Benchmarking vineyard management practices for premium wine grape production in high vigour sites

FINAL REPORT to
GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

Project Number: **RT01/04**

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Research Organisation: **Wine Industry Association, Western Australia**

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FINAL REPORT

Executive Summary

Management of vigorous varieties on vigorous sites can pose a challenge in the Pemberton and Denmark areas. Potential problems can be over-dense canopies resulting in poor ripening, diseased bunches, low quality and low yields.

Growers use various practices to manage this vigour. It was felt that it would be useful to document these practices, score the canopies and assess the fruit and wine. Exchange of ideas amongst the growers would be enhanced by a trip around each other's study site part-way through the study and a workshop when all the results were finalised.

A total of 13 vineyard sites were successfully set up and studied during the 2001/2002 growing season. All were Shiraz, growing mainly on Karri Loam soils. Nine of these sites were in or near the Pemberton region and four were in the Denmark area.

Site factors (soil type, slope, aspect, exposure) and vineyard factors (row orientation, row spacing, trellis type, vine age, etc) were noted by the Department of Agriculture.

Vineyard managers recorded weather data and all management practices used on the study site (to a standard format- in a pre-prepared booklet). Department staff visited regularly during the growing season.

Canopies were assessed at veraison by Department staff using the Scorecard method of Smart and Robinson (1992).

A bus trip at Pemberton was organised following the canopy assessments to allow growers to see and discuss each other's study sites.

Harvest measurements were taken at the nine Pemberton sites. Berries from the study vines were sampled at harvest by Department staff and analysed for berry weight, a range of chemical parameters and colour density. Twenty kilograms of grapes from the study vines at each of the nine sites in the Pemberton region were made into wine using micro-scale techniques following the method of Iland et. al. (2001).

The take-home messages from the study were:

- The fruit and wine made from the study was mostly of a very high standard, inferring that improved vine management in Pemberton may not be a very high priority from the quality viewpoint.
- The widely variable numbers of operations amongst growers for vine nutrition, canopy management and pest/disease control suggests that costs of production will also vary
- Canopy Score may be a reasonable indicator of fruit and wine quality for Pemberton
- The growers understand what the canopy should look like- and are competent at achieving this.

- Differing fruit exposure appears to explain much of the difference between the range of-
    - canopy scores
    - brix

      and possibly-
    - fruit colours
    - wine phenolics and anthocyanins
- Canopies could be improved by being less dense and narrower and more fruit exposure
- Practices relating to the nitrogen nutrition of vines may need addressing in Pemberton
- Chicory or other deep rooted cover crops may allow use of RDI and PRD to manage grape quality.

Future R&D needs were recorded by the group under the headings of:

- Cost of production (optimums in relation to end-point requirements)
- Controlling vigour (Sylvos-time of removing the downward shoot, cover crops to reduce soil moisture, canopy management techniques)
- Shiraz clones for cool regions (information search)
- Fruit exposure (leaf plucking trial)
- Earlier ripening (crop load, pruning and post harvest management trials)

In order to let other growers know about the results, the study group included two local consultants, each with a large client base, a major local winemaker and representatives of the local growers associations.

Many of the study findings are now being used in extension work by the Department of Agriculture and others.

Background

Parties: undertaking the study:

Pemberton Wine Region Association Inc. (Patrick Coutts. Ex-President)
Denmark Winegrowers Association (Ashley Cooper, Secretary)
Department of Agriculture: Colin McDonald (Albany)
Neil Lantzke, Bob Frayne (South Perth)
Eric Wootton (Manjimup)

Time frame: 2001/2002 grape growing season.

Introduction

Management of vigorous varieties on vigorous sites can pose a challenge in the Pemberton and Denmark areas. Potential problems can be over-dense canopies resulting in poor ripening, diseased bunches, low quality and low yields.

Growers use various practices to manage this vigour. It was felt that it would be useful to document these practices, score the canopies and assess the fruit and wine. Exchange of ideas amongst the growers would be enhanced by a trip around each other's study site part-way through the study and a workshop when all the results were finalised.

The work undertaken was closely aligned to the statement of need as in the original submission-

This project will help identify the site and management factors that limit the production of quality grapes in high vigour sites. The participants in the survey and growers attending the workshop will gain a better understanding of the factors that affect grape quality in their region. The study will help growers become more aware of the management options available and result in improved decision making. This benchmarking study will also assist in the development of detailed research proposals to produce improved management strategies in high vigour areas.

Objectives

The project adhered closely to the originally stated aims-

- *To quantify variability in wine grape quality for a premium variety grown on 10 sites in the Pemberton/Warren region and three sites in the Great Southern region.* Shiraz was the chosen variety and we eventually obtained nine sites in the Pemberton Region and four in the Denmark district. In addition to grape quality, wine quality was also assessed for the nine Pemberton sites.

- *To collect information on vine management and site factors associated with that variation in quality.* We also included canopy assessment (scorecard) after veraison.

- *To develop hypotheses for future research projects to start to quantify these relationships*

- *To conduct one or more workshops aimed at examining these relationships and providing direction to facilitate adoption of appropriate management methods.* The first workshop took the form of a bus trip around the sites after veraison. The second workshop was an examination of the overall results after vintage.

Design and method:

The project was a pilot study or an observational study. It was not designed to have the focus and rigour of a scientific experiment. Rather it was designed to engage the group of growers in comparing experiences, learning from each other and developing ideas/hypotheses for future work.

Conceptual model for the study

A diagram was used as a conceptual model for the study showing the factors being considered, their relationship to grape and wine quality and which parties were responsible for keeping the various records (Fig.1).

Confidentiality

The identity of the results for particular vineyards in the study remain confidential. Random letters were used in the study to distinguish between vineyards.

Site Factors and Production System Factors

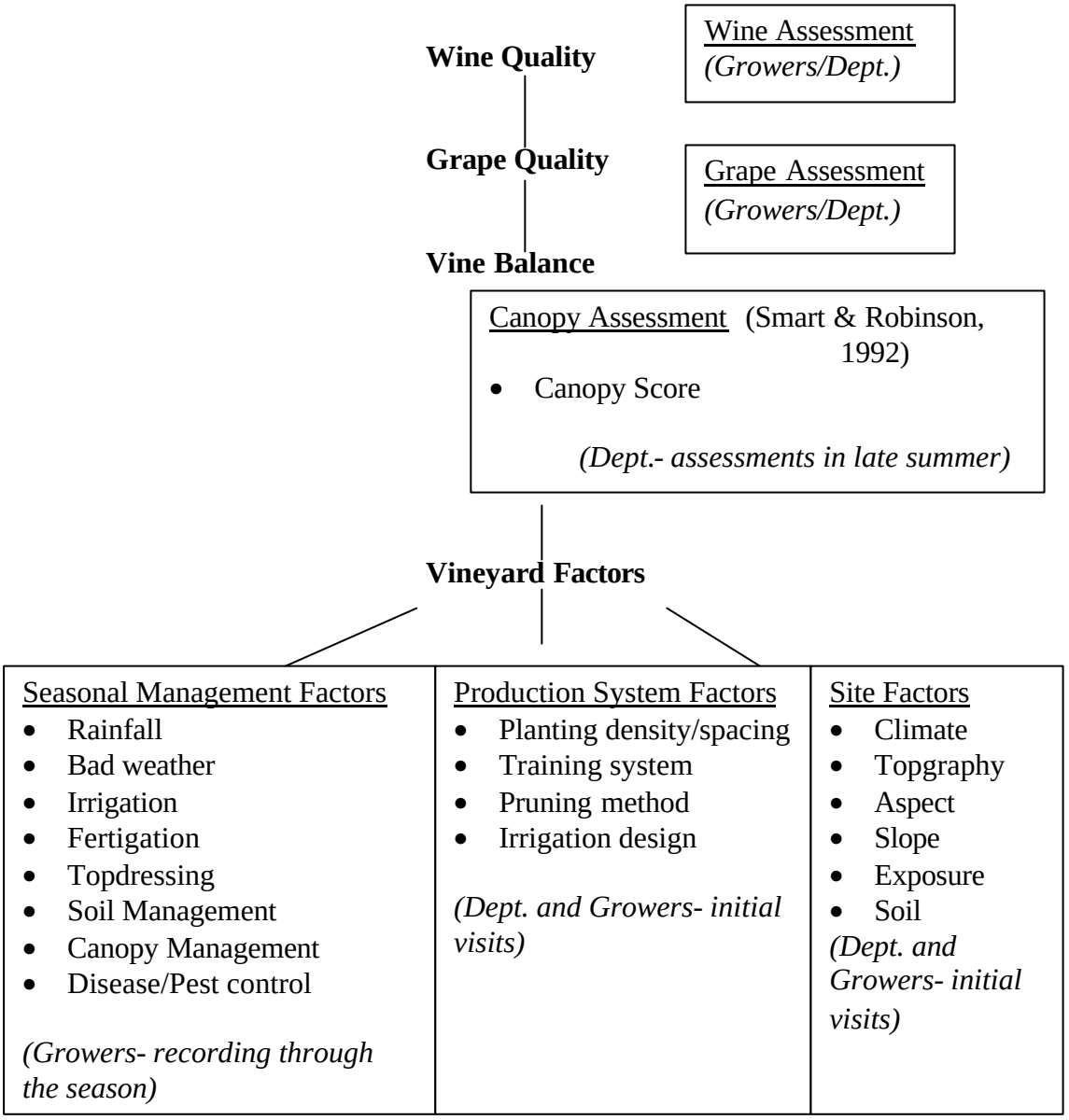
At each vineyard/block of Shiraz, at least 5 rows of vines were initially identified for the study. As far as possible the rows of vines for the study were chosen on areas of karri loam or deep, well drained gravely loam with a minimum of variation within the study area in terms of soil type and slope. All the sites were within the VH5 rainfall zone of Western Australia.

The site factors and production system factors that were considered in the study are listed in Figure 1. These were documented by Department staff in consultation with the particular growers. The topography, aspect, slope and exposure were assessed visually. The soil type was assessed by surface inspection, discussion with the grower and reference to the remnant vegetation that was near to (usually adjoining) each site. The production system factors were documented in discussion with the grower.

Seasonal Management Factors

Growers undertook to manage the site for the duration of the study according to their normal practice. Summaries of factors they recorded are listed in Figure 1. The detailed information was recorded in pre-prepared record books for each grower.

Figure 1. Shiraz vigour study
Assessments, recordings and who is responsible



Note: It is acknowledged that some factors may have more direct effects on quality than is shown in Fig 1.

Canopy Assessments

Shortly after veraison, Department staff identified a number of random panels within the study site at which to undertake canopy assessments. The number of panels assessed was either five on vineyards where there were four vines per panel (total 20 vines) or six on vineyards where there were three vines per panel (total 18 vines). The assessments followed the Scorecard method described by Smart and Robinson (1992).

Harvest sampling:

Growers recorded refractometer or hydrometer readings leading up to harvest and informed Department staff when 22-24 ^{0}Brix was approaching. At that stage (just prior to commercial harvest, except in one case) the study panels (those identified for the canopy assessments) were hand-harvested.

At each site, a random 1000 berries were firstly taken from the study panels. Then, from each bag of 1000 berries, a random 200 were set aside in bags for analysis of colour density and a random 50 were set aside in bags for the other laboratory analyses. The berries remaining from the 1000 berry samples (750 berries) were frozen for tasting at the final workshop.

The study panels were then hand-harvested, the fruit was weighed, placed in 20L tubs with plastic liners, a teaspoon of sodium metabisulphate added, the fruit covered over, cooled and sent to South Perth to be made into wine. The bags of 200 berries and 50 berries were included in the tubs and were analysed in the laboratory where the wine was made.

Both the wine making and the chemical analysis were done according to the methods of Iland et.al. (2000).

Iland, P., Ewart, A., Sitters, J., Markides, A., and Bruer, N. 2000, Techniques for chemical analysis and quality monitoring during winemaking Partick Iland Wine Promotions, Adelaide.

Smart, R. and Robinson, M. 1992. Sunlight into wine: a handbook for winegrape canopy management Winetitles, Adelaide

Results and Discussion

Setting up the sites

A total of 13 vineyard sites were successfully set up and studied during the 2001/2002 growing season. All were Shiraz, growing mainly on Karri Loam soils. Nine of these sites were in or near the Pemberton region and four were in the Denmark area.

The study was successfully taken through to wine-making on all of the nine properties at Pemberton. The four study sites were successfully set up at Denmark and the growers were visited monthly until veraison. One Denmark grower also participated in the Pemberton bus trip.
However, as little documented feedback was received from three of the Denmark growers and the vines were harvested before samples could be taken, this report is based on the more complete set of results that were gained from Pemberton.

The results were assessed using the format in Fig.2 for each of the nine properties. This format reflects the conceptual model shown in Fig 1.

Figure 2. Format for assessing the results of the nine vineyards (with the average result and range shown)

Wine Characters

	pH	Titratable Acidity g	Alcohol %	Anthocyanin mg/L	Total Phenolics mg/L
Ave	3.6	6.4	12.1	591	40
Range	3.5-3.7	6.1-7.1	11.5-12.5	504-688	32.2-50.0

Berry Characters

	Yield kg/m	Berry Weight (g)	Total Soluble Solids Brix^0	pH	Titratable acidity (g)	Malic Acid mg/L	Free Amino Nitrogen mg/L	Colour (mg/g)
Ave	2.4	1.6	22.5	3.3	7.1	2.2	107	1.4
Range	1.4-4.6	1.3-1.9	21.4-23.6	3.2-3.4	5.6-8.4	1.6-2.7	69-149	1.2-1.8

Canopy Scores

	Canopy Gaps	Leaf size	Leaf Colour	Canopy Density	Fruit Exposure	Shoot Length	Lateral Growth	Growing Tips	Total Score
Ave	3.5	7.3	8.0	2.2	4.7	9.9	8.8	10.0	54
Range	0.0-6.8	6.1-8.1	6.0-10.0	2.0-2.8	2.2-6.8	8.9-10.0	6.9-10.0	9.9-10.0	47-59

Vineyard Factors (summary data from record books used by the growers and the Dept. Ag was entered here- one sheet for each vineyard.)

Seasonal Management Factors		Production System Factors		Site Factors	
Rainfall	See Table 1 for overview of data	Vine age	See Table 2 for overview of data	Climatic zone	See Table 2 for overview of data
Bad weather		Row x vine spacing (m)		Topography	
Irrigation		Trellis System		Aspect	
Fertigation		Pruning Method		slope	
Foliar nutrients		Irrigation system		Soil	
Topdressing					
Ground Manag't					
Canopy Manag't					
Disease/Pest control					
Ground treatment					

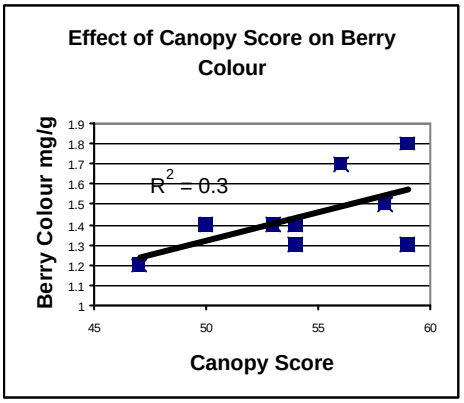
Table 1. Overview of the Management Factors among the Nine Vineyards

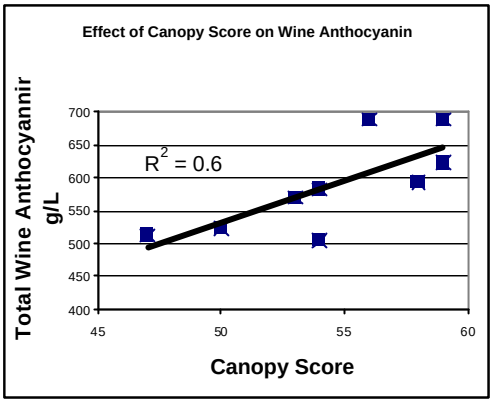
Factor	Vineyard					
	F	A	E	D	G	I
Irrigation	Began Jan	Began Feb		Began Jan		
Fertilser				Potato E	P, K, S	
Fertigation				Nil		
Shoot removal	Removed 19 shoots/ vine, left 33/m	Removed 20 shoots/vine				
Trimming/ Hedging Operations	2	1	2	3	4	?
Bunch Thinning	Feb	Mid Jan				
Disease and Pest Control	Good	Good	Adequate-good	Good	Good	Adequate
- no. times sprayed		10	5	14	15	?

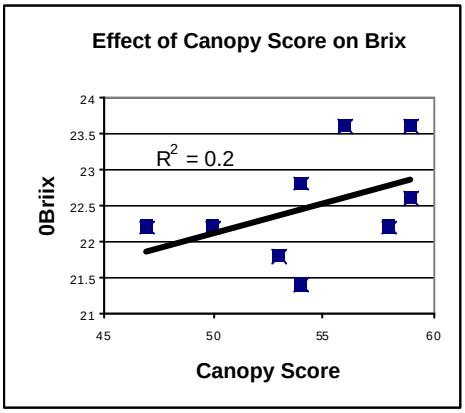
Table 2. Overview of Site and System Factors among the Nine Vineyards

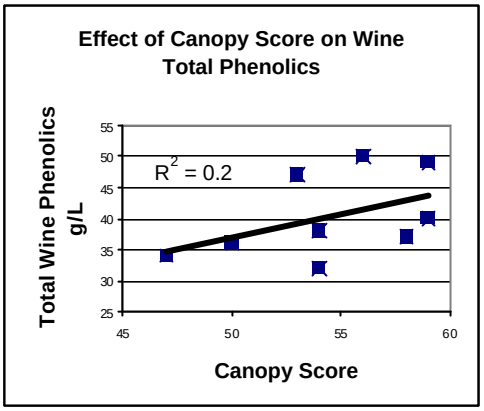
Factor	Vineyard							
	F	A	E	D	G	I	B	
wind exposure	exposed	partially exposed	exposed	exposed	exposed	sheltered	Partially exposed	
Soil type	Typical Karri loam	Typical Karri loam	Typical Karri loam	Karri loam	Gravelly loam-Karri and Marri	Karri loam	Typical Karri loam	
Vine Age	6 years	5 years	13 years	7 years	7 years	11 years	6 years	
Spacings-rows (m) x plants (m)	3 x 2	3 x 2	2.5 x 3	3 x 1.5	2.5 x 1.5	3 x 3	2 x 3	
Trellis System	Mid-height Silvos	VSP	VSP	VSP	Low VSP	VSP	VSP	
Pruning method	Spur plus one cane/vine	Spur	Spur	Spur	Spur	Spur	Spur	
Irrigation	Gypsum blocks	Gypsum blocks	Irrigating avoided	As judged necessary	As judged necessary	Gypsum blocks	As judged necessary	
Vineyard Floor	Perennial ryegrass	Perennial ryegrass	Volunteer sward	Volunteer sward	Volunteer sward	Volunteer sward	Clover	

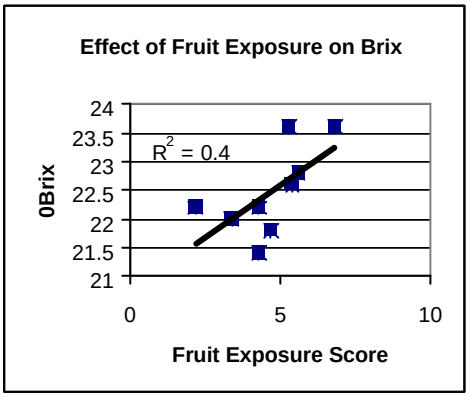
Figure 3. Some possible associations across the nine vineyards: canopy score as related to berry and wine











The nine results sheets as in Fig 2 (one for each property) were used to identify any associations of the various vineyard factors with the canopy scores, and the berry and the wine results. Where appropriate, correlation curves were plotted (Fig 3.).

Discussion points/questions covered at the final workshop are discussed below.

Do the Canopy Scores Indicate Fruit and Wine Quality?

- Greater canopy scores were associated with-
    - Greater colour in fruit…….. Correlation R^2=0.3 (weak)
    - More anthocyanin in wine…… Correlation R^2=0.6 (fair-good)

  Also-
    - Greater brix ……Correlation R^2=0.2 (very weak)
    - Greater phenolics in wine…… Correlation R^2=0.2 (very weak)

- ie Canopy Scores appear to be correlated with what we might expect.
- The correlations were usually weak but the trends were in the right direction.
- This suggests that canopy score may be a reasonable indicator of fruit and wine quality in Pemberton

What was good or bad about the Canopy Scores?

Overall- they were fairly high (47-59…….out of a max score of 80)
This suggests the growers have a good knowledge of what a canopy should look like and how to achieve this.

The good aspects of the canopy scores were-

Leaf colour, leaf size and health

- Suggests good management/conditions for vigour control, and good nutrition and health

Shoot length, laterals, growing tips

- But would be out of control if not well trimmed

The worst aspects were-

- Canopy gaps, leaf layer number and fruit exposure
- Need to be- less dense and narrower canopies

Canopy management operations – shoot thinning, trimming, bunch thinning, leaf plucking varied greatly, particularly in terms of numbers of operations. This would affect cost of production markedly.

What might the differences in canopy scores between vineyards tell us?

-The differences are mainly explained by different fruit exposures

Do site factors appear to affect canopy score, fruit and wine quality in this study?

(Site = the delimited area where the study panels were- climate, topography, aspect, slope, soil type)

- Nothing stands out as an over-riding effect
- Reason?- the sites were chosen to minimise variation
- The various factors are confounded within the system and management factors

Do production system factors appear to affect canopy score, fruit and wine quality in this study?

Vine age-

(Varied from 4 to 12 years in the study)

- nothing stands out ?

Row and Vine Spacing-

(Quite variable spacings- means can't compare yields per hectare
- used yield per metre of row (kg/m)

- nothing stands out?
- some good results from both extremes

Does trellis system appear to affect canopy score, fruit and wine quality in this study?

(The study had 5 VSP, 1 low VSP, 2 Silvos, 1 Scott Henry)

- there was good fruit and wine within every type of trellis system
- there was not enough replication to make firm comparisons

Does pruning system appear to affect canopy score, fruit and wine quality in this study?

(There were 5 spur, 2 cane, and 2 silvos in this study)

- there was not enough replication to make firm comparisons
- there was good fruit and wine within each type
- buds/m varied from 12-15/m to 25-27/m
- but people used various levels of shoot thinning and trimming
- there were some good fruit and wine at both extremes

Does irrigation system appear to affect canopy score, fruit and wine quality in this study?

(There were 7 drip-irrigated vineyards and 2 non-irrigated vineyards)
- there was some good fruit and wine from both
- there was not enough replication to make firm comparisons
- there were late rains on many properties that confused the issue

Do seasonal and management factors appear to affect canopy score, fruit and wine quality in this study?

Weather

There was a rain-storm during flowering

- fruit set at one study site appeared affected, but canopy score, yield, fruit and wine quality appeared relatively unaffected

late rains - Dec

- variable across sites but shoot tips had stopped growing at every site by February

Do fertiliser factors appear to affect canopy score, fruit and wine quality in this study?

(Quite variable practices were used by the growers- topdressed, fertigation, foliar, different products/ rates, different soil status, different approaches)

- Temporary potassium deficiency was noted at all sites in spring
- Some phosphorous deficiency was noted at most sites
- However, overall vine health was good, eg Canopy Scores showed good shoot growth, leaf size (6.1 – 8.1) and leaf colours (6 – 10).
- Berries often had less than ideal nitrogen (ideally- >110 mg/L free amino nitrogen. The average was 107 mg/L, with a range of 69 – 149 mg/L.) Surprisingly, the three vineyards with the lowest values had all applied N!. Is there a nitrogen issue here?

Does cover crop/ground cover appear to affect canopy score, fruit and wine quality in this study?

(Properties varied from ground cover based on rye-grass, clover, volunteer, and a chicory cover crop.)

- There were some good results within each type of ground cover however not enough replicates to make firm comparisons
- On the bus trip growers noted that the chickory appears to dry the soil, and reduces vigour. This site needed only one operation of vine-trimming. It was suggested that use of Chicory would dry the soil sufficiently to allow effective use

of RDI and PRD to manage fruit quality- which is otherwise not normally possible.

Does pest and disease management appear to affect canopy score, fruit and wine quality in this study?

- Disease and 'insect' control was adequate/good at all sites
- Powdery Mildew was a challenge
- Birds were a problem at only one site (near trees)
- Disease and 'insect' control programs varied from grower to grower
  - -number of spray applications
  - -chemicals and rates
  - -different circumstances?, different approaches?
  - -this would markedly affect cost of production

Outcome/Conclusion

Take home messages for growers from the shiraz vigour study-

- The fruit and wine made from the study was mostly of a very high standard, inferring that improved vine management in Pemberton may not be a very high priority from the quality viewpoint.

- The widely variable numbers of operations amongst growers for vine nutrition, canopy management and pest/disease control suggests that costs of production will also vary. It would be valuable to establish Pemberton 'Best Practice' (including costs) in regard to vine nutrition, canopy management and disease and pest management.

- Canopy Score may be a reasonable indicator of fruit and wine quality for Pemberton

- The growers understand what the canopy should look like- and are fairly good at achieving this.
-
- Differing fruit exposure appears to explain much of the difference between the range of-
  - canopy scores
  - brix

  and possibly-
  - fruit colours
  - wine phenolics and anthocyanins

- Canopies could be improved by being less dense and narrower and more fruit exposure

- Practices relating to the nitrogen nutrition of vines may need addressing in Pemberton

- Chicory or other deep rooted cover crops may allow use of RDI and PRD to manage grape quality.

The actual outcomes in relation to what was planned

The work has largely achieved the aims of the project as originally stated.

No major changes have been identified that may have improved the outcomes of the project. The same approach is now being used with growers in another region. All growers recorded that the study was worthwhile and made several suggestions. Two key suggestions were to do the bus trip and the canopy assessments as late as possible and to relate the results to the end point requirements of each grower (because this often varies from person to person).

The benefits of the project are essentially as originally stated- and are reproduced in the introduction to this report.

Future R&D needs were recorded by the group under the headings of:
- Cost of production (optimums in relation to end-point requirements)
- Controlling vigour (Sylvos-time of removing the downward shoot, cover crops to reduce soil moisture, canopy management techniques)
- Shiraz clones for cool regions (info search)
- Fruit exposure (leaf plucking trial)
- Earlier ripening (crop load, pruning and post harvest management trials)

It was agreed that further development and prioritising of these will be needed before any R&D proposals are put forward.

In order to let other growers know about the results, the study group included two local consultants, each with a large client base, a major local winemaker and representatives of the local growers associations. Many of the study findings are now being used in extension work by the Department of Agriculture and others.