Managing the fruitfulness of Menindee seedless

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QLD Department of Primary Industries & Fisheries

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Fruitfulness of tablegrapes. A scoping study.

TG03011

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MEDIA SUMMARY

A research, development and extension plan for the low fruitfulness problem in the tablegrape variety Menindee Seedless has recently been developed for the Australian tablegrape industry.

Symptoms of low fruitfulness include a lack of bunches and undersized bunches that are too small for premium quality fruit.

The plan outlines the key areas for research, development and extension work and future industry investment.

Horticulture Australia Ltd. on behalf of the Australian tablegrape industry, commissioned a national scoping study to determine the varieties affected by poor fruitfulness, the nature of the problem and severity in each of the production districts across Australia.

The scoping study was undertaken a team of tablegrape researchers from around Australia. The team was led by David Oag, Department of Primary Industries and Fisheries, and included scientists from CSIRO, Department of Primary Industries (Victoria), Northern Territory Department of Business, Industry and Regional Development, and Agriculture Western Australia.

Capturing the experiences of tablegrape growers from around Australia was a key aspect/step in establishing the fruitfulness problem and developing the RD&E plan. As part of the industry consultation process questionnaires were sent to tablegrape growers across Australia. Regional industry forums were subsequently held to expand on the information collected from the questionnaires.

Mr Oag said “feedback from industry demonstrated that Menindee Seedless was the variety worst affected by poor fruitfulness or a lack of bunches. Menindee Seedless is the most important variety within the tablegrape industry across northern Australia, making up approximately 70% of plantings.

As an early ripening, white seedless tablegrape Menindee Seedless is highly sought after by retailers and consumers.

In describing the RD&E plan Mr Oag said the plan contains two major strategies. The first is research to establish the key times in the floral cycle of Menindee Seedless in subtropical environments plus the factors for fruitfulness. The second is field research to develop vineyard management practices effective in maximising the fruitfulness of Menindee Seedless. “A lot of this field work can be successfully and cost effectively completed within existing tablegrape grower development groups such as GoGrape and Grape Cheque” Mr Oag said.

The other strategies within the plan include developing alternative varieties, a coordinated and enhanced transfer of information to growers, and development of financial information to assist Menindee Seedless growers in considering their options to growing Menindee Seedless.

Tablegrape growers and members of the public can obtain a copy of the RD&E investment plan from Horticulture Australia Ltd or their state representative of the Industry Advisory Committee.

TECHNICAL SUMMARY

Low fruitfulness can be a substantial problem in tablegrapes, particularly when grown in tropical environments. A scoping study was undertaken to ascertain the extent, nature and regional severity of the poor fruitfulness problem in tablegrapes across Australia.

Consultation with growers across Australia was the major source of local information on the problem. A questionnaire was sent to tablegrape growers in all the major production districts across Australia. The questionnaire included all tablegrape varieties and sought information on vine performance over a five year period. A number of regional forums were held to expand on the information gathered through the questionnaire. Several interviews with individual growers proved highly effective in obtaining specific details about the fruitfulness problem and the effectiveness of individual management practices.

Menindee Seedless was identified as the variety worst affected by low fruitfulness. Crimson Seedless suffers a mild fruitfulness problem, as does Thompson Seedless in more tropical locations (eg Carnarvon, Mareeba).

The low fruitfulness problem in Menindee Seedless occurs in tropical and temperate production districts in Australia. However, the problem is more severe in subtropical regions (ie NT, Qld, WA - Carnarvon).

The importance of Menindee Seedless within the Australian tablegrape industry warrants a concerted effort to resolve the low fruitfulness problem. Menindee Seedless makes up approximately 70% of plantings across northern Australia and is highly sought after by retailers and consumers. Currently there is no alternative early ripening, white seedless variety with a high level of recognition within the domestic market that could replace Menindee Seedless.

Bunch number and bunch size as the key components of fruitfulness is discussed, along with possible contributing factors. Gaps in current knowledge of the floral cycle, particularly for Menindee Seedless in subtropical environments, are highlighted. Times in the floral cycle when disruption to floral development may occur, resulting in partially developed floral structures or death of the floral primordium, is also discussed. Symptoms of poor fruitfulness observed in Australian vineyards are described.

A plan of research, development and extension activities to address the low fruitfulness problem has been designed. The first step involves establishing the timing of floral initiation and the key times in the floral cycle of Menindee Seedless, particularly in subtropical environments. The next step is to establish effective management practices that maximise the fruitfulness of Menindee Seedless.

Three smaller activities within the RD&E plan that can occur concurrently are:

- Identify and develop alternative varieties from the Australian breeding programme and imported varieties,
- information transfer to improve grower knowledge of the floral cycle and key factors contributing to fruitfulness, and
- comparative financial information on the viability of growing Menindee Seedless and the options available to growers.

It is recommended the Industry Advisory Committee accepts and utilise the RD&E plan to guide future industry investment in projects addressing the poor fruitfulness problem.

INTRODUCTION

This scoping study was commissioned by the tablegrape Industry Advisory Committee within Horticulture Australia Ltd.

The brief was "…..to design a research programme in fruitfulness of tablegrapes".

All tablegrape varieties were included during the industry consultation process, when feedback was sought from growers on the incidence of fruitfulness problems. It quickly became evident that Menindee Seedless was the primary variety with serious fruitfulness problems across Australia. Crimson Seedless was occasionally mentioned as having a mild fruitfulness problem.

Menindee Seedless constitutes approximately 70% of tablegrape plantings in the Northern Territory and Queensland, and is an important early season, white seedless variety in temperate production regions. Inconsistent, unpredictable and relatively low yield is a significant problem of Menindee Seedless, particularly in the subtropical environments of northern Australia.

Crimson Seedless is a fast emerging tablegrape variety in Australia, as evidenced by the rapid increase in plantings in both temperate and subtropical regions, and the success of the product in the market place (particularly exported fruit). The continued success of Crimson Seedless will in part depend upon improvements in vine productivity, and hence improvements in bud fruitfulness.

The purpose of this scoping study was to ascertain the severity of the poor fruitfulness problem in tablegrape varieties in Australia, the production districts where the problem is worst, and the management practices growers had found to be effective in improving fruitfulness.

A plan of research, development and extension activities addressing the problem of poor fruitfulness of tablegrapes was requested, for the purpose of guiding future industry investment.

The scoping study and this report concentrates on Menindee Seedless, the worst affected variety.

METHODOLOGY

A. Industry consultation to canvass the experiences and current knowledge of tablegrape growers around Australia in managing the fruitfulness of tablegrapes.

Two methods were used in consulting with industry, namely a questionnaire and regional forums

(a) Questionnaire

It is recognised that the tablegrape industry in Australia is very competitive, and that many individual operators jealously protect details of their vineyard practices and vine performance. It was therefore important to provide operators with a confidential opportunity to volunteer the specific information sought on the performance of Menindee Seedless.

A questionnaire was used to ascertain the severity of the fruitfulness problem around Australia, the tablegrape varieties affected, and identify the regions where the problem is most pronounced.

The questionnaire was designed to include quantitative responses where growers could use their vineyard records, and qualitative responses drawing upon their observations and experience.

The questionnaire provided individuals with the opportunity to be open and candid about their personal experiences as all responses remained private and confidential.

A copy of the questionnaire is included in Appendix 1. It was distributed as follows:

Queensland
A total of 180 questionnaires were posted to growers throughout Queensland.

Victoria
In Victoria the questionnaire was in the first instance distributed by hand to members of the Grape Cheque groups. There was a subsequent mail out to tablegrape growers in the Robinvale area, with 65 questionnaires being distributed in this way.

The major impediment to distributing the questionnaire on an industry-wide scale in the Sunraysia was the difficulty in obtaining access to comprehensive and up-to-date mailing lists of tablegrape growers. This is likely to be a problem with any future activities requiring the canvassing of all operators within the industry.

Northern Territory
In the Northern Territory approximately 20 questionnaires were hand delivered by Geoff Kenna.

Western Australia
In Western Australia Ian Cameron distributed over 90 questionnaires at preharvest field days held in the South West, Swan Valley, Geraldton and Carnarvon districts.

To familiarise growers with the project and encourage completion of the questionnaire, an overview of the project was presented at the Geraldton field day on 2 December 2003 by Mark Kristic, and at Carnarvon on 3 December 2003 by Peter Clingeleffer.

An extremely small number of completed questionnaires were received from Western Australia. This is probably due largely to the fact that varieties with poor fruitfulness are no longer grown in districts such as Carnarvon, where poor fruitfulness would otherwise be a problem. The approach in Western Australia has been to commercialise alternative varieties that are fruitful, instead of persisting with those varieties with fruitfulness problems. For example, Thompson Seedless is no longer grown in Carnarvon because of the poor fruitfulness problem.

General

In the absence of an industry mailing list, the questionnaire was also sent directly to a small number of interstate growers with whom the project leader already had established contact. In most cases this was done by email and the return rate of questionnaires from this group of growers was relatively high.

It was recognised that the questionnaire was generally limited to simple questions and that it was not practical to ask questions that required detailed or complex responses. It was important to ensure that the meaning of the question was clear so as to minimise the likelihood of the reader misinterpreting the question and providing an unintended response.

(b) Regional forums

The regional industry forums were designed to gather more detailed information from tablegrape growers than was possible with the questionnaire.

The original plan was to hold industry forums only in those regions where the questionnaire responses indicated that poor fruitfulness was an issue. Hence, industry forums were not conducted in Western Australia.

Industry forums were held at St George, Emerald and Mundubbera (August 2003), which are the three major tablegrape production districts in Queensland. Industry forums were also held in Victoria at Robinvale and Mildura (June 2003).

The number of growers attending regional forums were:

Emerald	8
Mundubbera	6
St George	4
Mildura	30
Robinvale	8

Each forum was of approximately 2 hours duration. Privacy of information was again a major consideration in selecting the techniques used and the structure of the forums. To achieve privacy and hence let growers feel comfortable enough to divulge information, a combination of group and individual activities were employed.

An overview of the project, the purpose of the industry forum and the eventual benefits to the Australian tablegrape industry (and hence individual operators), was presented to encourage participation and cooperation.

At each forum there were several operators who attended anticipating that they would receive a seminar on all that is known about fruitfulness in Menindee Seedless, and how to manage vines to improve fruitfulness. This was particularly the case in Victoria and at one location in Queensland, where those who attended the forum were mostly the relatively new growers in the district. This was a further

demonstration of the need for a coordinated programme for the transfer of current knowledge on Menindee Seedless and information on the floral development cycle in grapevines.

Most responses during the forums were drawn from a combination of experience, observation or opinion. Quantitative records of vine performance or vine response to specific management practices trialled in the vineyard were rare.

Forums consisted of the following key sessions:
1. Varieties.
The first exercise was for growers to nominate those varieties where poor fruitfulness can sometimes be an issue for them. The group was then asked to indicate the variety(ies) most affected by poor fruitfulness. Menindee Seedless was always nominated as the variety with the greatest fruitfulness problem, so the remaining activities of the forum were confined to Menindee Seedless.

2. Climate
The impact of individual climatic factors (temperature, light, rain, winter cold) on fruitfulness was then considered. The forum group was broken up into smaller discussion groups that each worked on one climatic factor.

3. Vineyard management practices.
The objective of this section of the forum was to obtain specific and more detailed information on vineyard management practices than was possible with the questionnaire. Growers were each given a worksheet and requested to provide details of the timings and rates used for nutrition, GA and irrigation, and the resulting vine fruitfulness from these management regimes. Growers were also asked to indicate the relative fruitfulness at bud positions along the cane.

A group activity was designed to determine common management practices within industry and the perceived impact of these on fruitfulness. The vineyard practices considered included canopy management, pruning method, trellis design, Dormex® use and rootstock. The commonly used management options within each vineyard practice were listed on a large sheet. For each option growers were asked to indicate whether the impact on Menindee Seedless fruitfulness, based on their observation, had been ‘positive’, ‘negative’ or ‘nil/unsure’.

4. Question and Answer.
A question and answer session followed to allow forum participants to make further comments or ask questions about things not already covered. Questions were mostly about the project, fruitfulness in grapevines, the most effective management practices for growing Menindee Seedless, and queries as to what were the comments at other forums.

5. Review and Summary.
Each regional forum concluded with a review and summary session. This session ascertained the importance of poor fruitfulness relative to all other issues facing the industry in that region, and provided an indication of whether or not growers considered the issue of vine fruitfulness warranted money being invested on R&D.

The potential contributing factors to poor fruitfulness had been dealt with separately and in isolation from each other, so growers were asked to select the three factors that they considered to have the biggest impact upon fruitfulness. The responses were pooled to give a ranking of the major issues perceived to influence tablegrape fruitfulness in that region.

(c) Interviews.

Interviews were also conducted with a small number of individual operators who volunteered. This was most productive in obtaining specific information on the severity of the fruitfulness problem, and vineyard practices found to be effective in improving fruitfulness.

B. Review of information by the project team, and future planning.

Following the regional industry forums, the project review group of David Oag (Qld), Peter Clingeleffer (Vic) and Mark Kristic (Vic) met to review all the information obtained from industry via the questionnaires, regional forums and interviews. This was combined with the limited scientific information available, primarily derived from winegrape research, to identify current gaps in the knowledge of factors influencing fruitfulness in Menindee Seedless.

A programme of RD&E activities was developed to improve our understanding of fruitfulness, and in particular the floral development of Menindee Seedless grown in subtropical environments.

RESULTS.

(a) Description of the problem/symptoms

The following descriptions are based on observations made in the field by the project leader and members of the project team.

The obvious symptom of poor fruitfulness is the lack of inflorescences. Failure to initiate an inflorescence is the primary cause of barren shoots, however, death of the floral primordium after initiation also leads to barren shoots.

Bud death and poor budburst indirectly contribute to poor bud fruitfulness. Initiation and development of the floral primordium may have occurred within the bud, but if the bud dies or does not burst then the result is also a lack of inflorescences on the vine.

Partially developed and undersized inflorescences also contribute to poor fruitfulness and yield potential. Partially developed floral structures indicate the process of floral development is incomplete. This may be due to insufficient time to complete floral development, and/or a disruption to the process. Described below are (i) the types of partially developed floral structures that have been observed in Menindee Seedless and (ii) other disruptions in the floral development process, along with suggested causal factors.

Figure 11. Fruitful tendril.

The fruitful tendril (Figure 11) is a partially developed inflorescence. The structure of the fruitful tendril indicates it has received the instruction to initiate but then failed to complete the process of floral development. Fruitful tendrils as a proportion of all inflorescences on the vine, varies between seasons. In Queensland's production districts fruitful tendrils can be a substantial proportion of the crop (up to 30%).

The events and factors that lead to development of a fruitful tendril are largely unknown. Are these structures initiated late in the season and then have insufficient time to complete development? Are there inadequate amounts or an imbalance in the endogenous plant growth regulators associated with floral development? If we can understand what is happening and subsequently develop appropriate vineyard management practices to encourage complete floral development, it should be possible to convert a low fruit yield into a desirable crop of fully developed inflorescences.

Undersized inflorescences (Figure 12) occur in varying proportions and like fruitful tendrils can make up a substantial proportion of the total inflorescence number in some seasons. Small inflorescences become small bunches at harvest, which adversely impacts on fruit yield and fruit quality. Undersized inflorescences appear to result from poor branching and failure of the rachis to elongate. Thus it is likely to be conditions after budburst in the current season that determines the incidence of undersized inflorescences. Temperature, nutrient supply (both stored and current), root activity and endogenous plant growth regulators are all likely to have a role in inflorescence growth.

Figure 12. Small inflorescence.

Figure 13. Floral primordium soon after budburst.

Death of the floral primordium occurs between budburst and flowering. The process is characterised by a small round floral structure approximately 2 - 4mm diameter (Figure 13) that fails to expand, and eventually falls off leaving no scar on the shoot. In subtropical areas the phenomenon may be extensive in some seasons. Death of the floral primordium differs from a fruitful tendril in that the shape of the floral structure prior to death suggests floral initiation was successful. It is expected that a bud containing this type of floral primordium would be rated as a fruitful bud during winter dormant bud dissections.

In most situations the growth of plant organs is governed by temperature and plant growth regulators (PGRs). It is therefore likely that both these factors play an important role in the incidence of floral primordium death. Other possible contributing factors are the level of root activity, nutrient supply, failure of the vascular system to connect with that of the shoot, and competition with vigorously growing shoots.

Abscission of inflorescence branches occurs closer to flowering, on normally developed inflorescences. The phenomenon is a serious problem in the Carnarvon district in all varieties, where it is known as “bunch abortion” (Figure 14), but rarely seen in central and eastern Australia. It is associated with a check in growth and subsequent boron toxicity. Inactive roots during spring and associated PGR levels are possible contributing factors.

Figure 14. “Bunch abortion” ie abscission of inflorescence branches. (Photo Ian Cameron)

Preflowering flower shatter of Menindee Seedless has been observed in most production districts across Australia. Unopen flowers fall off in the two weeks leading up to the start of flowering, leaving almost no flowers on the inflorescence (Figure 15). Flower shatter is doubly frustrating as it is often the early, large inflorescences that are most affected. Possible causes may include PGR imbalances, insect damage, and nutrient flush (as a consequence of the high nitrogen levels that have been more commonly applied in recent years).

Figure 15. Preflowering flower shatter.

Figure 16. Normal inflorescence of Menindee Seedless.

The project team believes a major step toward achieving acceptable fruitfulness and yield in Menindee Seedless will be an understanding of how to manage the vines to ensure all floral structures are retained, and that they continue to develop fully into normal, well sized inflorescences (Figure 16).

(b) Questionnaire

Completed questionnaires were grouped into regions to reflect environment and growing conditions. Hence, 'Central Qld' includes data from growers at Emerald and Charters Towers in Queensland, as well as at Carnarvon in Western Australia. 'NT' is data from growers at Ti Tree only. The 'Burnett' includes Mundubbera and Gayndah and surrounding area. 'SWQ' includes St George and surrounding area in south-west Queensland. The 'Sunraysia' includes Mildura, Robinvale and the NSW side of the Murray River.

For every anecdotal experience there is invariably another grower with the direct opposite experience. This makes it very difficult to establish relationships between vine performance and either the management practices used, or weather events.

The majority of growers indicated low fruitfulness is a problem (Question 6, data not presented). In the tropical regions almost all growers indicated low fruitfulness is a problem.

Extent of the problem.
The problem is a significant one, with more than 60% of respondents across Australia unhappy with the fruitfulness of their Menindee Seedless vines. The proportion of unhappy growers and level of dissatisfaction is more pronounced in the tropical production districts across northern Australia (Figure 1). Of particular note is that all growers at Emerald, Charters Towers and Carnarvon are unhappy with the fruitfulness of Menindee Seedless.

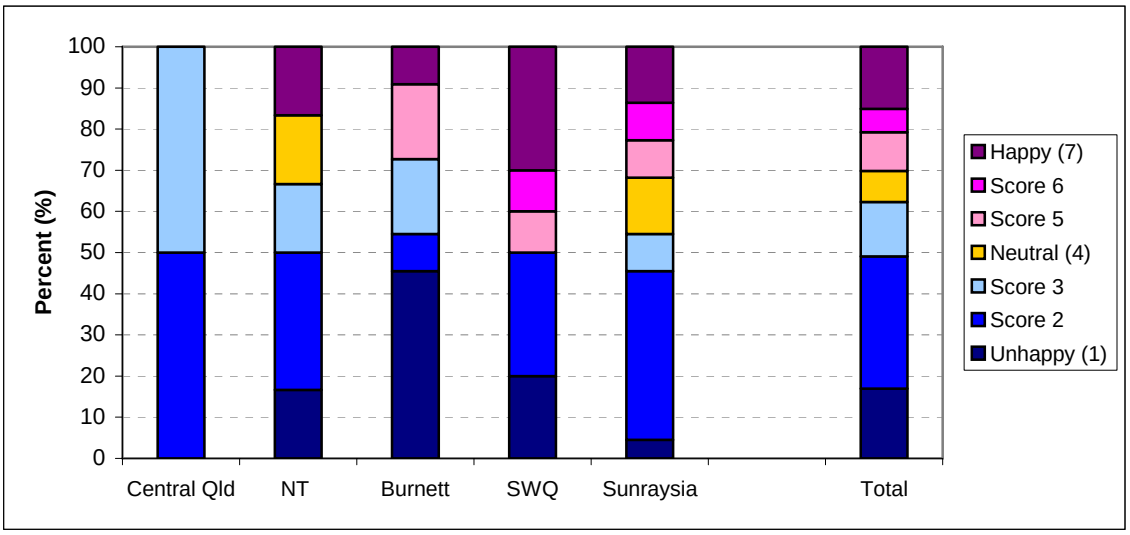


Figure 1. Grower satisfaction with the level of fruitfulness of Menindee Seedless vines.

Grower satisfaction with consistency of yield over the five seasons 1998/99 to 2002/03 is shown in Figure 2. Approximately 70% of growers are unhappy about the lack of consistency of yield from one season to the next. Again the level of dissatisfaction is more pronounced in the tropical tablegrape production regions of northern Australia.

The number of years during a five year period (1998/99 to 2002/03) when the actual yield was less than the desired yield is another way of indicating the level of poor fruitfulness. Growers were asked to indicate the number of seasons when the actual yield was less than the desired yield (Figure 3). Over 80% of growers across

Australia experienced two or more seasons in a five year period when the yield was less than desired.

In the tropical production districts (NT and Central Qld) all growers indicated the desired yield was not achieved in any of the five seasons. Only in the temperate regions did a small proportion of growers achieve desired yield in all five seasons.

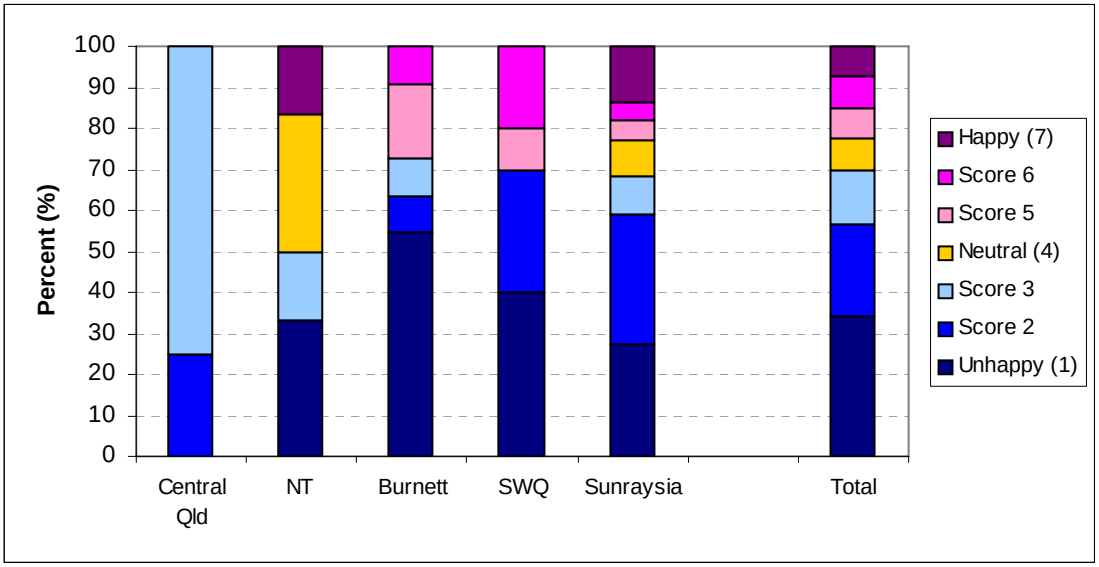


Figure 2. Grower satisfaction with consistency of yield of Menindee Seedless vines.

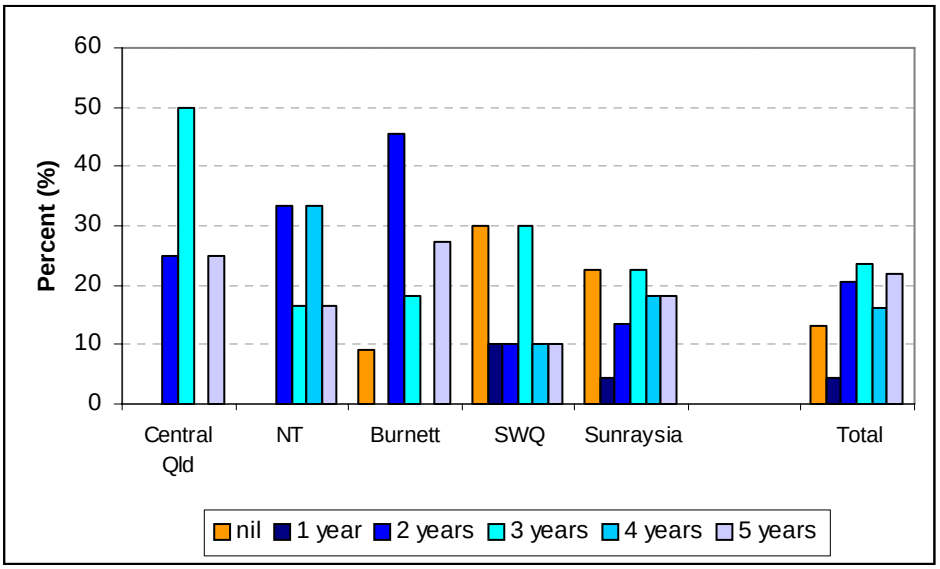


Figure 3. Number of seasons when yield was less than desired yield during the 5 seasons 1998/99 to 2002/03. Percent of respondents.

Components of fruitfulness

The questionnaire (Appendix I) included statements about the possible contributing factors to poor yield and low fruitfulness in vines, and asked growers if they agreed or disagreed. More than 70% of growers Australia wide believe low fruitfulness is primarily due to a lack of inflorescences (Figure 4). Further, the level of agreement with this statement was fairly unequivocal. The NT was the only exception. Approximately 50% of growers across Australia believed small inflorescence size prior to flowering is a primary contributing factor to poor yield (Figure 5).

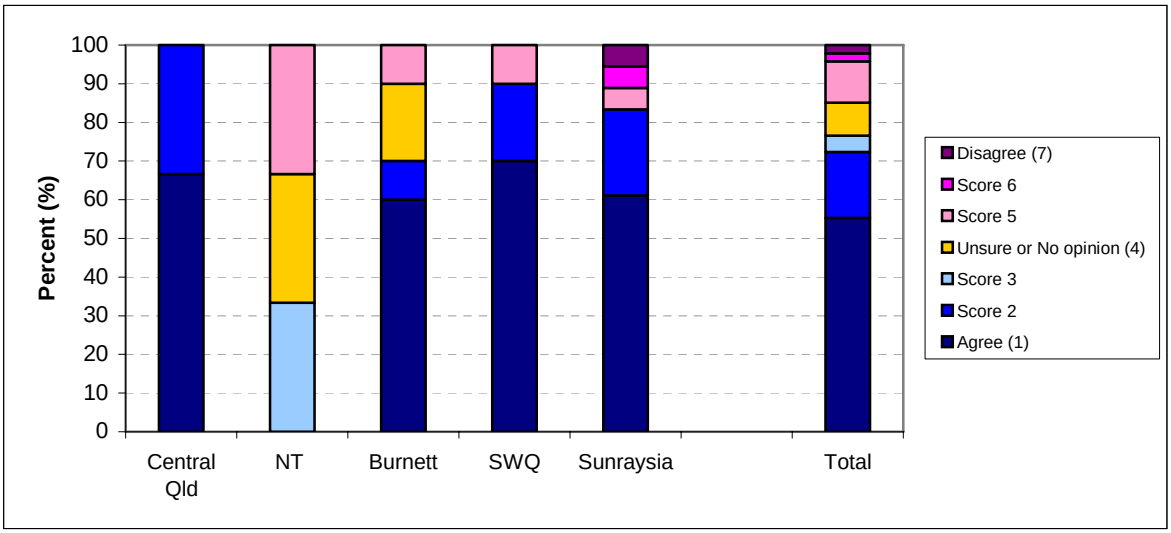


Figure 4. Percent of growers who believe "poor yield is primarily due to a lack of bunches".

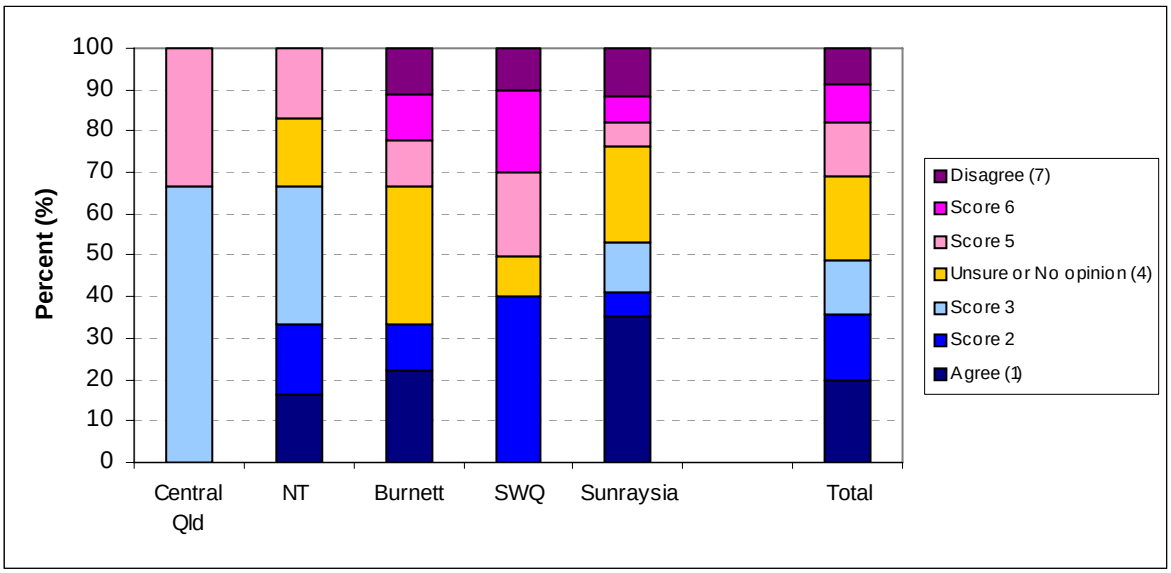


Figure 5. Percent of growers who believe "poor yield is primarily due to small inflorescence size before flowering".

A little less than half the individuals who answered Q9 (Appendix I) indicated they had noticed inflorescences (floral primordia) that failed to expand after budburst and would eventually die before flowering began (data not presented). Field observations by the project leader suggest this phenomenon is far more widespread than indicated by growers. The severity varies between seasons, and in bad seasons a significant proportion of bunches on the vine can be affected. The small size of the floral primordium makes it difficult to find amongst the foliage and most growers would not notice the condition unless shown.

The proportion of undersized inflorescences on a vine is important as it impacts upon the quantity of fruit at harvest. Grower assessment of the proportion of inflorescences on a vine that are undersized (ie lack the characteristic shape and size for Menindee Seedless) is shown in Figure 6. Clearly the proportion of undersized inflorescences can be substantial and appears to be a feature more prominent in Menindee Seedless than other varieties. It is a little difficult to ascertain if the phenomenon is more pronounced in tropical environments.

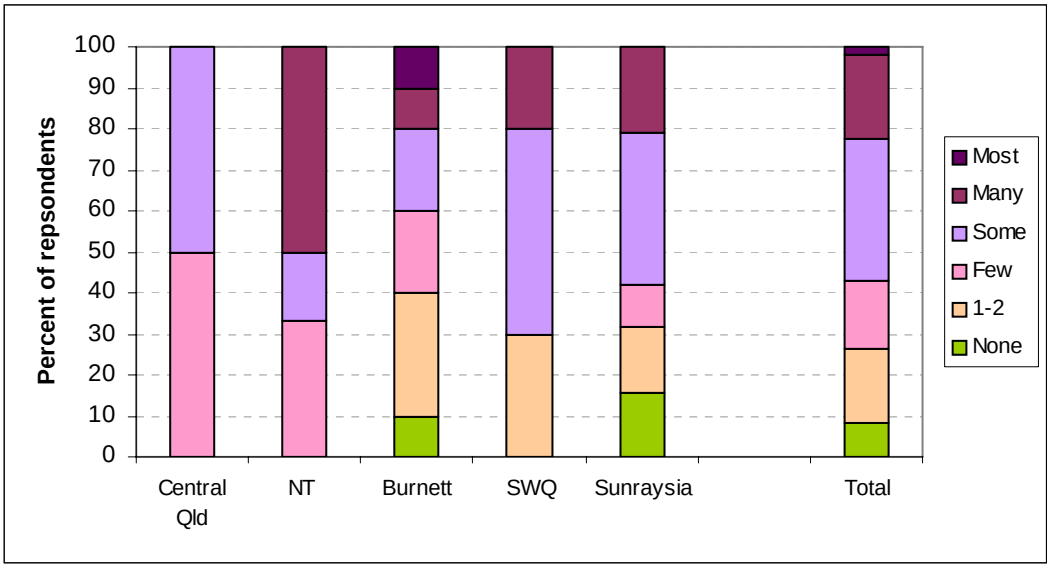


Figure 6. Undersized inflorescences as a proportion of all bunches commonly observed on Menindee Seedless vines.

Bunch thinning is not normally carried out in the subtropical production districts across northern Australia, as was reflected in answers to Q11 of the questionnaire. Presumably this is because there is less than the desired number of bunches on the vine and all bunches are retained for a economic yield. Thinning is performed only in the more temperate regions, and only by a minority of growers.

In all districts it is only a minority of growers that carry out bunch trimming, presumably because most bunches are not large and fruit set on the tail is good. The small bunch size is also supported by responses to questions 8 and 10.

The desired number of bunches per vine (Table 1) averages in the low 20's for production districts in the tropics, compared to the low 30's in temperate production districts.

Table 1. Desired average bunch number per vine of Menindee Seedless.

	Bunch Number	
Region	**Average**	**Range**
Central Qld	23	16 - 30
NT	23	10 - 30
Burnett	22	10 - 30
SWQ	32	24 - 40
Sunraysia	30	10 - 50

The incidence of several scenarios, all of which can potentially contribute to poor fruitfulness and low yield, is shown in Table 2. Growers were asked (Q13) to indicate if the particular problem or scenario had occurred in at least two seasons over a period of five seasons.

Table 2. The incidence of problems contributing to poor fruitfulness and low yield in Menindee Seedless, as a percentage of respondents.

	Uneven budburst	Bud death	Low % budburst	Low shoot nos	Apical dominance	Barren shoots	Undersized inflorescence	Floral primordium abscission	Inflorescence death	Preflowering flower shatter
Central Qld	80	60	80	60	60	40	80	100	60	0
NT	100	20	20	20	20	20	40	0	20	20
Burnett	50	25	38	13	25	75	38	13	25	50
SWQ	33	11	11	0	22	67	44	0	11	22
Sunraysia	82	55	50	18	5	32	23	9	0	23
Total	69	39	41	18	18	45	37	16	14	24

Three scenarios that commonly occur and are perceived to have the greatest impact on poor fruitfulness and low yield, are (i) low percent budburst, (ii) large number of barren shoots and (iii) high proportion of undersized inflorescences. There are a few problems that appear to have local importance. Bud death is widespread in the Sunraysia and consequently contributes to reduced fruitfulness and yield of vines. Inflorescence death is important in Carnarvon (WA) but rarely occurs in other production districts around Australia.

Comments on the problems contributing to poor fruitfulness and low yield in Menindee Seedless (Table 2) are as follows:

Uneven budburst

- high proportion of respondents in all regions
- probably due to Dormex® not used (Sunraysia) or inferior budburst management in the more tropical regions
- possibly associated with poor vine nutrient reserves and weather conditions during dormancy

Bud death

- high proportion likely to be associated with widespread use of GA in Sunraysia
- GA use in other districts less common, but increasingly being used.
- shading is a possible cause - associated with some trellis designs (eg sloping T) and shoot numbers (note few respondents indicating low shoot numbers as a problem)
- has been observed in Qld production districts by project leader; occurs after Dormex® application, particularly where Dormex® is applied early; not recognised by many growers as bud death is invariably included as low percent budburst.

Low percent budburst:

- significant issue in most districts
- associated with Dormex® use and the management of budburst in tropical regions (eg wetting agents, soil moisture, nutrient reserves, winter seasonal temperatures)
- appears to be a major contributing factor to low fruitfulness

Low shoot numbers:

- generally not considered an issue or contributing factor
- a naturally open canopy means there is no need to shoot thin and there is improved light penetration for floral initiation.

Apical dominance:

- not considered a problem by most growers
- perhaps more common in the tropical regions
- possible effect of apical dominance is competition between sinks within the plant, and elevated levels of some hormones
- apical dominance does not necessarily indicate if there is excessive vegetative growth or a shaded canopy

Barren shoots (ie lack of bunches):

- common problem in all production regions - both tropical and temperate environments
- another of the major contributing factors to low fruitfulness in vines

Small inflorescences:

- common in all regions and environments
- the impact of small inflorescences is lower fruit yield at harvest
- a major component of reduced fruitfulness and poor vine performance

Inflorescence abscission:

- the floral primordium fails to expand after budburst and eventually falls off before flowering
- low level of occurrence indicated by respondents
- high incidence in Central Queensland suggests the problem may be more common in tropical environments
- phenomenon is likely to be more common than indicated, as it is difficult to detect and easily missed
- the effect on fruitfulness and yield could well be far greater than previously anticipated.

Inflorescence death:

- partial or complete death of normally expanded inflorescence prior to flowering
- occurrence is not common
- appears to be more prevalent in tropical regions
- is perhaps a localised problem (note that Central Queensland includes Carnarvon, WA respondents)

Flower shatter:

- low to moderate occurrence
- appears more common in temperate regions
- does not occur every season
- impact can be considerable,
- the affected bunches are usually large inflorescences and often the early inflorescences on the vine
- loss of flowers is invariably near 100%
- causes are unknown and could include plant growth regulator imbalances, insect damage, nutrient flush
- has the potential to be a significant issue.

Growers were asked to indicate the relative impact of key vineyard resources (management, climate, budwood source, rootstock, soil) on vine fruitfulness (Figure 7). The majority of respondents in all districts indicated vineyard management had the greatest impact on fruitfulness. Climate and rootstock were equally the second most important resource factors for growers in all districts. In the Sunraysia, most growers were very clear about the substantial impact rootstocks have on fruitfulness. This is perhaps because of the greater number of years' experience Sunraysia growers have of using rootstocks with Menindee Seedless, and the longer lag time before the full effects of rootstocks become apparent. In all districts around Australia, soil was considered to have the least impact on fruitfulness.

Grower opinions on budwood source were mixed, and a large proportion of growers were unsure of the impact of budwood source on fruitfulness. Planting material has the potential to significantly impact on fruitfulness and vine performance, as evidenced with wine grapes and other crops. This is particularly so where virus contamination is involved. Anecdotal evidence from a few growers who have had experience with the different performance of Menindee Seedless vines from different sources, supports the view that budwood source can affect vine fruitfulness.

The 10% to 15% of growers (30% for budwood source) who were 'unsure' of the impact of each resource upon vine fruitfulness, suggests a lack of understanding of the factors governing floral initiation and inflorescence development in Menindee Seedless.

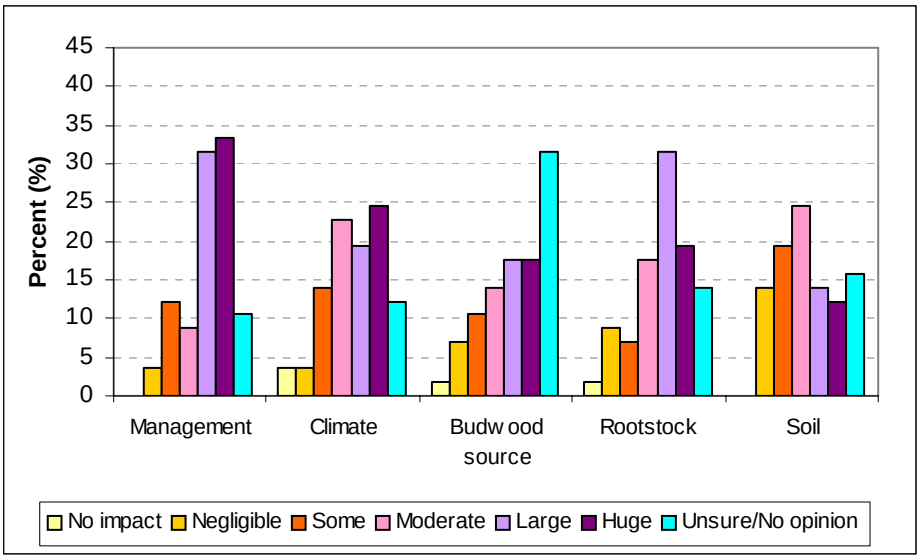


Figure 7. Grower opinion of the relative impact of vineyard resources on vine fruitfulness.

Vineyard management was divided up into individual operations/practices to specifically determine those that were considered by growers to have the greatest impact on fruitfulness (Appendix 1,Q16). Of these, growers considered vine nutrition to have the greatest impact on Menindee Seedless fruitfulness (Figure 8). Water and canopy management were equally considered to have the next greatest impact on fruitfulness (Figure 8).

Approximately 40% of growers believed trellis design had either a 'large' or a 'huge' impact on fruitfulness. A similar proportion of growers believed GA sprays significantly affect fruitfulness. The question did not ask for a directional answer, hence the 'huge' impact on fruitfulness indicated by growers could equally be positive or negative.

It is unclear if growers were referring to bud fruitfulness or in fact fruit quality (ie berry size) when responding to the question on GA sprays. The use of GA has been rare until recent years because of the possibility of disrupting floral initiation and reducing bud fruitfulness. The application of GA to increase berry size has become more common over the last two or three seasons, however, the effect on bud fruitfulness has not been documented.

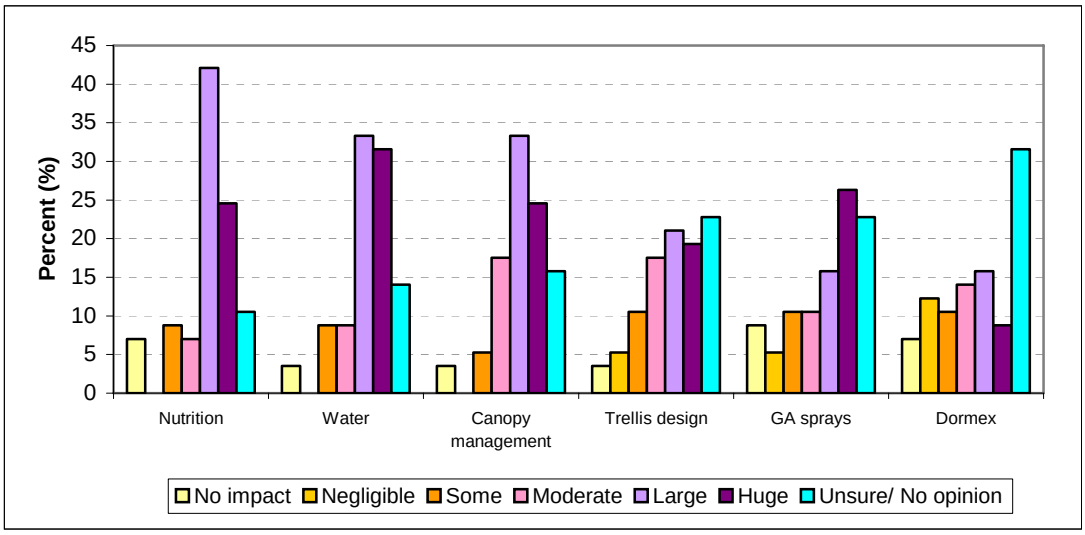


Figure 8. Grower opinion on the impact of individual vineyard practices on fruitfulness.

A relatively high proportion of growers had 'no opinion' or were 'unsure' of the likely impact of individual vineyard practices on fruitfulness. This indicates that growers are potentially making poor choices and decisions in the vineyard, leading to costly effects on productivity.

The 30% of growers who had 'no opinion' or were 'unsure' of the effect of Dormex® on fruitfulness are likely from the Sunraysia, where few growers in the Sunraysia use Dormex® on Menindee Seedless.

Sunlight was considered by growers to be the most important climatic factor influencing fruitfulness (Figure 9), with over 40% of growers rating the impact on fruitfulness as either 'large' or 'huge'.

Temperature is believed to have a substantial impact on fruitfulness. However, it is not apparent whether this is high temperature stress during floral initiation, or cool spring temperatures leading to abscission of the floral primordium and/or poor growth of the inflorescence.

Rain was not considered to be important amongst the climatic factors. It is the one climatic factor that can be simulated to some extent by irrigation management.

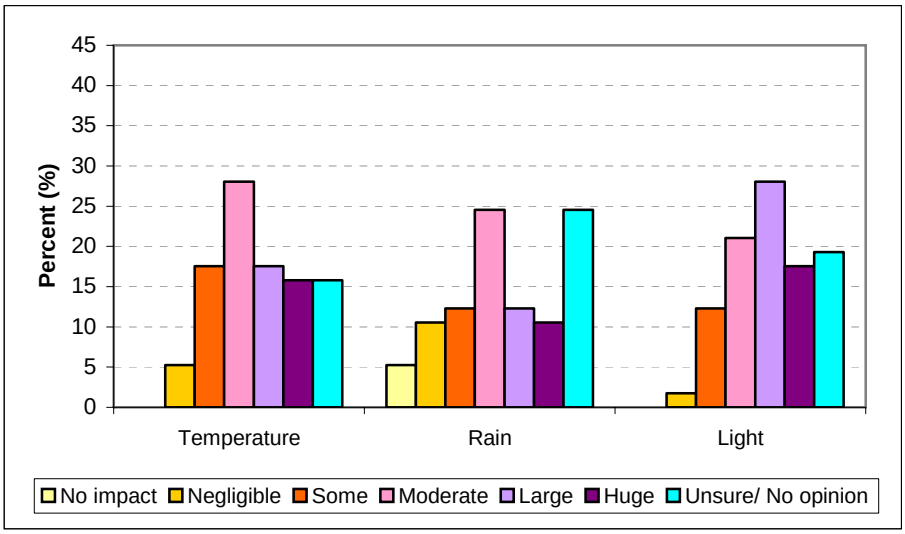


Figure 9. Grower opinion of the impact of climatic factors on fruitfulness.

(c) Regional forums.

The purpose of the regional forums was to expand on the questionnaire responses by gathering more detailed and specific information about the same factors included in the questionnaire.

Whilst there was a two-way exchange of information that presented new information to both the growers and project team, the desired level of detail and specifics sought was not achieved. This was attributed to of some growers being unwilling to disclose the information, whilst other growers simply did not have the specific information to answer the questions.

Certainly information that an individual has but their neighbour does not have can translate into a commercial advantage, although usually only for a short term. However, often such a perceived commercial advantage is of little benefit to the individual and not in the longer term interests of both the individual and the industry. For example, where the broader consumer population becomes disenchanted with the industry's product because the majority of individuals produce inferior quality to what the market expects. Such a scenario is more pronounced in a period of over-supply.

As an industry, including the service organisations assisting the tablegrape industry, we need to ask ourselves how can we obtain the desired level of detailed, accurate information in future scoping projects.

Whilst the forum activities and questions requested a directional response, the information provided was not directional and/or did not indicate the magnitude of the impact on fruitfulness. Consequently the information is a synopsis of the management practices currently used by Menindee Seedless growers across Australia.

Information obtained at the regional forums is summarised below.

Light
Growers generally are aware of the long established understanding that sunlight is an important factor for floral initiation, but are unclear how this specifically applies to

Menindee Seedless or to subtropical environments. There were examples of contradictory statements from growers about the growth stages when light was important. The importance of sunlight for floral initiation in Menindee Seedless, particularly in subtropical environments, is unknown. Specifically, the critical sunlight levels (minimum required, optimum, excessive), receptive organ(s) (bud, adjacent leaf or foliage) requiring sunlight exposure, and the critical growth stages and duration of light levels are not known for Menindee Seedless.

Trellis types
The two trellis types used by most growers in all districts are the sloping T and the Y trellis. If other trellis designs (eg diamond, link, gable) that have V shape separation of foliage are also grouped with the Y trellis, the use of these two trellis types over other trellises is even more apparent and significant.

Comments from the group at Robinvale highlighted the shading problems and poor quality of canes associated with the sloping T trellis (see Appendix 2 for details). Clearly this trellis design is not ideal for Menindee Seedless, at least in a temperate environment.

Canopy management
Feedback to the questionnaire clearly indicated that canopy management was considered by growers to have a substantial impact on fruitfulness. In the regional forums canopy management was broken down into specific practices, namely leaf removal, shoot removal, summer hedging and use of moveable foliage wires.

The practices of leaf removal, shoot removal and summer hedging were common amongst those growers of Menindee Seedless attending the forums. It could not be ascertained from grower responses whether these practices were used to improve floral initiation and fruitfulness, manage vine growth or for some other reason. The use of moveable foliage wires to separate the foliage and open the canopy was rare. Again, none of the forum participants was able to indicate the impact of each canopy management practice on fruitfulness of Menindee Seedless.

Table 3. The use of canopy management practices by forum participants.

Canopy management practice	Sunraysia (temperate)	Queensland (subtropical)
Leaf removal	8	3
Shoot removal	12	5
Summer hedging	11	3
Moveable foliage wires	3	0

Dormex®
Growers were asked in a group activity to indicate the concentration of Dormex® used, the time of application relative to natural budburst and whether there was a positive or negative effect on fruitfulness. Whilst concentration and time of application details were provided, few growers indicated the impact of Dormex® on fruitfulness and vine performance.

The outstanding features of Dormex® use by growers of Menindee Seedless were:
Sunraysia:
- most growers do not use Dormex®
- when used, Dormex® was applied at concentrations up to 3.5% for natural budburst

Queensland:

- most growers in Queensland use Dormex®
- most growers use concentrations >3.5%
- applications were timed to promote budburst 2 to 4 weeks before natural budburst
- applications to promote budburst 6 weeks before natural budburst led to lower fruitfulness

All the direct and indirect effects of Dormex® on vine fruitfulness, floral initiation and survival of floral primordia have not been determined. From discussions in the regional forums it is clear most growers do not fully understand the impact of Dormex® on vine physiology and productivity, and hence are unable to adjust their Dormex® management practices to maximise vine fruitfulness.

Temperature

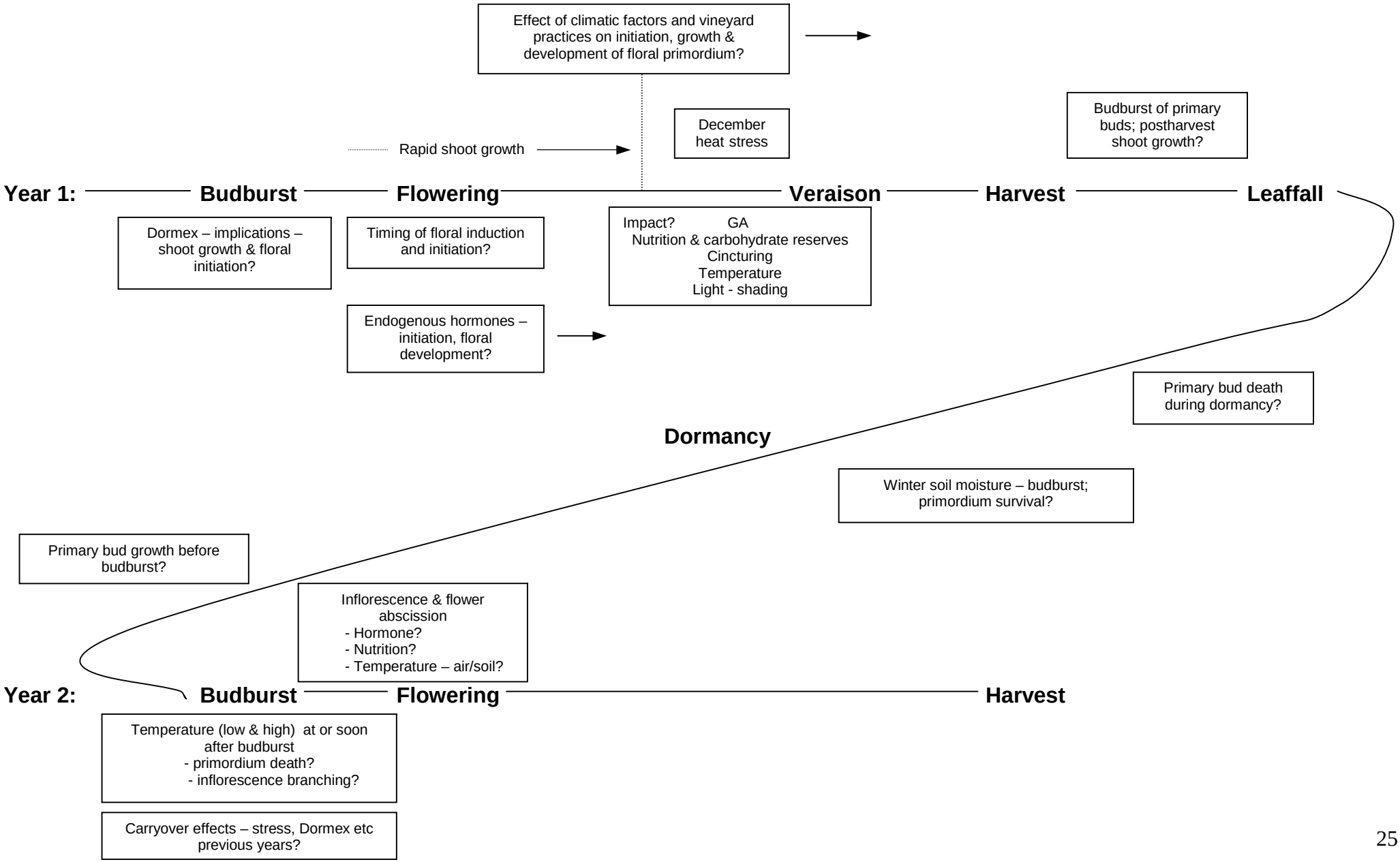
As with sunlight, there was some contradiction between forum participants on the effects of high temperature on bud fruitfulness. The difference in opinion may have been based on location, with growers in the Sunraysia indicating no adverse affects of high temperature.

The statement "42^{o}C for 2 weeks after flowering did not adversely affect bud fruitfulness" suggests that some growers currently misunderstand the available scientific knowledge and the effect of temperature on floral initiation and vine fruitfulness. Alternatively this observation may indicate that the effect of temperature on fruitfulness of Menindee Seedless is different to that in other varieties.

Following the industry consultation activities, project team members Peter Clingeleffer, Mark Kristic and David Oag conducted a review of the information obtained. Gaps in current knowledge and critical times in the annual floral cycle were identified and are represented in Figure 10. This became the basis for developing a proposed RD&E strategy (Table 4).

Figure 10. Annual Cycle of Floral Development in Grape Vines

Possible points of disruption in floral initiation and development in Menindee Seedless



DISCUSSION

The following discussion of the problem of poor fruitfulness within the Australian tablegrape industry relates to the variety Menindee Seedless. The suggested RD&E Strategies and Investment Plan (Table 4) has been designed specifically for Menindee Seedless, however the strategies would be equally applicable to the mild fruitfulness problem that occurs in Crimson Seedless.

The fruitfulness problem
The definition of fruitfulness as the number of inflorescences on the vine before flowering and before crop load adjustment, has been used in this scoping study. An inflorescence is any structure with a minimum number of flowers, and hence includes undersized inflorescences and fruitful tendrils. Thus fruitfulness is a combination of bunch number and inflorescence size.

Poor fruitfulness in Menindee Seedless is more than just a low number of bunches resulting from inadequate floral initiation. It also includes the survival of the floral primordium within the bud through to budburst the following season, as well as the survival and continued growth of the inflorescence from budburst to flowering. Further, bud death and percentage budburst both have an indirect effect on the number of inflorescences on the vine at flowering. Factors contributing to low bunch number include poor floral initiation, bud death, poor budburst and death of the floral primordium after budburst.

Small inflorescences and partially developed floral structures are another component of poor fruitfulness and low yield potential. These types of floral structures appear to be associated with either insufficient time in the previous season to complete floral development, or indicate a disruption to the floral development process. Factors contributing to inadequate inflorescence size include low flower numbers, failure of rachis to elongate and branch, abscission of branches on the inflorescence and preflowering flower shatter.

Vine fruitfulness is also reduced by bud death. Early applications of Dormex® to vines of Perlette grown in the Coachella Valley led to bud death and lower vine fruitfulness (Dokoozlian, pers. comm.). Bud death occurred after Dormex® application and the external appearance of the bud remained normal until well after budburst. It is unknown if Menindee Seedless responds in the same way when grown in the subtropical production districts across northern Australia.

Growers in the Mundubbera and St George GoGrape groups have for some years conducted dormant bud inspections to determine the level of fruitfulness. Each year bud mite can be found to some extent inside a number of buds. Invariably several of the buds with bud mite will be dead, however a causal relationship has not been established.

Dead buds with no bud mite have also been detected in the dormant bud inspections. Exactly when these buds died (pre or post leaffall) is unclear. These buds appear normal during winter and are difficult to differentiate from healthy buds at pruning. Possible causes of bud death include shading or GA applied in the previous season, and low soil moisture during the winter.

Reports from several growers provide strong evidence of differences in vine fruitfulness between vines sourced from different supplies. This raises questions as to what is the potential fruitfulness of existing Menindee Seedless vines, and whether

the potential fruitfulness is the same for all vines or differs between sources of planting material.

Substantiating any differences in vine performance associated with the source of planting material would be useful in (i) deciding whether or not to persist with existing vines, and (ii) determining the scope to improve the fruitfulness of Menindee Seedless vines. In addition, material of the variety Sugraone is now available in Australia, although access is restricted to growers licensed by Sun World.

Develop effective management practices
To develop successful management practices for improving the fruitfulness of Menindee Seedless, it is first necessary to establish the timing of floral initiation and the key critical periods in the floral cycle. The second step is to establish the major causal factors that govern initiation, inflorescence development and survival. From this it will become apparent which steps in the floral cycle can be manipulated through vine management, and when to apply these management practices.

The first two steps require scientific research. The final step to develop effective management practices can be largely and cost effectively addressed through grower industry groups such as GoGrape and Grape Cheque.

Many growers try different vineyard practices to solve the fruitfulness problem, but fail to get a clear answer because the observations and recordings of vine performance are insufficient or too broad. In addition, these trials may be inappropriately designed to meet the desired objective, lack the rigour necessary to achieve reliable and repeatable answers, or observations may be *ad hoc.* Growers often lack the training to appropriately interpret any results obtained or fully understand their implications. Scientific input and direction from a viticulturist would capitalise on the effort individual growers are currently spending on trying to resolve the fruitfulness problem in Menindee Seedless.

Light, temperature, nutrition, water stress and daylength are all factors that affect the formation of the inflorescence primordium. The impact of each of these inputs the on fruitfulness is not necessarily the same for all tablegrape varieties. Similarly, the effect of each on the fruitfulness of Menindee Seedless is not known. This understanding is necessary to identify which are the most important factors driving floral initiation and development of the floral primordium, and hence should be manipulated through vineyard management practices.

The management practices that, from grower feedback and limited fieldwork, appear to have substantial impacts upon vine fruitfulness are:

Dormex®
- essential for tablegrape production in regions with warm winters
- directly affects budburst and bud death
- indirectly affects floral initiation and survival of floral primordium after budburst

Nutrition
- fertiliser rates have generally been decreasing over the last ten years
- growers have now started to reverse this approach, and use higher rates of fertiliser. Early signs are suggesting higher fruitfulness.
- Sun World licensed growers in Australia have recently been advised to use very high nutrient rates, particularly nitrogen

Water

- work within the GoGrape groups indicates maintaining soil moisture during the postharvest and winter periods increases vine fruitfulness

Cincturing

- recent work within the GoGrape groups indicates cincturing increases bud fruitfulness

Gibberellic acid sprays (GA)

- increasingly being used but there is no quantified information regarding effects on bud fruitfulness in the following season
- becoming a commercial imperative for acceptable fruit quality in the market (larger berry size)
- potential risks associated with use, as Menindee Seedless appears to be a variety sensitive to GA

Future work in developing effective management practices to maximise vine fruitfulness should primarily concentrate on these practices.

Dormex® may have an impact upon floral initiation. Early application of Dormex® advances the time of budburst. The newly developing buds on the current season shoots then go through floral initiation at an earlier calendar date than would occur following natural budbreak. Low temperatures at this time would likely have an adverse effect on floral initiation. Dormex® use could also affect survival of the floral primordium when early budbreak leads to early season shoot growth that coincides with relatively cold temperatures.

There is very little definitive, scientifically based information available on growing Menindee Seedless and managing fruitfulness, floral initiation and floral development. Several small projects have generated some interesting information on the floral cycle of Menindee Seedless, and have considered key potential critical times (FR01002), and management practices for improving fruitfulness (FR01019 - GoGrape). Both projects have indicated where to concentrate future R&D effort, more so than provide detailed answers on how to manage the poor fruitfulness problem.

Sun World is providing information and advice on how to grow Menindee Seedless, and appears committed to continuing this service. In the last 12 months Sun World has substantially increased the number of growers signed up to its group. This is a closed group with the information not available to individuals outside the group. Of significance, the information provided is from experience gained from other countries and growing environments, and is not directly applicable to conditions in Australia. The Sun World representative in Australia recently acknowledged they do not have all the answers on how to manage Menindee Seedless successfully under Australian growing conditions.

The segregation of Menindee Seedless growers into separate groups creates the possibility that some sections of the industry will take on improved technology and progress faster than others. Individual business competitiveness is part of a free market economy, but needs to be balanced against the potential ramifications for the industry and hence all growers. Where non-uniform advances in fruit quality occur between grower groups and the disparity leads to customer dissatisfaction with the inconsistency of the product, it is likely to be to the detriment of all growers of

Menindee Seedless. Examples of this scenario have been occurred as recently as the 2004/05 season.

Grower knowledge and information transfer
There is a need to improve growers' understanding of the cycle of floral initiation and development, along with the factors known to influence fruitfulness both positively and negatively. The effective manipulation of fruitfulness through the targeted application of vineyard management practices can only be achieved with such knowledge. Significant gaps and weaknesses in the current knowledge base of tablegrape growers became evident during this study.

There will also be a need in future for a single coordinated effort to collate, interpret and disseminate to Australian growers all the information available on managing the fruitfulness of Menindee Seedless. This will include finding and accessing information available from overseas. Such an activity will require a small budget and could be an adjunct to one of the larger RD&E projects within strategies 1 or 2 (Table 4).

Alternative varieties
A new early maturing white seedless variety that is fruitful in subtropical environments must be a high priority within the national tablegrape breeding project (TG03008). However, breeding is a long term strategy and a suitable alternative to Menindee Seedless may take years to develop and make available to industry.

Therefore, the concurrent evaluation and development of new varieties recently available in Australia is an equally important imperative. New varieties from other breeding programmes offer the possibility of finding a suitable alternative in the more immediate future, as they only require testing for suitability to local growing conditions. This effort should not be confined simply to early white seedless varieties, but include all grape types that have some market appeal. The new varieties recently available in Australia include several that are public domain.

A cost effective way for evaluating new varieties is to use grower groups with support from researchers (eg GoGrape, Grape Cheque). Such an approach has been particularly successful in Western Australia in the development and rapid industry adoption of a new variety.

Financial information
Provision of realistic financial information would greatly assist and enable many growers to make an informed choice on whether or not to continue growing Menindee Seedless. Approximately 40% of growers who completed the questionnaire indicated an intention to remove at least some of their Menindee Seedless vines if the fruitfulness problem could not be "solved".

Many growers have been distracted by the relatively high price per carton historically paid for Menindee Seedless, and therefore not focused on the gross income, cost of production and profit per hectare. Financial analysis of existing and alternative price and cost of production scenarios would be beneficial to determine the economic viability of individual growers and the industry as a whole.

Information on the rate of return on investment for growing Menindee Seedless and how this would change with changes in fruitfulness, yield or price is the type of information beyond the capabilities of many growers. The threshold level of fruitfulness required for a return to a reasonable profit level is important baseline information for individual growers to plan their business, and for the industry to plan it's level of commitment to resolving the Menindee Seedless fruitfulness problem. A

cost-benefit analyses of real situations would be most useful in assisting individual growers in deciding whether to continue growing Menindee Seedless or switch to another variety.

Conclusion
Menindee Seedless is an important variety in the early maturing production districts across subtropical northern Australia. The variety is grown in almost every country that has an early ripening, subtropical tablegrape industry. In every instance, poor fruitfulness is the major problem with the variety Menindee Seedless. Despite this, the only country that has a significant research effort on fruitfulness is Brazil. Growers in every other country are left to struggle and manage the problem as best they can. Consequently, Australian tablegrape growers will not be able to rely on another country to undertake the necessary research to develop a solution to the fruitfulness problem, nor subsequently make that information available to us.

RECOMMENDATIONS

The Australian Table Grape Association (ATGA) and Table Grape Industry Advisory Committee (IAC) within Horticulture Australia Ltd. accept the RD&E Strategies and Investment Plan.

Table 4. RD&E STRATEGIES and INVESTMENT PLAN

	Strategy	Actions	Timeframe	Budget[1] ($/yr)
1	Establish the timing of floral initiation and the key times in the floral cycle of Menindee Seedless, particularly in subtropical environments.	• Quantify the period of floral initiation. • Determine times when fruit bud development is disrupted. • Determine causal factors of disruption of floral development, and threshold levels eg. temperature, nutrient reserves, endogenous plant hormones, light.	2005 - 2008	$50,000
2	Establish effective management practices to maximise fruitfulness of Menindee Seedless.	• Dormex® • Nutrient and carbohydrate levels. • Cincturing. • Soil moisture. • GA and other growth regulators. • Canopy management. • Utilise regional grower development groups.	2006 - ongoing	$30,000 $20,000
3	Information transfer	• Review and collate advances in knowledge (particularly in subtropical environments, including overseas). • Provide information and training to growers. • Utilise regional grower development groups	2005 - 2009	$5000
4	Cost benefit analysis of options available to growers of Menindee Seedless.	• Calculate the costs and returns for common scenarios within the industry. • Provide financial information on options available. • Establish relative genetic potential of Menindee Seedless.	2007 - 2008	$25,000
5	Alternative varieties	• Breed superior varieties to replace Menindee Seedless. • Evaluate and develop early, white seedless varieties from overseas.	2005 - ongoing	Breeding - see national breeding project. $15,000

1. Budget is indicative only.

APPENDIX 1.

Fruitfulness Questionnaire

Name:
Address:

Town: **Postcode:**
Tel.:
Fax.:
Email:
State:
Total area of vines:
Varieties grown: *(Please tick the varieties you grow and insert the variety name of other varieties grown but not listed)*

Calmeria		Muscat Hamburg		Superior Seedless	
Cardinal		Purple Cornichon			
Crimson Seedless		Ralli Seedless			
Dawn Seedless		Red Globe			
Flame Seedless		Ribier			
Menindee Seedless		Thompson Seedless			

Horticulture Australia Ltd in conjunction with the Australian Table Grape Association has commissioned a scoping project on fruitfulness in tablegrapes. The primary purpose of the project is to ascertain how severe is the problem of low fruitfulness, what varieties are affected and in which regions the problem occurs. The information obtained from growers across Australia, through this questionnaire and a series of regional forums, will be used to develop an R&D programme of projects for future research. This will assist industry in allocating funding to projects designed to resolve the problem of low fruitfulness.

The information you provide will remain **confidential**. Only pooled information will be published.

Meaning of fruitfulness.

Fruitfulness refers to the size of inflorescences and number of inflorescences on a vine.

An inflorescence is any structure with a number of flowers or florets (unopened flowers). This becomes a bunch with berries after flowering.

Fruitfulness is the number and size of inflorescences after budburst. Yield is the number of bunches harvested.

Please confine your answers to the performance of mature cropping vines only. Do not include information for young vines that have not yet reached mature crop loads.

Information on vine fruitfulness is sought for the last 5 seasons - (1998/99 to 2002/03 seasons).

Section A. Extent of Problem.

Q1. Have you been happy with the **level** of fruitfulness of your vines over the last 5 seasons? *(Please circle number)*

	Unhappy			Neutral			Happy
Crimson Seedless	1	2	3	4	5	6	7
Flame Seedless	1	2	3	4	5	6	7
Menindee Seedless	1	2	3	4	5	6	7
Superior Seedless	1	2	3	4	5	6	7
Thompson Seedless	1	2	3	4	5	6	7
Other varieties……..	1	2	3	4	5	6	7
……..	1	2	3	4	5	6	7

Q2. Have you been happy with the **consistency** of fruitfulness over the last 5 seasons? *(Please circle number)*

	Unhappy			Neutral			Happy
Crimson Seedless	1	2	3	4	5	6	7
Flame Seedless	1	2	3	4	5	6	7
Menindee Seedless	1	2	3	4	5	6	7
Superior Seedless	1	2	3	4	5	6	7
Thompson Seedless	1	2	3	4	5	6	7
Other varieties……..	1	2	3	4	5	6	7
……..	1	2	3	4	5	6	7

Q3. Over the last 5 seasons (1998/99 to 2002/03) how many seasons has the harvested yield been below the desired yield? *(Please circle number)*

	Number of seasons					
Crimson Seedless	0	1	2	3	4	5
Flame Seedless	0	1	2	3	4	5
Menindee Seedless	0	1	2	3	4	5
Superior Seedless	0	1	2	3	4	5
Thompson Seedless	0	1	2	3	4	5
Other varieties……..	0	1	2	3	4	5
……..	0	1	2	3	4	5

For Questions 4 & 5, please provide details for the varieties listed plus any other varieties you grow that have a low fruitfulness problem. Insert harvested fruit yield as ***either*** *kg/vine* ***or*** *boxes (10kg)/ha*

Q4. What was the **worst** year for fruitfulness in the last 5 seasons? Please provide preflowering bunch counts and/or the fruit yield harvested. *(Do not include low yields that were due to other factors eg. rain)*

Variety	Season	Preflowering bunch numbers (bunches/vine)	Yield	
			kg/vine	10kg boxes/ha
Example variety	*2001/02*			*2800*
Crimson Seedless				
Flame Seedless				
Menindee Seedless				
Superior Seedless				
Thompson Seedless				
Other ……				
Other ……				

Q5. What was the **most** fruitful year in the last 5 seasons? Please provide preflowering bunch counts and/or the fruit yield harvested.

Variety	Season	Preflowering bunch numbers (bunches/vine)	Yield	
			kg/vine	10kg boxes/ha
Example variety	*2001/02*			*2800*
Crimson Seedless				
Flame Seedless				
Menindee Seedless				
Superior Seedless				
Thompson Seedless				
Other ……				
Other ……				

Q6. Do you consider low fruitfulness to be an issue in any of the varieties you grow?

Yes ☐ No ☐ If No, go to Q19

Section B. Key components of fruitfulness.

Please indicate your level of agreement to the statements in Q7 & Q8, for each of the varieties you grow. (Please circle)

Q7. "Poor yield is primarily due to a lack of bunches"

	Strongly agree			Unsure or No opinion			Strongly disagree
Crimson Seedless	1	2	3	4	5	6	7
Flame Seedless	1	2	3	4	5	6	7
Menindee Seedless	1	2	3	4	5	6	7
Superior Seedless	1	2	3	4	5	6	7
Thompson Seedless	1	2	3	4	5	6	7
Other varieties *(Please specify)*							
…….	1	2	3	4	5	6	7
…….	1	2	3	4	5	6	7

Q8. "Poor yield is primarily due to small inflorescence size (before flowering)"

	Strongly agree			Unsure or No opinion			Strongly disagree
Crimson Seedless	1	2	3	4	5	6	7
Flame Seedless	1	2	3	4	5	6	7
Menindee Seedless	1	2	3	4	5	6	7
Superior Seedless	1	2	3	4	5	6	7
Thompson Seedless	1	2	3	4	5	6	7
Other varieties *(Please specify)*							
…….	1	2	3	4	5	6	7
…….	1	2	3	4	5	6	7

Q9. Have you ever noticed inflorescences that fail to grow after budburst, then die and drop off before flowering? If yes, please tick to indicate those varieties affected.

Yes ☐ No ☐

Crimson Seedless	☐
Flame Seedless	☐
Menindee Seedless	☐
Superior Seedless	☐
Thompson Seedless	☐
Other varieties	
…….	☐
…….	☐

Q10. On average, what proportion of all inflorescences on a vine would be undersized (ie lack the characteristic shape and size for the variety). This includes fruitful tendrils with berries. *(Please tick)*

	None	Odd 1 or 2	Few	Some	Many	Most of them
Crimson Seedless	☐	☐	☐	☐	☐	☐
Flame Seedless	☐	☐	☐	☐	☐	☐
Menindee Seedless	☐	☐	☐	☐	☐	☐
Superior Seedless	☐	☐	☐	☐	☐	☐
Thompson Seedless	☐	☐	☐	☐	☐	☐
Other varieties *(Please specify)*						
…….	☐	☐	☐	☐	☐	☐
…….	☐	☐	☐	☐	☐	☐

Q11. In most years do you have to bunch thin or bunch trim? *Please indicate for the varieties listed and any other varieties you grow that have poor fruitfulness.*

	Bunch Thin		Bunch Trim	
	Yes	No	Yes	No
Crimson Seedless	☐	☐	☐	☐
Flame Seedless	☐	☐	☐	☐
Menindee Seedless	☐	☐	☐	☐
Superior Seedless	☐	☐	☐	☐
Thompson Seedless	☐	☐	☐	☐
Other varieties				
…….	☐	☐	☐	☐
…….	☐	☐	☐	☐

Q12. What is your desired bunch number per vine? *Please indicate for the varieties listed and any other varieties you grow that have poor fruitfulness.*

	Desired number of bunches per vine
Crimson Seedless	
Flame Seedless	
Menindee Seedless	
Superior Seedless	
Thompson Seedless	
Other varieties:	

Q13. In the last 5 seasons (1998/99 to 2002/03) have any of the following problems occurred in more than one year in your vineyard? *(Please tick)*

- ☐ Bud death
- ☐ Low percent budburst
- ☐ Uneven budburst
- ☐ Low shoot numbers per vine
- ☐ Dominance of apical shoots
- ☐ Excessive number of barren shoots
- ☐ Excessive number of undersized inflorescences
- ☐ Inflorescence abscission (inflorescence fails to grow, then drops off)
- ☐ Inflorescence death (partial or complete death of a normally developing inflorescence, prior to flowering)
- ☐ Flower shatter prior to flowering (individual flowers fall off before opening leaving an almost bare bunch stalk)

Section C. Factors contributing to fruitfulness and management strategies.

Q14. In your experience, what impact does each of the following have in determining the fruitfulness of your vines? *(Please tick)*

	No Impact	Negligible	Some	Moderate	Large	Huge	Unsure or No opinion
Your management practices	☐	☐	☐	☐	☐	☐	☐
Climate	☐	☐	☐	☐	☐	☐	☐
Source of budwood	☐	☐	☐	☐	☐	☐	☐
Rootstock	☐	☐	☐	☐	☐	☐	☐
Soil	☐	☐	☐	☐	☐	☐	☐

Q15. To what extent does each of the following aspects of **climate** affect the fruitfulness of your vines? *(Please tick)*

	No Impact	Negligible	Some	Moderate	Large	Huge	Unsure or No opinion
Temperature	☐	☐	☐	☐	☐	☐	☐
Rain	☐	☐	☐	☐	☐	☐	☐
Light	☐	☐	☐	☐	☐	☐	☐

Q16. In your experience to what extent does each of the following aspects of **vineyard management** affect the fruitfulness of your vines? *(Please tick)*

	No Impact	Negligible	Some	Moderate	Large	Huge	Unsure or No opinion
Nutrition	☐	☐	☐	☐	☐	☐	☐
Water	☐	☐	☐	☐	☐	☐	☐
Canopy management	☐	☐	☐	☐	☐	☐	☐
Trellis design	☐	☐	☐	☐	☐	☐	☐
GA	☐	☐	☐	☐	☐	☐	☐
Dormex	☐	☐	☐	☐	☐	☐	☐

Q17. Have you evaluated any vineyard management practices to improve fruitfulness of problem varieties?

Yes ☐ No ☐

Please briefly describe the management practices evaluated and indicate if each was effective or ineffective. *If additional space is required, please attach a separate sheet.*

Vineyard management practice evaluated	Effective	Ineffective

Q18. Will you remove vines if the problem of low fruitfulness is not solved?

Yes ☐ No ☐

If yes, please list the varieties likely to be removed.

Variety	Rootstock(s) *(optional)*

Q19. Additional Comments.

(Please add any comments, thoughts or information on the problem of low fruitfulness in tablegrape vines, as well as solutions for overcoming the problem.)

THANK YOU

APPENDIX 2.

Grower Comments and Questions from Regional Forums

LIGHT (ENTERING CANOPY):

Mildura.
Budburst to flowering

- Shoot thinning to increase light entering canopy to
  ⇒ Improve quality current season bunches
  ⇒ Better bud fruitfulness (BF) next year

- Shoot thinning can also have negative impact on BF, space created in canopy encourages new growth (lateral shoots?) → closes canopy and no increase in BF.

General

- Light required from just after budburst to after harvest.
- Too much light immediately after flowering can damage canes for following year.
- Less light required veraison to harvest.
- Light from after budburst to prior veraison important for good BF in following year; optimum filtered or dappled light.

Related factors

Soil type, trellis design, row orientation all contribute to amount of light entering canopy. Also irrigation, N nutrition, rootstock (perhaps).

Light affects fruit bud formations at 3 times:

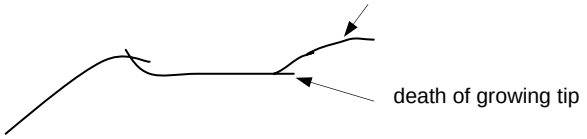
1. before veraison, ie. during December – small impact.
2. veraison – moderate impact on BF.
3. harvest to leaf-fall – aids maturity of canes; light important during this period; period when light has biggest impact on BF.

Robinvale

Light interception during November and December (ie flowering to pre-veraison).

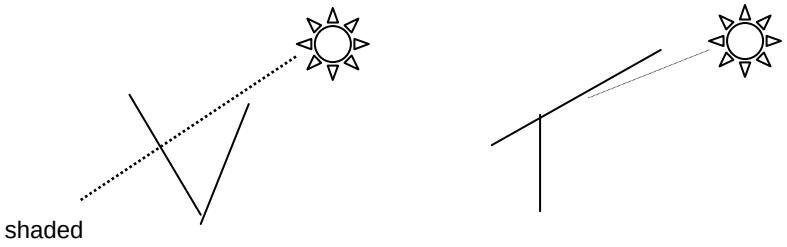
Sloping T

- Foliage lines in mat; particularly bad/dense on low side
- Canes are poor quality
- Long internodes
- Canes dieback from tip
- Weaker
- Shorter
- Also can see more lateral extensions from shoot tip (growing tip death)



Trellis design and shading

- exposed side best canes; 60-70% difference E>W.
- west side = least light → lower BN and poorer FQ.



Queensland

Remove lateral shoots → increased BF following year (but tried only one year).

TEMPERATURE

Robinvale

- High temperatures (35^{o}C) for 3 weeks after flowering increases BF following year.
- Cold and wet conditions at budburst → uneven budburst (bb)
  → ↓ budburst
- Cool spring decreases bb in following season

Mildura

High temperatures (42^{o}C) during 2 week period after flowering did not adversely affect BF following year.

- Low temperature at budburst decreases budburst (%) and bunches. Dormex helps.
- High temperature (not specified) from just before flowering to just after veraison increases BF (positive affect).

Queensland

- Cool spring slows shoot growth and low BF next season.
- Cool conditions after budburst can continue through to flowering.
- Hot conditions through entire season (2002) – low crop following year (2003).
- Cold temperatures after Dormex applied → poor budburst.

Questions – information not known

1. Covers: effects on (1) temperature and (2) light when applied veraison to harvest.
   causes cane death?
2. Cincturing – effectiveness
3. Vine vigour – impact on BF, competition with floral initiation/developing primordium.
4. Sultana – information required – effectiveness of TS (as rootstock) on BF.
5. Bud count – impact, appropriate level.

WINTER CONDITIONS

Sunraysia:

- wet winter → highly fruitful vines
- dry winter (also means more frosts)/low rainfall → slow and weak shoot growth after budburst
- mild winters → sporadic uneven bb

Queensland:

- cold winter → larger bunches and more bunches (probably due to increased % budburst).
- cold (temperature not specified) after Dormex application → sporadic budburst.
- 15^{o}C at Dormex application → even budburst.

RAIN

Robinvale:

Leaf-fall to budburst:
good rain → better performance following season;
u/vine sprinklers to emulate rain (winter).

Queensland:
rain – nil affect on fruitfulness;
good rain November (pre veraison to pre harvest) → better fruitfulness following year.

DORMEX

- essential to increase BF in current year, ie – maximises budburst, number of shoots and hence bunches.
- positive influence on following year – spray crown promotes better renewal cane growth.