- Trials will be conducted on one variety only and at a single vine growth stage.
- An air blast, air shear and hand-gun (powered hand lance or knapsack) sprayer will be used in trials to determine and compare dilute volumes.
- Ideally 4 replicates of each trellising system will be sprayed 3 times each (12 replicates per trellis for each sprayer). Due to time constraints it is likely that there will be no replication of trellising systems.

Dilute volume estimation using UCR and AVCARE recommendations will be made after each vine canopy has been characterised and measured but before actual field trials commence.

For each trellis type and sprayer combination the point of run off will be estimated and objectively described where possible ie. Evenness and degree of coverage, droplet size, level of 'wetness'.

It is likely that after having set up machinery to adequately spray the inner leaves of a canopy, the point of run off will be judged to have been achieved once the outer leaves are thoroughly wet.

Calculating water volumes by hand held equipment

Equipment needed:-

Handgun or handlance
Spray tank and pump
Stop watch
Tape measure
Notebook and pen
Calculator
Water sensitive cards to assess spraying or dye

- Fill tank with water and wetter/sticker at the concentration to be added to the spray mixture.
- Place full cone nozzle in hand gun (TEEJET TG-1 or equivalent).
- Set pressure (aim for 10 bar) and measure flow rate and record result in litres/minute.
- Mark out 15 to 20 metres of row.
- Spray one side of canopy and record time taken.
- Spray other side of canopy and record time taken.

- Add times and convert to litres sprayed.
- Convert result to litres/100 m (UCR) or litres/Ha.
- Repeat procedure at least 3 times and average the results.

Notes:
- Spray canopy standing at 30°- 45° to row to maximise penetration of the spray plume into the centre of dense, large canopies.
- Use a full cone nozzle, which produces a spray plume with a long throw to get into the middle of the canopy.
- Use the spot spraying connection on your spray rig if you have no small spray pack.
- The pump on a bike spot sprayer may not be strong enough to produce a spray plume with droplets fine enough or with enough throw to be useful in determining spray volume.

Sample calculations for how much water was applied.

Flow rate from hand sprayer @ 1000kPa	=1 L/min
Seconds to spray 15 m of vine	= 240 seconds = 240 ÷60 = 4 min
Liquid Volume to spray 15 m of vine	= 4 min x 1 L min = 4 L
Volume per 1 m of vine	= 4 L/15 m = 0.27 L/m

Per Ha
metres of row /ha = 10,000 m^2 ÷ row spacing m
ie. for 3.6 metre row spacing 10,000 ÷ 3.6 = 2777.8 m

therefore vol/ha = 0.27 L/m x 2777.8 m/ha
= 741 L/ha

Per 100 m of Row
Volume per 100 m = 100 x 0.27 = 27 L

Mornington Peninsula Vignerons Association - Dilute Volume Trials

Results summary

Canopy

- VSP spur-pruned E-L stage 14; Mid-January, open canopy, shoot thinned (Figure 1)
- Canopy size: 0.3 by 0.6 metres; 3 metre row spacing

Sprayers

- Travel speed and set up (air direction, volume and speed) adjusted to maximise coverage
- Turbomiser droplet size 90 – 100 micron VMD
- Force 10 droplet size 130 – 150 micron VMD (Albuz 8 'red' nozzles, 4 - 10 bar)
- Knapsack droplet size >180 micron VMD

Run	Equipment	Spray volume	Result
1	Silvan Turbomiser (single-row; top and bottom heads at canopy)	280 L/ha* (8.1 L/100m)	Some leaves reaching point of run off but uneven across canopy *Spray volume generally used at this stage of the season by grower
2	Silvan Turbomiser	450 L/ha (13.5 L/100m)	Most leaves quite wet and some large droplets have formed
3	Hardi Force 10 (single-row; top and bottom heads at canopy)	500 L/ha (15 L/100m)	Wet leaves similar to Turbomiser at 450 L/ha but much less even ie. Some leaves were quite dry
4	Hardi Force 10 (bottom heads only)	360 L/ha (10.8 L/100m)	Better targeting with bottom heads results in more even wetness compared to (3)
5	Knapsack sprayer (non-penetrating hand lance)	13 L/100m	Equivalent wetness to sprayers although droplets on leaves were larger
6	UCR calculation	6 L/100m	Based on 30 L/ UCR

Outcomes

- General agreement by group that the dilute volume for the canopy at this stage of the season was 400 - 450 L/ha eg. A chemical concentration factor of 2 would be required if concentrate spraying using 200 L/ha
- Still some uncertainty as to what the point of run off was meant to look like and whether droplets coalescing at the leaf margins was an acceptable indicator
- Spray volume required to achieve "wetness" using the Turbomiser was similar to the Force 10 sprayer but droplets were finer and coverage more even probably due to the finer droplet spectrum produced by the Turbomiser (Compare Figure 2 with Figure 3)
- Spray volume required to achieve the point of run off seemed to be confirmed using the knapsack sprayer but overall droplet size was larger and coverage less even compared to the sprayers (Figure 4)
- Unit canopy row calculations appeared to underestimate the dilute volume by approximately 50% at this stage of the season

Other considerations

- Droplet size is an important factor when determining the point of run off by visually examining leaves
- Sprayer set up also has a significant impact on determining the dilute volume as poor sprayer targeting will result in a higher dilute volume than necessary
- As foliage development in shoot-positioned canopies is dominated by shoot elongation spray volume requirements should correlate well with growth
- When using UCR calculations for early season applications the spray plume from spraying equipment is the effective height of the canopy, not the actual vine
- Results obtained from hand lance trials need to be viewed as minimums for effective chemical application by machinery in most instances (may not be the case late season)
- A non-penetrating hand lance technique for determining dilute volumes is more comparable to machinery application than a method where the hand lance is placed inside the vine canopy
- Dilute volumes determined using a knapsack sprayer may be considerably higher later in the season compared to those obtained using vineyard sprayers (this is a result of inefficiencies due to the hand-lance being moved over a large leaf surface area resulting in "excess" water being sprayed onto the canopy)



Figure 1. VSP canopy used in trials



Figure 2. "Point of run off" using Turbomiser sprayer



Figure 3. "Point of run off" using Force 10 sprayer



Figure 4. "Point of run off" using knapsack sprayer

Appendix 4. Short course information

Spray Application Viticulture Workshop

Short course 1:00 – 5:30 pm

Workshop Topics

1:00 Introduction
- Strategic spraying
- Application & Biological targets
- Resistance management

1:30 Spray Equipment
- Overview of sprayer types & components
- Work rates calculator

2:00 Spray quality – From tank to target
- Droplet formation and behaviour
- Drop size, coverage and spray nozzles

2:30 *Coffee Break*

2:45 Evaluation tools
- Water sensitive cards
- Dyes

3:00 Optimising sprayer set-up
- Canopy, air output and water volumes
- Spraying bunches

3:30 Labelling Issues - Interpreting label rates
- Chemical label changes - Using rate/100 L
- Dilute and Concentrate spraying

4:15 *Field session - Sprayer set up and evaluation*
- Calibration/ Maintenance
- Sprayer adjustments
- Spray poles/ Evaluation demonstration

5:30 Conclusion

Cooperative Research Centre for Viticulture

Spray Application in Viticulture

Topic descriptions – Short Course

Introduction
This unit introduces the concept of strategic spraying as opposed to calender application, discusses targeting and timing sprays effectively and outlines resistance management strategies for viticulture.

Spray equipment
This module considers the types of equipment currently available for spray application in viticulture in terms of spray technology used, components, set up and maximising performance, versatility and cost. Factors to consider when purchasing a sprayer will also be outlined.

Spray quality - From tank to target
This topic explains how spray droplets are formed and how their behaviour can be manipulated to optimise the spray application process. The various nozzle technologies used are described and nozzle selection discussed.

Evaluation tools
The various tools available for evaluating spray coverage and effectiveness of changes to sprayer set up and operation are identified in this unit. Discussion will focus on the assessment of droplet density and distribution inside a vine canopy using water sensitive cards and fluorescent dyes.

Optimising sprayer set-up
This unit identifies the major factors that impact on spray penetration and distribution. It outlines procedures for optimising sprayer set up to maximise and even out coverage through the vine canopy.

Labelling Issues - Interpreting label rates
This topic explains the changes in pesticide label directions and why the rate per hectare expression is inappropriate for spraying vines. The importance of applying a sufficient dose onto the spray target will be demonstrated and methods to achieve this discussed. The relationship between dilute and concentrate spraying will also be outlined. Examples of the new label directions and calculations required for determining chemical rates are provided.

Field session - Sprayer set up and evaluation
The participants will have an opportunity to put into practice some of the concepts discussed in the workshop by setting up a sprayer and evaluating spray coverage using water sensitive cards. Important aspects of sprayer calibration will also be discussed.

Appendix 5. Seminar evaluation

Grapecheque Spray Application Day February 2004 Evaluation Results

29 evaluation forms returned

1. What part/s of the spray application day did you enjoy most?

Topic	No. of responses
Spray volume calculation presentation	10
Spray demonstrations	9
Talking with others	4
Miscellaneous	4
Roger Loveless' presentation	3
No response	3

Spray volume calculation presentation – 10
- Watching the confusion with the calculations
- Formula calculations
- Dilute/concentrate spray talks
- Explanation of x factor and dilute/concentrate
- X factor calculation
- Concentration factor info

Spray demonstrations – 9
- Sprayer set-up
- Seeing different units and how effective they are
- Seeing actual spray penetration on vines
- Being outside
- Demonstration of different machines
- Sprayer set up
- Spray unit demos

Talking with others - 4
- Talking to industry reps
- Interaction with other persons in the same industry and to hear their different comments
- Talking with other growers and their opinions

Roger Loveless' presentation – 3
- First presentation was very good
- Presentation – biological/practical applications and training

Miscellaneous - 4
- Roger and Hugh from Bayer
- No set preference
- Knowledge gained

- The whole afternoon

No response – 3

2. Your understanding of the topic before the session was:

	Scale	No. of responses
Very poor	1	3
	2	3
	3	10
	3-4	2
	4	7
Very good	5	4
	Total	29

3. Your knowledge of the topic after this session is:

	Scale	No. of responses
Very poor	1	0
	2	0
	3	3
	3-4	1
	4	14
	4-5	4
Very good	5	7
	Total	29

23 respondents said their knowledge of the topic had increased as a result of the session. Six reported no change.

4. What were the most beneficial things you learnt?

- How to best calculate coverage
- How to adjust concentrate spray
- General upgrade
- Refreshment on certain issues
- Volume spray calculation
- X factor calculation to canopy
- No response – 1111
- Angling spray jets to maximise spray penetration
- Understanding of x factor and how to calculate how much chem/water use and to try to understand all the spray on and in canopy
- Seeing different spray units in operation
- I am on the right track with modern thinking in chemical applications
- Air volume and how it affects spray coverage and how to alter and set up spray cart of improve coverage

- Determination of water volume and concentration factors
- Modes of action; labels; rates of volume
- The x factor
- Anything and everything I learn is beneficial
- Calculation of canopy size
- Water volumes and effectiveness
- Airflow importance (direction/speed)
- How much water to use per ha
- Difference between dilute and concentrate water values
- Calculating concentrate rates
- VCR
- Rate calibration
- Application rate calculation
- Spray timing is critical – smart spraying
- Calculations and testing efficiencies
- Testing, cards, other systems of working out rates

5. What benefits did you feel you got from attending this activity? (please circle those that apply to you)

Category	No. of responses
New knowledge that is useful	23
New skill/techniques you can apply	19
A change of attitude	6
Increased understanding of the issues	24
Increased understanding of other people's opinions	9
Time to think	6
Little or no benefit	0
Other – reinforcing what we are doing is right	1

6. What will you do on your farm differently as a result of the day?

- Calibrate more often
- Change speed when spraying
- Follow up my spraying staff
- An improved performance
- Spray calibration
- Recalibrate
- Do more testing of spray application
- Better assessment of spray application
- More time working on a sprayer
- Check how well our machine will operate from now on
- Check on speed and air…….use of chemicals
- Reassess spray efficiency – visually & check chemical calculations
- Nothing
- Reassess spray cart set up

- Use water sensitive cards more often
- Slow down
- Put it into practice
- Maybe increase water rates
- Take more care over the spraying
- Spend more time calibrating our machine
- Glad bosses were in attendance so they also have an understanding of all the processes we use
- Make up a spray pole
- Reassess effectiveness of our spray application
- Measure canopy and work out x factor
- Check more on canopy presentation
- Maybe change tractor speed in applicable
- Check with cards more regularly
- More testing in vineyard
- More targeted spraying
- Try different speeds and air pressures
- Higher application rates
- More water per hectare
- More testing
- May maintain records differently
- More records for QA
- May change point of run-off & nozzle direction
- Keep the water sensitive cards that we use
- No response - 3

7. Other comments:

- Interesting to see how other spray carts operate and compare
- Very interesting
- This should have been done two years ago
- Keep in touch – more field days
- Great arvo – will go back to farm and apply a few things I've learnt
- Very useful. Look forward to next session.
- When doing mathematics on board maybe use an example from one of the attendee's vineyard
- Thanks
- Enjoyable afternoon
- Well done
- Thank you for the opportunity to learn with others
- Worthwhile day – puts focus back on an often mundane topic

Appendix 6. 2004 AWITC spray application course program

12th Australian Wine Industry Technical Conference, Melbourne, Victoria

Workshop W67

Advances in vineyard spray application

Yering Station, 29th July 2004
9:00 am - 5:00 pm

Program

9:00 am	Strategic spraying and advances in pesticide application
9:45 am	Spray targeting for viticultural pests and diseases
10:30 am	*Morning tea*
11:00 am	Pesticides: present and future technologies
11:45 am	Improving pesticide performance
12:30 pm	*Lunch*
1:15 pm	Using chemical label rates effectively
2:00 pm	Integrated sprayer setup and evaluation
3:00 pm	*Afternoon tea*
3:15 pm	Field session: Sprayer setup, evaluation and dilute volumes
4:45 pm	Workshop conclusion

Introduction

This workshop will focus on practical methods for improving the efficiency of spray application in the vineyard. It will also provide participants with knowledge of the latest developments in pesticide application including pest and disease control, adjuvant technology and calculating chemical rates.

Participants will gain a clear understanding of how to correctly set up their spray equipment and best target sprays in a changing canopy while getting the right amount of pesticide to the target pest. An outdoor session will demonstrate the principles of effective spray application including sprayer adjustments and evaluation.

Much of the information provided in this workshop is part of the CRCV training package, "Research to Practice® Spray Application in Viticulture".

Facilitator: John Lopresti, CRCV Project Leader "Research to Practice® Spray Application in Viticulture", Biosystems Engineer, PIRVic Knoxfield

John Lopresti is employed within Primary Industries Research Victoria (PIRVic) as a Biosystems engineer. He has over 12 years of experience in research, extension and training and has authored and co-authored over forty research reports.

Since 2000 John has led the Research to Practice Spray application in viticulture program funded by GWRDC and CRCV. Over the last 4 years he has facilitated and presented topics in 25 pesticide application workshops as well as conducting numerous short courses for GrapeCheque and grower groups throughout Australia.

Workshop summary

Strategic spraying and advances in pesticide application

- Introduction and workshop overview
- Integrated approaches to pest management and strategic spraying
- Review of the pesticide application process
- Recent advances in application technology

Spray targeting for viticultural pests and diseases

- Review of biological and application targets
- Vine canopy management for improving spray access
- The role of chemical control in pest management
- Applying sprays for common pests and diseases

Pesticides: present and future technologies

- Pesticide mode of action and "how they work"
- Formulation technology
- Resistance management strategies
- "Soft" pesticides and future technologies

Improving pesticide performance

- Tank mixes and compatibility
- Water quality
- Adjuvant selection and use
- Recent advances in adjuvant use for viticulture

Using chemical label rates effectively

- Review of chemical rate, dose and coverage
- Label rate changes and rates per hectare
- Dilute and concentrate spraying
- Calculating dilute volumes - Methods and examples

Integrated sprayer setup and evaluation

- Brief overview of spray equipment
- Sprayer setup process and techniques
- Optimising spray coverage
- Recent research: Sprayer setup and minimising spray drift

Field session: Sprayer setup, evaluation and dilute volumes

- Operation and adjustment of different sprayers
- Spray evaluation using spray poles
- Calculating dilute volumes using a knapsack sprayer
- Sprayer setup and evaluation demonstration

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