Comparative analysis of four early white, seedless table grape cultivars in the Orange River area

by

Henning Burger

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Supervisor:
Dr MA Vivier

Co-Supervisor:
Dr C Orth
Ms A Sadie

DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

Henning J. Bürger

SUMMARY

The table grape industry is a major contributor to the South African economy, directly through foreign earnings from this predominantly export-based industry, as well as indirectly through the employment of thousands of people. It is a growing industry and consists of several production areas. The fastest growing table grape production area in South Africa is the Lower Orange River area, which produces some of the earliest grapes in the Southern Hemisphere. The biggest river in South Africa irrigates this area and it has an extreme climate characteristic of semi-desert areas. This area is considered to be optimal for the production of high quality, early, white seedless grapes. Previously, this area was predominantly planted to Sultanina vines for the purpose of raisin production. When seedless table grapes became a consumer preference, the producers very successfully converted their production practices to yield export quality seedless grapes from the established Sultanina vineyards. Extensive new plantings as well as re-plantings occurred in this area, also including newer cultivars from local and overseas breeding programmes. Being a viticultural and economical hot-spot, the Lower Orange River area is attracting much attention as a table grape production area and it also formed the backdrop to this study.

The cultivar profile is changing in the area and it is projected that Sultana-, Regal-, Prime Seedless and Sugraone will be the four major early, white seedless cultivars in 2005. Based on this knowledge and prompted by a lack of information regarding production costs and general profitability of the new cultivars, this study was initiated in the form of a comparative analysis between the four mentioned cultivars spanning the early, middle and late regions of the Lower Orange River area. The approach used extracted information regarding cultural input costs (specifically labour as man-hours and the consequent costs) per manipulation performed in the vineyards. This approach is different from the more general method of obtaining input costs for a specific area based on combined mean values, often not distinguishing between cultivars. The specific aims of the study included a comparative analysis of input costs for production cultural practices per main manipulation action, as well as a comparative analysis taking into account productivity, value and extraordinary costs related to each of the four cultivars. To this end, 22 experimental plots were identified for use in the study. Collaboration of the production managers of each of the experimental plots were procured and information regarding production costs per manipulation and productivity of each cultivar and experimental plot were extracted from their own record keeping systems or from documents provided to the production managers. The value (price achieved) of the various cultivars for the 2001/2002 table grape season were put into perspective by using data from a survey which included information regarding payments for the various cultivars during the season in the Lower Orange River area. Information regarding fruit and vine royalties was obtained from the various plant breeders' rights holders of the various

cultivars, where applicable. Primary descriptions of each experimental plot concerning general cultivation practices and information regarding the specific season were used to qualify results obtained from the various blocks.

Several complicating factors impacted on the study and specifically the subsequent analyses of the results. Some of the factors were already identified as complicating factors in the planning stage of the study and were mostly linked to the recent introduction of two of the cultivars to the Orange River area. From the data gathered and the analyses performed it became clear that it would be difficult to discern significant differences (where significant is defined as $P \leq 0.10$), but clear trends were observed and indications obtained. Based on the input cost analyses of this study it is proposed that mature Prime Seedless will have the highest labour input and cultural production cost of the four cultivars, followed by Sugraone. The labour input and the cost for the production cultural practices studied for young Prime Seedless vines were very high in comparison to the mature Sultana Seedless and Sugraone vines, especially for the canopy management and bunch manipulation actions. Prime Seedless was especially prone to the set of small and uneven berries, which lead to very high labour input requirements and subsequent cost for bunch manipulations. Sugraone is also known for the set of small and uneven berries in the Lower Orange River area, especially in difficult climatic seasons, also requiring high labour input for bunch manipulations.

The initial indication is that mature Sultana- and Regal Seedless will require similar labour inputs for cultural production practices. The fact that Regal Seedless does not require expensive gibberellic acid (GA) applications, or girdling for thinning and berry enlargement purposes, is a tremendous advantage from a production cost point of view. Accordingly, initial indications are that Regal Seedless will have the lowest cultural production cost of the four cultivars. Regal Seedless was prone to the set of uneven berries during the year of study and accordingly it is suspected that this factor will ultimately determine the labour requirements and cultural production input cost, especially in difficult climatic seasons. The labour input and ultimately the cultural production cost for Sultana Seedless will be determined by the correct timing and concentration of the GA applications for thinning and berry sizing.

Sultana Seedless and Sugraone produced high yields during the 2001/2002 table grape season in the Lower Orange River area. Yield information from the various experimental plots confirmed that there is little to choose between the two cultivars in terms of yield when cultivation conditions and practices are optimal. Large variation was observed in the yield results from the Regal- and Prime Seedless experimental plots. This is largely due to the recent introduction of the cultivars to the area and the consequent scarcity of blocks of these cultivars that are in full production. It was impossible to identify clear trends in terms of the future productivity of mature Regal- and Prime Seedless, but some indications of labour inputs could be extracted and qualified.

Early maturing Prime Seedless and Sugraone performed very well in terms of price, especially in the harvest period prior to week 50. This advantage of high prices early in the season is, however, not always applicable to early cultivars in the later maturing regions of the Lower Orange River area. Later during the season, after week 50, when the supply of table grapes to the overseas markets has increased sharply, Sultana Seedless is usually the best performer in terms of price of the four cultivars. The ultimate price obtained by a cultivar is to a large extent determined by supply and demand, quality and acceptance of the specific cultivar.

This study and its outcomes have a strong regional (Lower Orange River) and local (South Africa) impact and the specific results will undoubtedly be valuable to the producers, exporters and other role-players with vested interest in the cultivars studied or in table grape production *per se*. The methodology adopted in this study, however, is of broader interest and clearly shows the advantage of having detailed and qualified information regarding cultivation practices and bringing it in relation to the labour and consequent costs required per action. This should lead to more business intelligence and realistic planning on the producer side when decisions regarding the choice of a cultivar for a specific production area with a particular marketing scope have to be made. This study has also paved the way for similar studies, specifically with regard to the detailed description of the methodology that was established. Knowledge of the problems experienced in this study provides a useful reference for the planning and execution of similar studies.

OPSOMMING

Die tafeldruifindustrie dra grootskaals by tot die Suid- Afrikaanse ekonomie: regstreeks deur middel van buitelandse valuta vanaf hierdie hoofsaaklik uitvoer-gebaseerde industrie, asook indirek deur werkverskaffing aan duisende mense. Dit is 'n vinnig groeiende industrie en bestaan uit verskeie produksie-areas waarvan die Benede-Oranjerivierarea, waar van die vroegste druiwe in die suidelike halfrond geproduseer word, tans die meeste groei toon. Die grootste rivier in Suid-Afrika vloei deur hierdie gebied wat deur uiterste klimaatstoestande, soortgelyk aan die van semi-woestyngebiede, gekenmerk word. Hierdie gebied is baie gunstig vir die produksie van hoë-gehalte, vroeë, wit pitlose druiwe. In die verlede is hoofsaaklik Sultanina vir die produksie van rosyne in hierdie gebied verbou. Namate pitlose tafeldruiwe voorkeur begin geniet het onder verbruikers wêreldwyd, het produseerders in die area hul verbouingspraktyke suksesvol aangepas vir die produksie van uitvoergehalte tafeldruiwe vanaf die grootskaalse, reeds gevestigde Sultanina-wingerde. Uitgebreide aanplantings en heraanplantings, wat nuwe cultivars van plaaslike en oorsese teelprogramme ingesluit het, is in hierdie gebied gedoen. Die vinnige groei in tafeldruifaanplantings en -uitvoere, asook die ekonomiese impak van die industrie in die Benede-Oranjeriviergebied, het die afgelope aantal jaar sterk op die voorgrond getree en het gevolglik gedien as agtergrond vir hierdie studie.

Die cultivarprofiel in dié area is besig om te verander en volgens vooruitskattings gaan Sultana, Regal, Prime Seedless en Sugraone die vier prominente vroeë, wit, pitlose tafeldruifcultivars in 2005 wees. Gebaseer op hierdie feit en na aanleiding van 'n behoefte aan meer inligting met betrekking tot produksiekostes en algemene winsgewendheid van die nuwe cultivars, is 'n vergelykende studie aangaande die vier genoemde cultivars in die Benede-Oranjeriviergebied geloods. Die benadering wat gedurende die studie gevolg is, het inligting aangaande produksie-insetkoste (spesifiek arbeid in man-ure en gevolglike koste) per manipulasie onttrek. Hierdie benadering verskil van die meer algemene metodiek om insetkoste-inligting van 'n spesifieke area van gekombineerde gemiddelde waardes te verkry. Met so 'n benadering word gewoonlik geen onderskeid tussen cultivars getref nie.

Die spesifieke doelwitte van hierdie studie het 'n vergelykende analise aangaande die insetkoste van die produksiepraktyke per hoofmanipulasie/aksie ingesluit, asook 'n analise waar produktiwiteit, waarde en buitengewone koste van die vier cultivars in ag geneem is. In totaal is 22 eksperimentele persele gebruik in die studie. Samewerking van die produksiebestuurders van die onderskeie esperimentele persele is verkry ten opsigte van die verskaffing van inligting oor produksiekoste per manipulasie, en die produktiwiteit per cultivar en eksperimentele perseel. Die produksiebestuurders het die nodige dokumente ontvang om die inligting te onttrek, of kon die inligting verskaf soos dit in hul rekordhoudingsisteem voorgekom het. Die waarde (prys behaal) van die onderskeie cultivars vir die 2001/2002-seisoen is in perspektief gestel deur gebruik te maak van 'n

opname wat in die Benede Oranjeriviergebied plaasgevind het. Hierdie opname het inligting oor die uitbetalings van die onderskeie cultivars in die area vir die 2001/2002-seisoen ingesluit. Inligting rakende die stok- en vrugproduksie-tantieme is vanaf die onderskeie plantttelersregtehouers van die cultivars verkry. Primêre beskywings van die algemene verbouingspraktyke van elke eksperimentele blok en inligting oor die spesifieke seisoen is gebruik om die data wat vanaf die esperimentele persele verkry is, in perskektief te stel.

Verskeie kompliserende faktore het die studie en die ontleding van data beïnvloed. Verskeie van hierdie faktore is reeds geidentifiseer met die beplanning van die studie en was meestal gekoppel aan die onlangse bekendstelling van Regal en Prime Seedless aan die Benede-Oranjeriviergebied. Na aanleiding van die data wat ingesamel en ontleed is, was dit duidelik dat dit moeilik sou wees om betekenisvolle verskille (waar "betekenisvol" as $P \leq 0.10$ gedifinieer is) tussen die cultivars uit te lig, maar dat dit egter wel moontlik sou wees om aanvanklike indikasies en tendense te kry. Gebaseer op die insetkoste-ontleding van die studie blyk dit dat volwasse Prime Seedless die hoogste arbeidsinsette en produksiekoste van die vier cultivars gaan hê, gevolg deur Sugraone. Die arbeidsinsette en koste van die produksie-aksies wat van jong Prime Seedless bestudeer is, was baie hoog in vergelyking met volwasse Sultana Seedless- en Sugraone-stokke, veral ten opsigte van lowerbestuur en trosmanipulasies. Prime Seedless was veral geneig tot die set van klein, oneweredige korrels, wat tot baie hoë arbeidsinsette en gevolglik koste vir trosmanipulasies gelei het. Sugraone is ook daarvoor bekend dat dit geneig is tot die set van klein, oneweredige korrels in die Benede-Oranjeriviergebied (veral in moeilike klimaatseisoene), wat gevolglik tot hoë arbeidsinstte vir trosmanipulasie lei.

Die aanvanklike aanduiding is dat volwasse Sultana en Regal Seedless min of meer die dieselfde arbeidsinsette vir verbouing sal vereis. Die feit dat Regal Seedless nie duur gibberelliensuur (GS)-behandelings vir blomtrosuitdunning of korrelvergroting benodig nie, is 'n enorme voordeel in terme van produksiekoste. Gevolglik is die aanvanklike aanduiding dat Regal Seedless die laagste produksieskoste van die vier cultivars sal hê. In die studiejaar was Regal Seedless egter geneig tot die set van onweredige korrels en gevolglik word verwag dat hierdie faktor uiteindelik die arbeidsinsette en produsiekoste van die cultivar sal bepaal, veral in moeilike klimaatseisoene. Die arbiedsinsette en produksiekoste van Sultana Seedless sal bepaal word deur die korrekte tydsberekening en konsentrasie van die GS-behandelings vir uitdunning en korrelvergroting.

Sultana Seedless en Sugraone het gedurende die 2001/2002-seisoen hoë opbrengste in die Benede-Oranjeriviergebied geproduseer. Oesdata inligting van die onderskeie esperimentele persele het bevestig dat daar min te kies is tussen die twee cultivars in terme van produktiwiteit wanneer verbouingstoestande en -praktyke optimaal is. Groot variasie is egter waargeneem in die opbrengsresultate van die Regal en Prime Seedless. Dit is hoofsaaklik as gevolg van die onlangse bekendstelling van die twee cultivars in die area en dus ook die beperkte aantal blokke van die cultivars wat reeds in vol produksie was. Dit was dus onmoontlik om duidelike tendense in terme van die toekomstige produksie van volwasse Regal en Prime Seedless te identifiseer. Indikasies van arbeidsinsette en produksiekoste kon egter wel verkry word.

Vroeg rypwordende Prime Seedless en Sugraone vaar baie goed in terme van die prys wat dit behaal, veral in die oesperiode voor week 50. Hierdie voordeel van hoë pryse behaal vroeg in die seisoen is egter nie altyd van toepassing op vroeë cultivars in die later rypwordende areas van die Benede-Oranjeriviergebied nie. Later in die seisoen (na week 50), wanneer die aanbod van tafeldruiwe op oorsese markte skerp toegeneem het, is Sultana Seedless gewoonlik die beste presteerder in terme van prys van die vier cultivars. Die uiteindelike prys wat deur cultivars behaal word, word tot 'n groot mate bepaal deur vraag en aanbod, kwaliteit en aanvaarding van die cultivar deur die verbruiker.

Die studie en die uitkomste daarvan het 'n sterk streeks (Benede-Oranjerivier) en plaaslike (Suid-Afrika) impak, en die spesifieke resultate sal ongetwyfeld van waarde wees vir produseerders, uitvoerders en ander rolspelers met bestaande belange in die cultivars of vir tafeldruifproduksie as sulks. Die metodiek wat in hierdie studie gebruik is, is egter van breër belang en wys duidelik die voordele daarvan om gedetailleerde en gekwalifiseerde inligting aangaande produksiepraktyke te hê, wat dit ook in verband bring met arbeid en gevolglike koste per aksie. Dit behoort te lei tot meer besigheids-intelligensie en realistiese beplanning deur die produseerder met betrekking tot cultivarkeuse vir 'n spesifieke produksiearea met 'n spesifieke bemarkings geleentheid. Hierdie studie het ook die weg gebaan vir soortgelyke studies, spesifiek ten opsigte van die gedetailleerde beskrywing van die metodiek wat gevestig is. Kennis van die probleme wat in hierdie studie ondervind is, kan dien as nuttige verwysing vir die beplanning en uitvoer van soortgelyke studies.

This thesis is dedicated to my parents, Buks and Annetta, and my sister, Sorietha.

BIOGRAPHICAL SKETCH

Henning Burger was born in Upington, South Africa, on 2 June 1978. He attended Groblershoop Primary School and matriculated at Groblershoop High School in 1996. Henning enrolled at Stellenbosch University in 1997 and obtained a BScAgric degree in Viticulture and Genetics (Plant breeding) in 2000. In 2001, he enrolled for an MScAgric degree in Viticulture at the same University.

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PREFACE

This thesis is presented as a compilation of six chapters. Each chapter is introduced separately; the research results are presented in chapters three to five and cryptically summarised and concluded in chapter six.

Chapter 1 **General introduction and project aims**

Chapter 2 **Literature review**
Table grape production in the Lower Orange River area: Historical background, current situation and future prospects

Chapter 3 **Research design**
Site selection and primary description of experimental plots

Chapter 4 **Research results**
Comparative analysis of the input costs linked to the cultural production practices of four white seedless table grape cultivars cultivated in the Lower Orange River area

Chapter 5 **Research results**
Comparative analysis of four white seedless table grape cultivars taking into account productivity (yield), value (price achieved) and extraordinary costs (vine and fruit production royalties)

Chapter 6 **General discussion and conclusions**

I hereby declare that practices described are not recommendations, but represent production procedures and methods used on each of the experimental plots in the study. The use of trade names in this thesis does not constitute an endorsement or recommendation nor is any criticism implied by omission of similar products.

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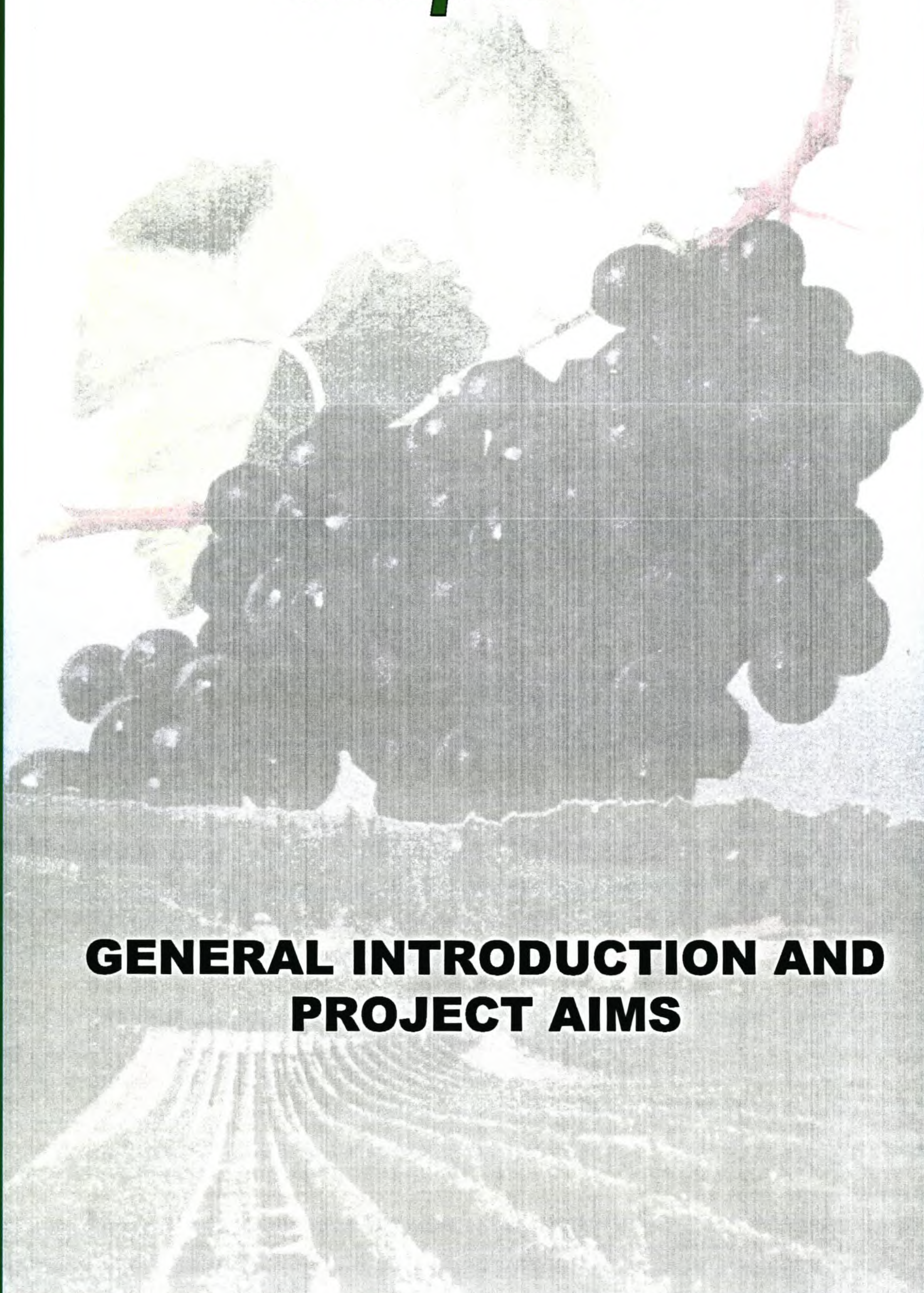
Chapter 1



GENERAL INTRODUCTION AND PROJECT AIMS

GENERAL INTRODUCTION AND PROJECT AIMS

1.1 INTRODUCTION

For decades, people from around the world flocked to South Africa's Orange River region where they hoped to find instant riches in the prolific diamond deposits that have been sedimented along the riverbanks throughout the ages. Agricultural producers along the lower part of the river have more recently been harvesting another type of "diamond"; namely sweet and juicy grapes grown in the desert conditions along the riverbanks. In this region, the Orange River irrigates vineyard upon vineyard from Groblershoop in the north, down to its entrance in the sea at Alexander Bay, to delivers some of the world's best quality seedless grapes. These grapes, which are harvested between November and February, are widely appreciated by customers around the world (Anon, 2001).

Consumer preference mapping showed that seedless table grapes became sought-after during the 1980's and this presented the Lower Orange River area of South Africa with an excellent opportunity. The area was already widely planted with Sultanina grapes, largely for the purposes of raisin production. With some changes to the production procedures of the established Sultanina vineyards in this area, it was possible to market these grapes as seedless table grapes, thus obtaining a valuable international market share in table grape exports.

The producers along the Lower Orange River area have adapted their cultivation practices over the years through success and failure to suit the unique climate and environmental conditions of this area. Cold, yet sunny winter days and hot, dry summers combine with the rich desert soil to produce early and top quality table grapes. Unique cultivation practices such as evaporative cooling, application of rest breaking agents, etc. in combination with the desert like conditions of the area ensure early maturity, high prices, good quality and satisfactory yields. The Orange River is currently the fastest grape-growing region in South Africa. Compared to the 1999/2000 season, the 2001/2002 crop has doubled in size. Production is expected to increase up to 19 million cartons by the year 2006 (ORPA, 2002).

The table grape industry in South Africa is an important industry for the local economy, since it earns foreign currency, but also employs a significant proportion of the rural people in the vicinity of table grape production units. The labour force is thus also benefiting from the growth in the industry. It directly and indirectly provides considerable employment opportunities as full-time, part-time and casual positions. Currently more than 150 000 people are dependent on the grape industry for their livelihood (Anon, 2001).

Today, Sultana Seedless is still the leading variety in this area and contributed 56% to the 2001/2002 crop (ORPA, 2002). Sugraone is also a well-known white seedless cultivar in the Lower Orange River area and represented 26% of the

2001/2002 crop (ORPA, 2002). The cultivars, Regal- and Prime Seedless are new introductions to the cultivar spectrum of this area. It is envisaged that in three years' time Prime Seedless will contribute 11% to the annual crop and Regal Seedless 7% (ORPA, 2002). Due to the recent introduction of Regal- and Prime Seedless in the Lower Orange River, virtually no information is available on these cultivars regarding output yields, market performance, input costs and overall economic performance. Economic impact studies concerning productivity, payments and tendencies in production costs of table grapes are performed on a routine basis in the various production regions of South Africa (and the world). In the South African table grape industry, Frudata S.A. was contracted the past few seasons to conduct economic impact studies in the Lower Orange River, Berg, Olifants and Hex River areas. These studies typically encompass collected data from a range of production units per area and include productivity, payments and production costs. The data is combined to provide total averages for productivity, payments and especially production costs for general table grape production in the region and do not differentiate between the cultivars included in the study, except in terms of payments. These studies provide producers with a generalised overview of productivity, payments and production costs tendencies within a region. The production cost part of the studies relies heavily on averages and a breakdown into the cost per specific action of the cultivation practices does take not place. Very little (if any) studies have been undertaken in South Africa to economically break down production cost in its components or actions per cultivar. Usually cultivars are compared with each other in terms of total production cost. Comparisons of the various cultivars in terms of viability and cost effectiveness per action, specifically considering the labour input will be very insightful when choices regarding the optimal cultivar profile for a specific production area have to be made.

Salaries and wages contributed up to 52% of the estimated production cost (J. van Zyl, Capespan, South Africa; Personal Communication, 2001) of table grape production in South Africa in 2001. According to this figure, labour cost is the major contributor to total production cost of table grape cultivation. It is evident from this information that a table grape cultivar that requires less labour inputs than another has a definite financial advantage in the production cost category. It does not, however, mean that a low labour input cultivar will ensure higher returns than a high labour input cultivar. Aspects such as maturation date, price achieved on the marketplace, productivity (yield) etc. in collaboration with production input cost (with labour input cost as one of the major factors in this category) determine the profitability of a specific cultivar.

Labour availability for table grape production is a very important factor, especially in a fast expanding region such as the Lower Orange River area. The lack of local workers, despite massive unemployment in the region, is being described as the major obstacle to further expansion of the table grape industry in this region. Most seasonal workers for table grape cultivation in the Lower Orange River area are recruited from other areas and with the new plantings in the area, extra labourers need to be employed. Much time will be needed to train these new workers each year. The human factor is essential for success with table grape farming in South Africa and should be taken into account when new plantings are planned (Van Niekerk, 1999). Landowners have also been squeezed by higher labour costs. These have been driven by changed labour laws, the rise of farm unions and increased weekly wages. The owners' solution usually involves shedding of permanent labour and using seasonal labour.

The effect of HIV/AIDS on the labour force of table grape production in the Lower Orange River area is also starting to take its toll. The effect of AIDS on table grape labour is at this point in time more indirectly due to a loss of labour efficiency and productivity than the direct loss of labour force. Since most workers in the Lower Orange River are recruited from other areas, it often happens that a family member dies of AIDS and producers are forced to provide transport to the funeral. At first sight it may seem like a small problem, but with an increasing incidence of these incidents, it can have a major impact on labour efficiency and productivity, especially in the critical harvest period. The extra cost of transport also increases production cost. Again, cultivars with low labour inputs have tremendous advantages from a human resource point of view. It is clear that labour availability is just as an important factor to consider as maturation date, price achieved on the marketplace, productivity and production cost when decisions regarding cultivar choice are made for new plantings.

1.2 PROJECT AIMS

In view of all the abovementioned factors, a study was undertaken to compare the predicted four most important, white seedless table grape cultivars in the Lower Orange River area. The overriding aim of this project was to obtain initial indications and trends regarding the relative cost-effectiveness (especially in terms of labour) and the long-term potential of *Vitis vinifera* cultivars Sugraone, Sultana, Regal and Prime Seedless in the Orange River area. Although this aim appears to have a strong regional (Orange River) and local (South African) focus, the approach adopted should yield valuable specific details regarding production of these cultivars that could be compared to international information on these cultivars and their cultivation.

It is proposed that the cultivars will be compared taking into account productivity (yield), value (price achieved at the marketplace), farming input cost (pruning, canopy management, bunch manipulations, etc.) and extraordinary other costs (vine and fruit production royalties where applicable). The farming input costs per cultivar will be broken down, presented and compared per input action to determine the cost for each of the main production cultural actions (pruning, canopy management, bunch manipulations, etc). This aspect is quite novel within the South African grapevine context and should provide interesting economical data, but is also foreseen to add certain complexities to the proposed study.

The data obtained will be investigated for statistical significant differences between the cultivars at testing of means at the 10% level (Nelsen, 2002) in order to identify possible trends within the data and to give an early indication of the long-term economical viability and cost-effectiveness (in terms of production costs, labour, etc.) of the cultivars. To achieve this, the following approaches resulted:

General approach:

(i) To distribute a database questionnaire with the help of ORPA (Orange River Producer Alliance) to all their members early in 2002 to compile information related to the 2001/2002 table grape season regarding general cultivation practices and input costs specifically on the chosen four table grape cultivars that would serve as control/comparison with the results from the experimental plots.

Specific approach:

(i) To select suitable experimental sites along the Orange River. The experimental plots should cover the whole of the Lower Orange River production area from Groblershoop in the east to Blouputs in the west in order to provide a representative sample of early, medium and late harvesting dates typical to the area;

(ii) To perform primary or base descriptions of each experimental plot regarding pruning, application of rest breaking agents, action and commencement dates of spring and summer canopy and bunch manipulations, gibberellic acid applications, etc;

(iii) To perform a comparative analysis of the input costs for production cultural practices per main action/manipulation of the cultivars Sultana Seedless, Sugraone, Regal- and Prime Seedless cultivated in the Lower Orange River area;

(iv) To perform a comparative analysis of the four white seedless table grape cultivars taking into account productivity (yield), value (price achieved) and extraordinary costs (vine and fruit production royalties).

1.2.1 COMPLICATING FACTORS REGARDING THE PROPOSED EXPERIMENTAL OUTLAY

Complexities of this proposed study include the fact that Regal- and Prime Seedless were only recently introduced to this area. The first plantings of these cultivars took place only in 1997. According to the statistics of ORPA (2001), 15 and eight hectares of Regal and Prime Seedless, respectively, were planted in 1997/1998 in the Lower Orange River area. The oldest Regal- and Prime Seedless vineyards in the area were thus only three years old when the study was planned. Identification of sufficient and comparable experimental plots for Regal- and Prime Seedless, which was already bearing fruit, was therefore problematic.

The fact that the whole Lower Orange River area will be included in the study will contribute significantly to internal variation in the data. The very young age and limited number of experimental plots available for Regal- and Prime Seedless vines might be responsible for a low degree of accuracy within the same manipulation. Other factors that might inflate variation include differences in production areas, production units, age of vines, rootstock, soil type, management and labour of various production units, production procedure used, etc.

Within the framework of the proposed study and its project aims, and taking into account the inherent problems that might occur with the analysis, analysis of the costs per cultivation action for the four seedless cultivars along the Lower Orange River area remain a worthwhile effort and will be the main focus of the study. The results of the study should provide present and future producers of these cultivars with valuable information regarding the cost-effectiveness and possible profitability of the cultivars when faced with the daunting task to choose cultivars for their production units.

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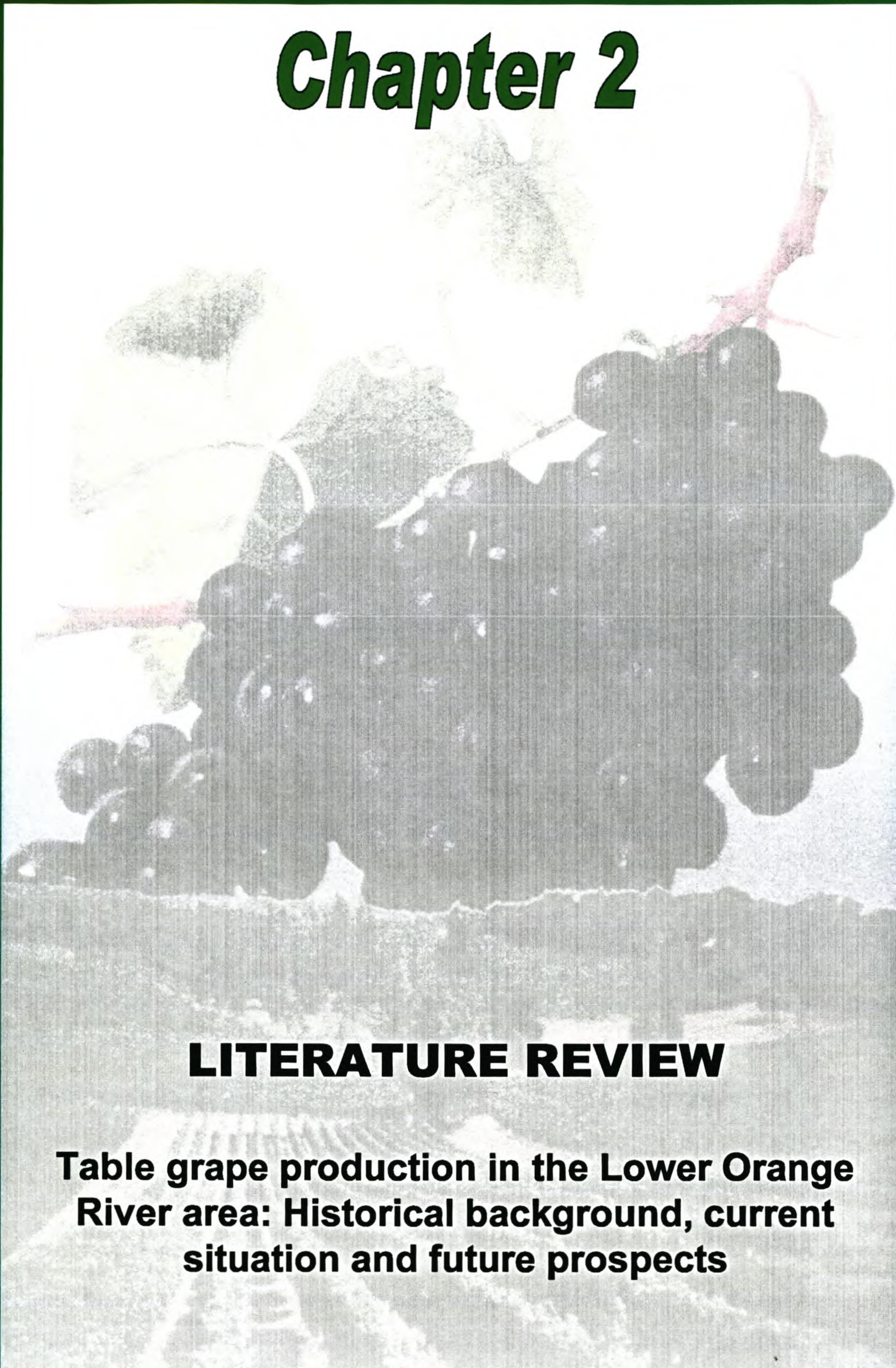
Chapter 2



LITERATURE REVIEW

Table grape production in the Lower Orange River area: Historical background, current situation and future prospects

LITERATURE REVIEW

2.1 INTRODUCTION

When Seedless table grapes became trendy on the international markets, the traditional raisin grape region of the Lower Orange River area, with its established Sultanina vineyards, was faced with an excellent opportunity to market their harvest as table grapes, thus gaining valuable market share in this profitable niche market. Through success and failure, the producers along the Lower Orange River area have adapted their cultivation practices over the years to suit the unique climate and environmental conditions of this area to produce top quality table grapes, which are known and respected on international markets all over the world. The Orange River area exceeded all expectations and is now the fastest grape growing region in South Africa. During the 2000/2001 season the Orange River Producer Alliance (ORPA) reported that almost eight million export cartons were produced in this area, whereas this figure almost doubled during the 2001/2002 season (ORPA, 2002). According to future predictions by ORPA, production and exports are expected to increase up to 19 million cartons by the year 2006.

Table grape production along the Lower Orange River area has come a long way since the first vines were planted in the 1940's and the first table grapes were exported from this region in the 1980's. Here, a brief overview of the historical background of table grape production in this region, the unique environmental conditions, and accordingly the unique cultivation practices used to produce table grapes, will be discussed. The profitability of table grape farming, the current cultivar profile and statistics of this region will also be highlighted. According to predictions by ORPA (2001), the white seedless cultivars Sultana Seedless, Sugraone, Regal Seedless and Prime Seedless will be the four widest planted table grape cultivars along the Lower Orange River by the 2005/2006 season. An overview is given of these major cultivars, their characteristics, recommended cultivation practices along the Lower Orange River and their shortcomings. Concomitant with the expansion of table grape production, certain obstacles also arise, which have to be addressed to ensure the long-term profitability and viability of table grape production along the Lower Orange River area. We will examine some of these obstacles and specifically how decision-making about future plantings will be influenced in this region. This overview aims to provide an update and better understanding of the history, current situation and future prospects of the table grape production along the Lower Orange River area.

2.2 HISTORICAL BACKGROUND, STATISTICS AND CULTIVAR PROFILES OF THE LOWER ORANGE RIVER AREA

From the inception in 1654, when Jan van Riebeeck imported the first vines into South Africa, the viticultural industry has developed into a large and important agricultural sector. The first grapes were pressed by Van Riebeeck on the 2nd of February 1659, and included Hanepoot and Muscadel cultivars. Although the plantings included table grape varieties, almost all the early governors focused on wine production and it was not until 1886 that the first table grapes were exported to the United Kingdom (Kriel and Micklem, 1951).

The cultivation of grapes in the Lower Orange River area first made headway in the 1940's and over the following decade the industry expanded gradually. With the completion of the Gariep dam (formerly, Hendrik Verwoerd dam) in 1972 and the Van der Kloof dam (formerly, PK le Roux dam) in 1977, thousands of hectares of arable land along the riverbanks became available to irrigation farming from the stabilised Orange River.

The 1970's are considered the golden era in the history of grape farming along the Lower Orange River area. In 1966 a wine quota was granted to the farmers of the Orange River area and plantings of wine grapes increased dramatically. The very fertile soil, abundant water and dry, warm summers made the cultivar, Sultana, very popular amongst farmers for the purposes of wine and raisin production. The first Sultana vines were planted in 1928 at Kakamas and are still today the most widely planted cultivar along the Lower Orange River area (De Villiers and Du Plessis, 1999).

Many of the farmers along the Lower Orange River that traditionally cultivated Sultanas for wine and raisin production was encouraged to adjust their vineyards for the production of Sultana Seedless table grapes. The Lower Orange River area (from Groblershoop to Blouputs) was identified as the ideal region to develop for the production of seedless table grapes. Research on cultivation practices and new grape cultivars that became available ensured a noticeable growth in the export table grape trade. The 1982/1983 season was the start of the export of seedless table grapes from South Africa (De Villiers and Du Plessis, 1999) and in 1985 a total of 65 000 cartons was exported from the Lower Orange River area (Anon., 1993). In 1988, a total of 608 000 five kilogram cartons export grapes were produced by 120 producers (De Villiers and Du Plessis, 1999). At this stage, almost all the vineyards along the Lower Orange River were established on own root, making the vineyards highly susceptible to phylloxera and nematodes, which lead to low yields and poor quality. Grafted material on resistant rootstocks constituted the solution to this problem for new table grape plantings. The heavy, silty soils along the river regularly caused very dense canopies and consequently infertility amongst many cultivars, especially Sultana. Higher yields and quality were achieved with new trellising systems to accommodate the dense canopies (Anon., 1993). During 1993, 3.6

million five-kilogram cartons were exported from the Lower Orange River area (Gouws, 1995).

The growing demand for seedless table grapes on overseas markets was an attractive challenge for the table grape industry along the Lower Orange River area. This was one of the few branches in agriculture that still had enormous growth potential. More and more table grapes were planted in a westerly direction (still higher temperatures, lower continental) on the red, sandy soils commonly found outside the dark, fertile alluvial terraces along the river. Maturation could be enhanced to such an extent that Sultana grapes could be supplied to the European market one to two weeks before Christmas. Research pointed out that by using dormancy-breaking substances such as cyanamide in mid winter, the late winter and early spring temperatures were adequate to maintain the advantage of an early budding, and that maturity could consequently be advanced towards the second half of November (Saayman, 1988).

Blouputs (Fig. 2.1), along the Lower Orange River, was up till 1995 known as the location in the Southern Hemisphere where the first table grapes of the season were harvested. This, however, changed from 1996 when the cultivation of table grapes commenced lower down the Orange River where the river becomes the boundary with Namibia on the historical sheep farm, Schuitdrift. This region was initially not seen as being suitable for table grape production since the winters were too short and the summers too warm. These problems were addressed by forcing the vines into dormancy in winter and by adapting the summer cultivation practices to suit this specific area with its very high summer temperatures. The successes obtained in overcoming the negative effects of the climate in this area, lead to the planting of vineyards even lower down the river to produce table grapes that reach maturity during the first week of November. This lead to further growth in table grape exports from the Lower Orange River area, since very high prices were achieved for the early table grapes from this region on overseas markets (Anon., 1996a).

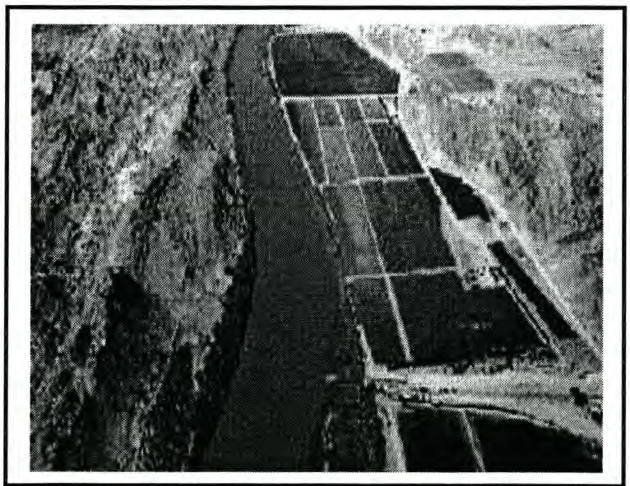


Fig. 2.1 The Blouputs Valley in the Lower Orange River as seen from the air (www.orpa.co.za).

Since the bulk of South Africa's table grape crop is exported, the cultivation of any table grape cultivar in South Africa is largely determined by overseas demand and market share obtained by marketing. The future prospects of this region as a major seedless grape producing region seemed assured (Saayman, 1988) due to several reasons, including: (i) Excellent infrastructure already existed to support cultivation for this niche market; (ii) high mean summer temperatures ensures early maturation and harvesting during December and January and (iii) Sultana is already adaptation to the desert-like climate.

At the end of 2000, a total of 5400 hectares of table grapes were already established in the Orange River area districts (ORPA, 2001), with Kakamas and Groblershoop, respectively as the districts with the most and least hectares of table grapes established (Fig. 2.2). The average yield of table grapes per bearing hectare along the Lower Orange River for the 1999/2000 and 2000/2001 seasons is summarised in Table 2.1. The average yield of export quality table grapes (class 1 and class 2) was 2292 cartons (4.5 kg) per bearing hectare for the 1999/2000 and 2000/2001 seasons.

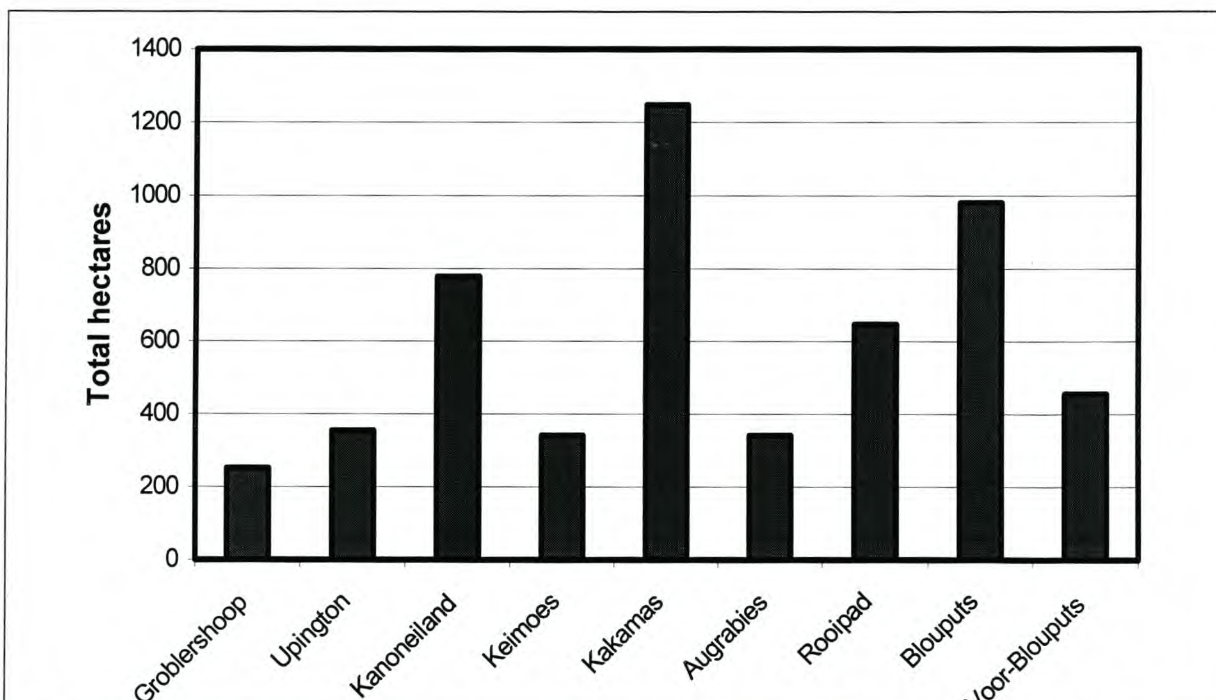


Fig. 2.2 Total hectares of table grapes planted per district in 2000 in the Orange River area (ORPA, 2001).

There were dramatic increases of table grape plantings along the Lower Orange River from 1998 to 2000 as can be seen from Table 2.2. In 2001, however, the total new plantings was almost half of the previous year. Future plantings are expected to continue, but at a lower annual rate than in the past. Farmers have realised that the widespread growth along the Lower Orange River area is straining the markets with the large amounts of seedless table grapes that are exported from this area. The large-scale development of new vineyards also has a big impact on management, labour and cost management. These factors will increasingly effect the decision of farmers to expand in the future or not (Van Niekerk, 1999).

Table 2.1 Yield (4.5 kg units) per bearing hectare for the 1999/2000 and 2001/2002 seasons in vineyards of the Orange River area (Frudata S.A., 2000 & 2001).

	Class 1		Class 1.5		Local		Processed		
Season	4.5 kg/ha	%	4.5 kg/ha	%	4.5 kg/ha	%	4.5 kg/ha	%	Ton/ha
1999/2000	2220	55	92	2.3	475	11.8	1197	29.6	18.2
2000/2001	1761	58	509	17	367	12	379	13	13.6
Average	**1991**	**56.5**	**301**	**9.65**	**421**	**11.9**	**788**	**21.3**	**15.9**

Sultana Seedless, Sugraone, Flame Seedless, Prime Seedless and Regal Seedless are the five most expansively planted cultivars (Table 2.2 and Fig. 2.3) in decreasing order along the Lower Orange River area. Sultana Seedless and Sugraone are the prominent cultivars cultivated in the area (Van der Merwe *et al.*, 1997), but a shift in the cultivar profile is foreseen in the future towards cultivars that need less labour and are more resistant to pathogens and berry crack. Prime- and Regal Seedless are two white seedless table grape cultivars that are becoming popular amongst producers according to the new planting statistics of this area. Flame Seedless is the only red seedless cultivar that is established on a grand scale.

Table 2.2 Total hectares established/year/cultivar (ORPA, 2001).

Planting Year	Before 1998	1998	1999	2000	2001	Total (Hectares)
Alphonse Lavallée	0	5	0	0	0	**5**
Crimson Seedless	3	0	2	20	9	**34**
Dan Ben Hannah	10	0	0	0	4	**14**
Flame Seedless	276	40	94	71	27	**508**
La Rochelle	61	6	6	0	0	**73**
Prime Seedless	5	3	28	220	127	**383**
Red Globe	47	49	46	19	3	**164**
Regal Seedless	10	5	30	145	36	**226**
Sugraone	637	126	118	97	39	**1017**
Sultana Seedless	2263	291	245	306	136	**3241**
Victoria	8	3	40	40	11	**102**
Other	136	10	30	20	16	**212**
Grand Total (ha)	**3456**	**538**	**639**	**938**	**408**	**5979**

The Orange River is exceeding all expectations and is now the fastest grape growing region in South Africa. In the 1999/2000 season 6.897 million and in the 2000/2001 season 7.827 million export cartons were produced in this area (ORPA, 2001). A dramatic increase took place during the 2001/2002 season, with an astonishing 14.460 million cartons being exported. The very good climatic conditions of this season, in conjunction with the large scale new plantings that took place the last couple of years were responsible for this huge increase (Table 2.3 and Fig. 2.4) in the number of cartons produced. According to the predictions by ORPA, this is expected to increase up to 19.6 million cartons by the 2005/2006 season.

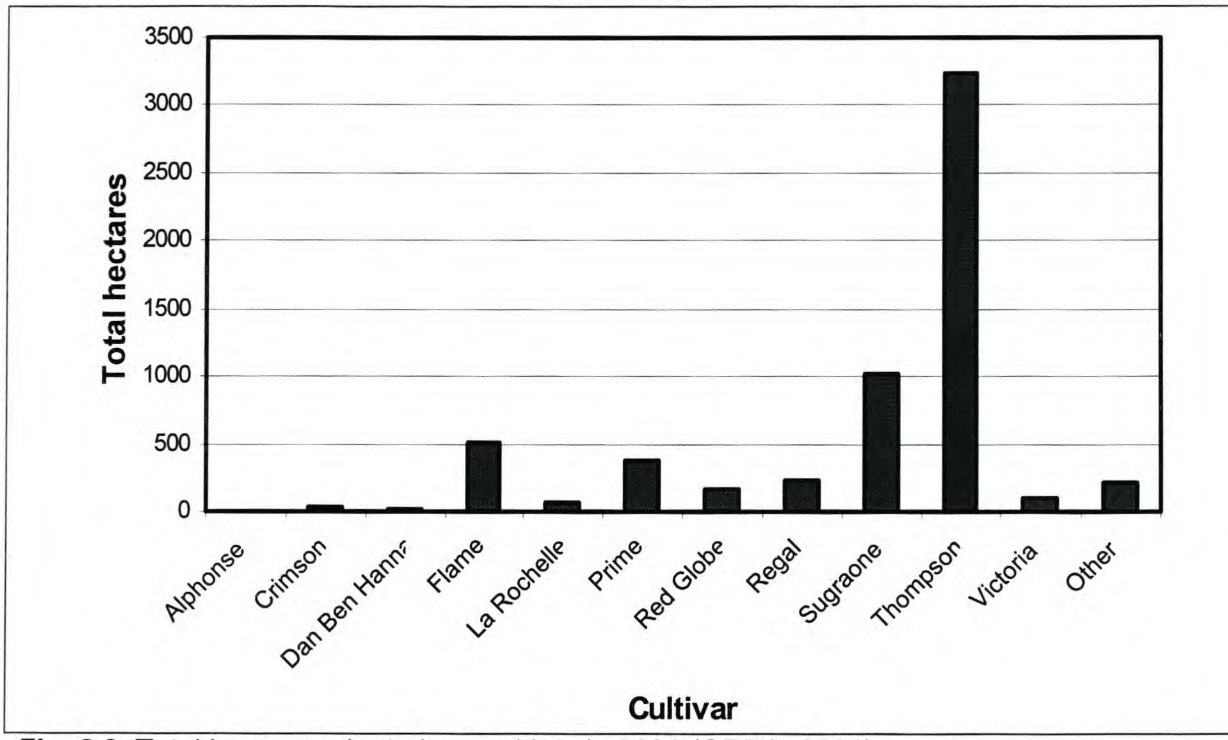


Fig. 2.3 Total hectares planted per cultivar in 2001 (ORPA, 2001).

Table 2.3 The actual production figures for the 1999/2000 to 2001/2002 seasons and the projected figures for the 2002/2003 to 2005/2006 seasons for each cultivar (ORPA, 2002).

CROP ESTIMATE BY CULTIVAR ' OOO Cartons (Class 1 & 1.5)						
	ACTUAL	**ACTUAL**	**ACTUAL**	**FORECAST**	**FORECAST**	**FORECAST**
Season	**1999/2000**	**2000/2001**	**2001/2002**	**2002/2003**	**2003/2004**	**2005/2006**
Flame	403.30	504.00	1074.00	1211.70	1357.70	1497.20
La Rochelle	322.30	286.00	440.00	476.30	474.90	483.20
Prime	0.00	84.20	145.00	721.70	1296.70	2161.60
Red Globe	96.30	124.90	511.00	503.40	561.00	601.20
Regal	5.30	11.30	166.00	470.10	821.80	1346.40
Sunred	28.00	10.90	21.00	39.00	39.00	39.00
Sugraone	2000.10	2417.70	3792.00	3414.70	3574.70	3737.10
Sultana	3965.80	4317.20	8088.00	8181.40	8545.80	9108.40
Victoria	24.10	30.00	41.00	177.80	257.50	397.50
Crimson	0.00	1.70	128.00	27.50	35.50	55.80
Other	51.80	39.60	54.00	122.00	122.40	141.80
TOTAL	**6897.00**	**7827.50**	**14460.00**	**15345.60**	**17087.00**	**19569.20**

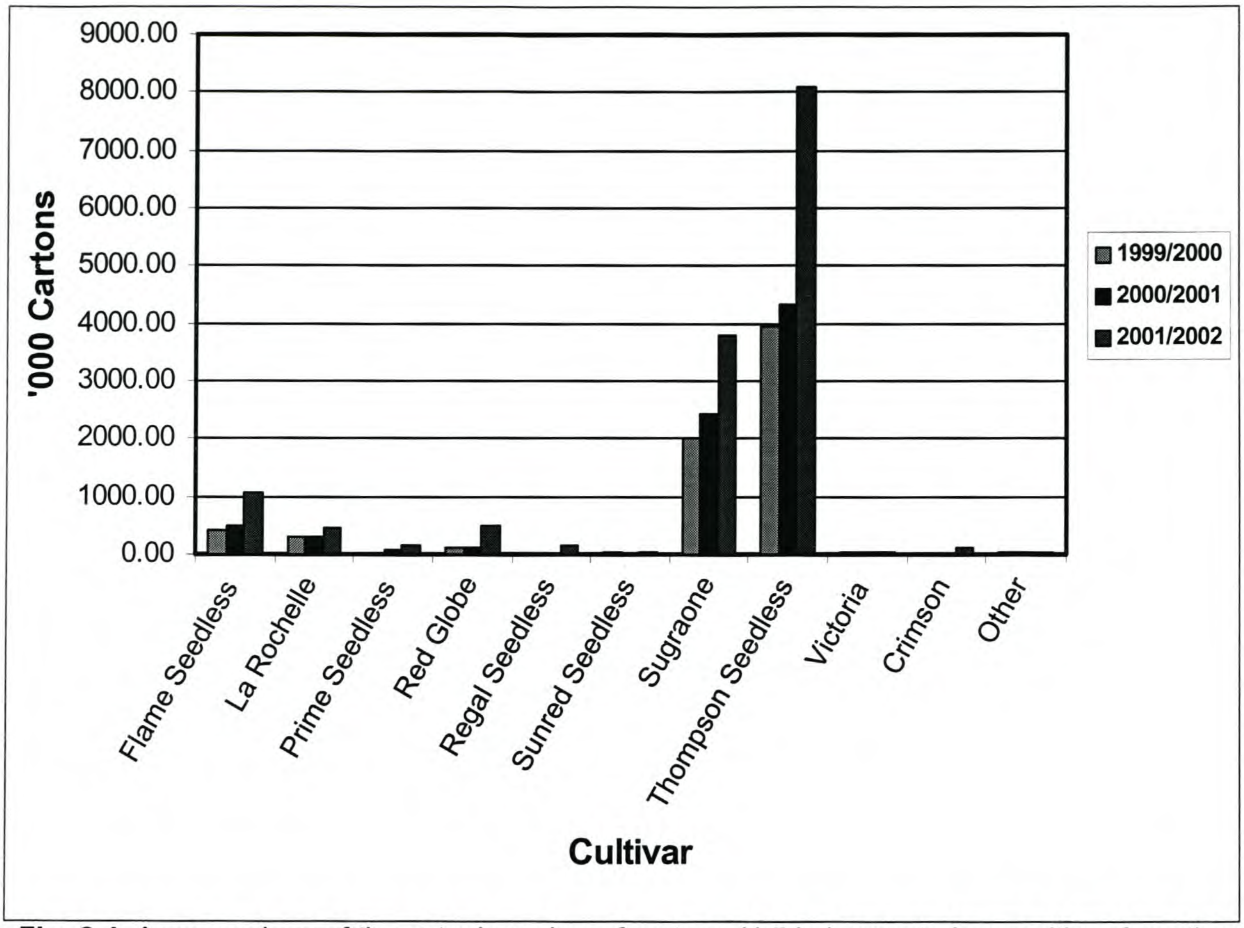
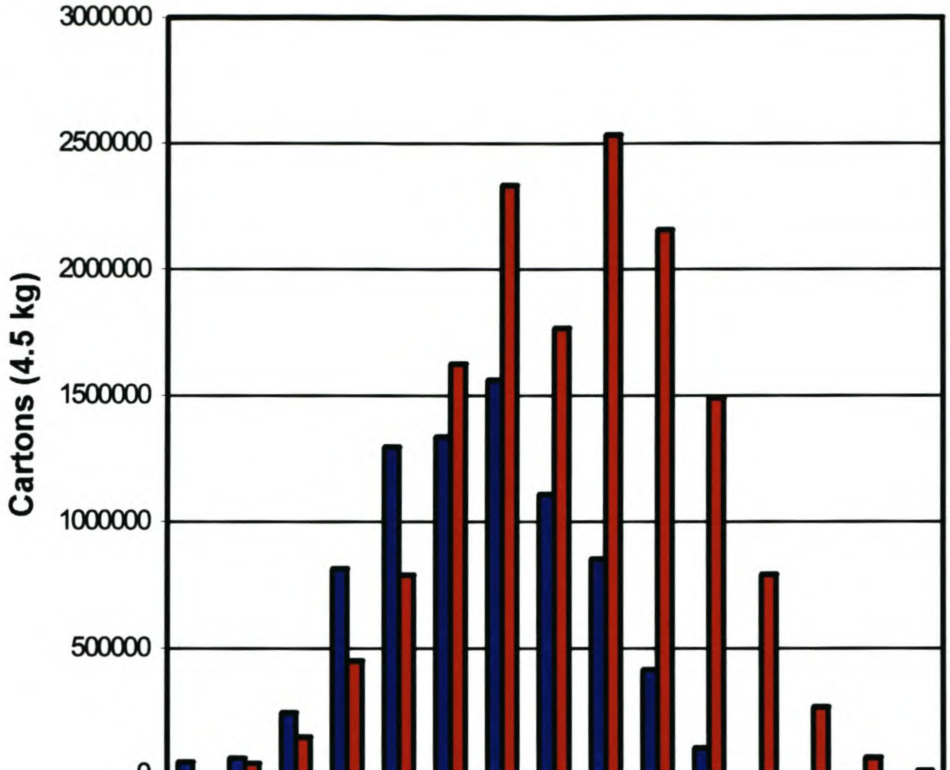


Fig. 2.4 A comparison of the actual number of cartons (4.5 kg) exported per cultivar from the Lower Orange River area during the 1999/2000 to 2001/2002 seasons (ORPA, 2002).

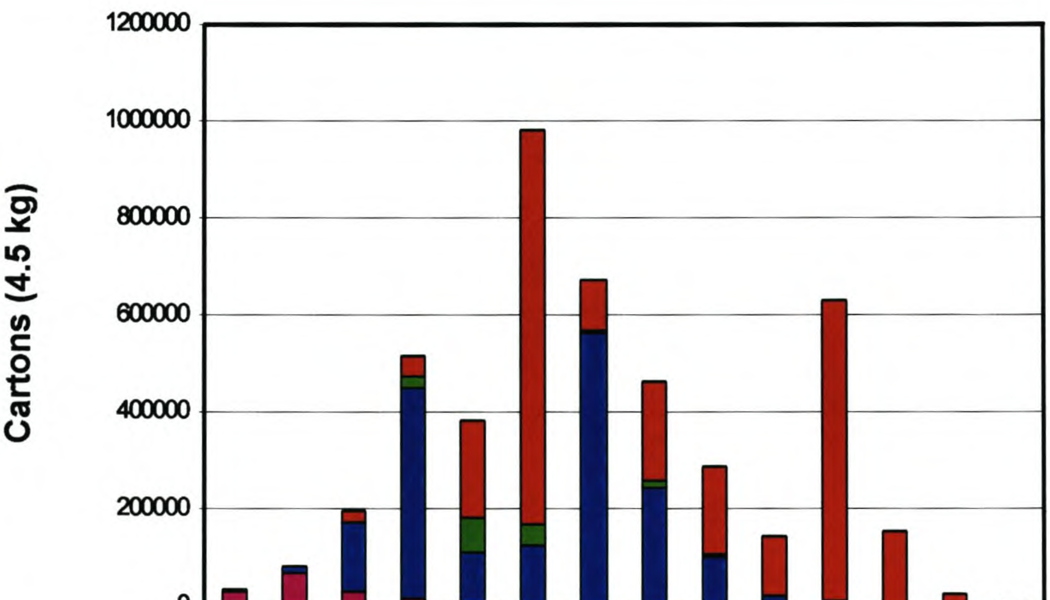
Harvesting of the early cultivars commences roundabout weeks 45-46 in the Lower Orange River area (Figs. 2.5-2.7). Prime- and Flame Seedless are the first cultivars to reach maturity and are usually the first cultivars to be harvested followed by the rest according to maturation date. As can be seen from Fig. 2.5, the peak weeks for harvesting in the 2000/2001 season were weeks 50-52. Harvesting, however, commenced a week later in the 2001/2002 seasons reaching a peak from week 51 up to week 2. Harvesting is usually finished by week 7 in the Lower Orange River. Prime Seedless (Fig. 2.6) is the first white seedless cultivar to be harvested (weeks 46-49) followed by Sugraone (weeks 47-3), Regal Seedless (weeks 48-2) and Sultana Seedless (weeks 48-7). Harvesting of the red seedless (Fig. 2.7) cultivars starts with Flame Seedless (weeks 46-2), followed by Sunred Seedless (weeks 2-6). Harvesting dates, however, vary from season to season and from region to region in the Lower Orange River due to the factors already mentioned.



	45	46	47	48	49	50	51	52	1	2	3	4	5	6	7
2000/2001	47550	61725	243979	812323	1294650	1336350	1559310	1108340	849705	412571	104420	0	0	0	0
2001/2002	0	40425	147614	448608	787669	1622950	2333450	1763780	2534480	2155920	1489520	789990	266316	65975	13476

Packing week

Fig. 2.5 Comparison of the total number of cartons (4.5 kg) supplied per packing week in the Lower Orange River area during the 2000/2001 and 2001/2002 seasons (ORPA, 2002).



	46	47	48	49	50	51	52	1	2	3	4	5	6	7
Thompson Seedless	0	1280	21440	47239	202234	817590	105803	206487	181043	126088	618117	150128	25776	3377
Regal Seedless	0	0	3424	23548	71366	42384	6344	15025	4668	0	0	0	0	0
Sugraone	2720	11800	138964	430596	105543	122216	560160	242494	102356	17634	8373	0	0	0
Prime Seedless	30257	67196	30145	14951	2707	309	0	0	0	0	0	0	0	0

Fig. 2.6 Total number of cartons (4.5 kg) of white seedless grapes supplied per packing week per cultivar in the Lower Orange River area for the 2001/2002 season (ORPA, 2002).

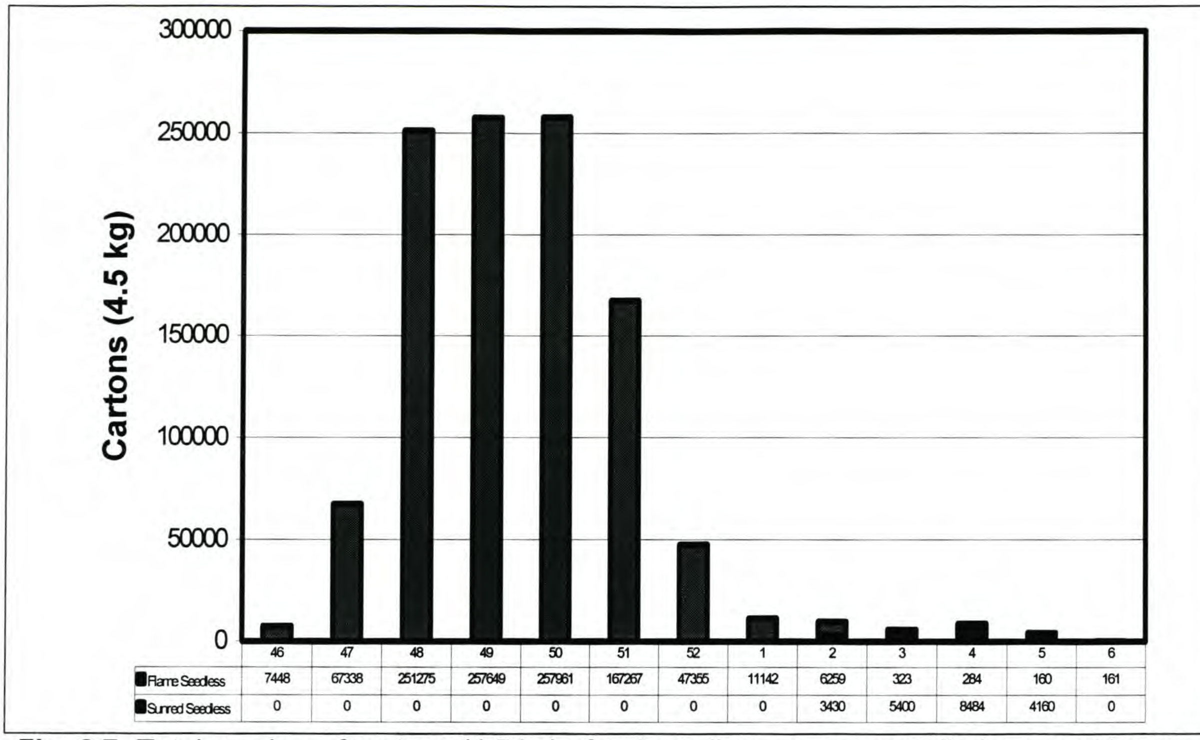


Fig. 2.7 Total number of cartons (4.5 kg) of red seedless grapes supplied per packing week per cultivar in the Lower Orange River for the 2001/2002 season (ORPA, 2002).

Table 2.4 shows the global market allocation of table grapes from the Lower Orange River area for the 2000/2001 and 2001/2002 seasons. The United Kingdom, followed by the rest of Europe is the largest markets for table grapes from the Orange River. In the 2001/2002 season, 86% of table grapes produced in this area was exported to the markets of the United Kingdom and Europe. This was a total of 12.43 million 4.5 kg cartons. North America (3%), the Middle East (4%) and the Far East (5%) complete the global market allocation (Fig. 2.8) for the Orange River table grapes. Small amounts of table grapes are also sent to other markets (2%), such as African countries (ORPA, 2002).

Table 2.4 Global market allocation of Orange River table grapes for the 2000/2001 and 2001/2002 seasons (ORPA, 2002).

ORANGE RIVER GRAPES: GLOBAL MARKET ALLOCATION						
	Actual 2000/2001 4.5kg cartons (million)	**%**	**Exporters Target 2001/2002** 4.5kg cartons (million)	**%**	**Actual 2001/2002** 4.5kg cartons (million)	**%**
UK + EIR	3.700	47	5.920	50	6.940	48
EUROPE	2.100	27	3.895	32	5.490	38
SUBTOTAL	**5.800**	**74**	**9.815**	**82**	**12.430**	**86**
NORTH AMERICA	0.800	10	0.780	6	0.440	3
MIDDLE EAST	0.300	4	0.520	4	0.578	4
FAR EAST	0.700	9	0.870	7	0.723	5
OTHER	0.200	3	0.115	1	0.289	2
SUBTOTAL	**2.000**	**26**	**2.285**	**18**	**2.030**	**14**
TOTAL	**7.800**	**100**	**12.100**	**100**	**14.460**	**100**

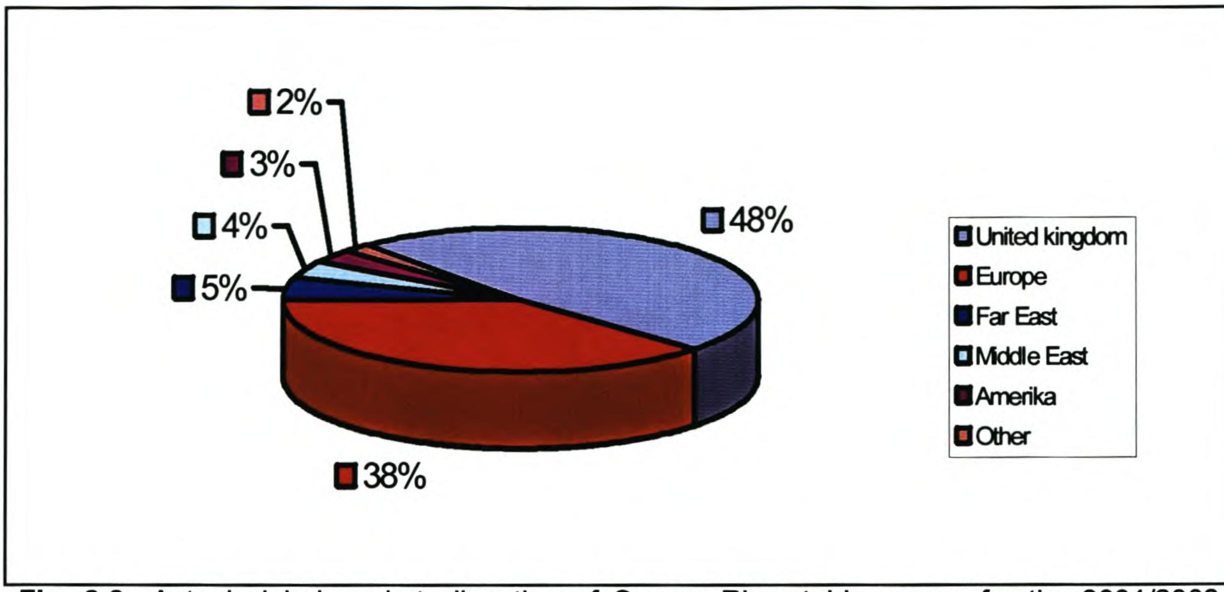


Fig. 2.8 Actual global market allocation of Orange River table grapes for the 2001/2002 season (ORPA, 2002).

Apart from an expected increase in cartons of grapes exported, significant changes will also occur in the cultivar profile of the Lower Orange River area. Figs. 2.9 and 2.10 clearly show that a significant shift in the white seedless cultivar profile is expected from the 1999/2000 season (Fig. 2.9) up to the 2005/2006 season (Fig. 2.10).

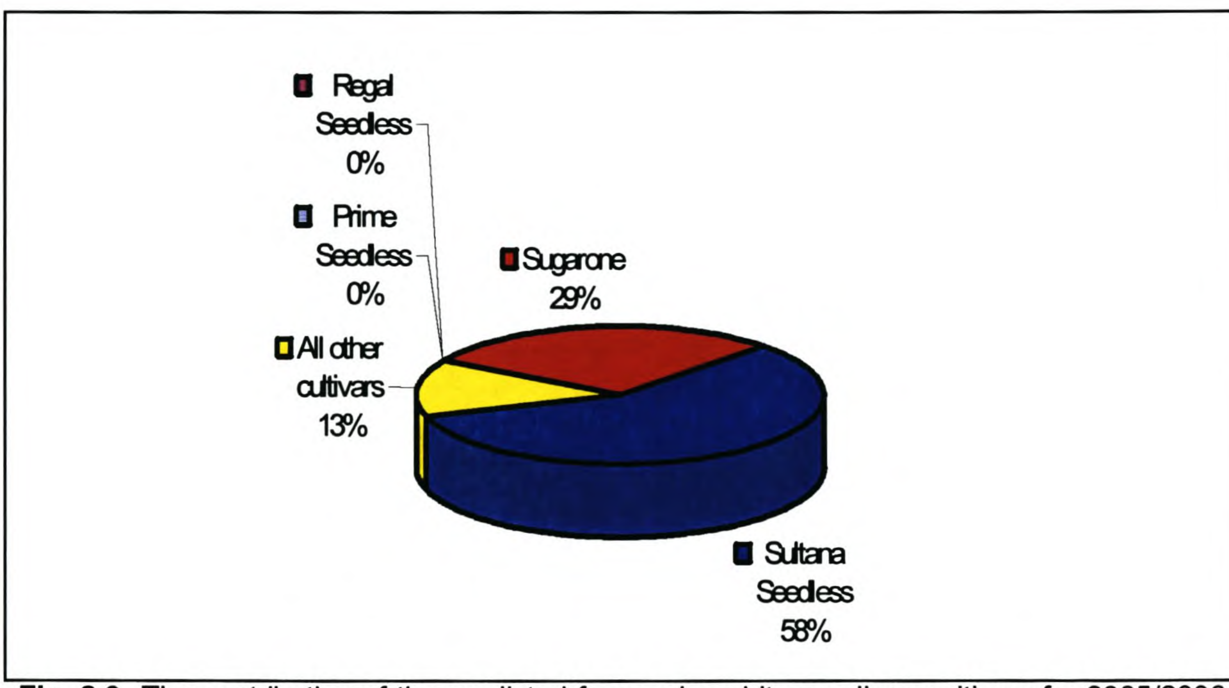


Fig. 2.9 The contribution of the predicted four major white seedless cultivars for 2005/2006 season in the Lower Orange River area in the 1999/2000 season (ORPA, 2002).

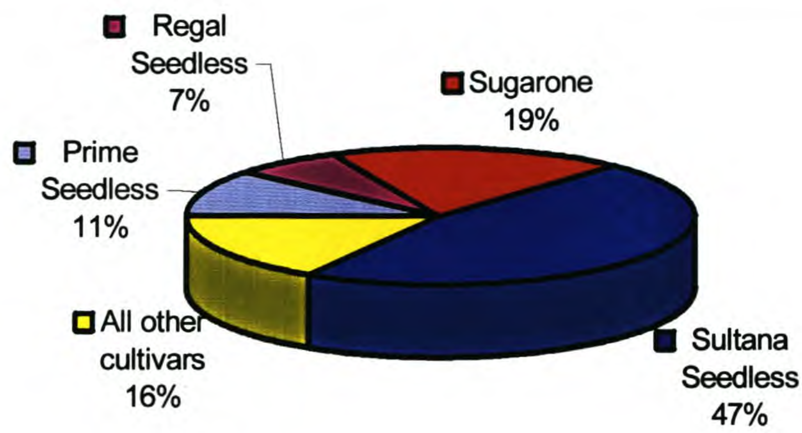


Fig. 2.10 The projected contribution of the predicted four major white seedless cultivars for the Lower Orange River area in the 2005/2006 season (ORPA, 2002).

During the 1999/2000 season, Sultana Seedless and Sugraone contributed 87% to the total cartons exported from the Lower Orange River area (Fig. 2.9). The other cultivar contributions of note were Flame Seedless and La Rochelle. The contribution of the other cultivars, including those of Regal- and Prime Seedless was negligible. According to future predictions, this cultivar profile is steadily changing with Regal- and Prime Seedless being larger contributors to total exports and the contribution of Sultana Seedless and Sugraone decreasing along the Orange River (Fig. 2.10). Of the other cultivars, Flame Seedless will be the major red seedless cultivar in the future, also contributing extensively to total exports from this area. The contribution of the other cultivars will remain relatively small towards total table grape exports. The white seedless cultivars, however, will still be the major contributors to table grape exports from the Lower Orange River.

2.3 THE PRODUCTION OF HIGH QUALITY TABLE GRAPES IN THE AREA

2.3.1 DEFINING THE PRODUCTION AREAS

The Lower Orange River area is at the moment the second largest table grape-producing region in South Africa with more than 5000 hectares of established vineyards in 2001 (ORPA, 2001). Annually, some 700-800 hectares of table grapes are planted in this area, which include both replacement and new plantings (Weksler, 2000). Today the Lower Orange River area stretches from Onseepkans in the west to Groblershoop in the east, spanning a distance of approximately 400 km along the river (Van der Merwe *et al.*, 1997). There are significant differences between the areas covered by this stretch due to variation in elevation, soil type, annual rainfall, chilling units, water table levels and other factors. All these factors influence the timing of the harvest (Weksler, 2000). The western part with its high temperatures (up to 47°C) and low annual rainfall (100 mm and less) are the earliest areas where harvesting commences during middle November. The eastern part with its lower temperatures and higher rainfall starts the harvest later (Van der Merwe *et al.*, 1997). As can be seen from Table 2.5, the Lower Orange River area has been subdivided into an early region (between Onseepkans and Augrabies), middle region (between Augrabies and Kakamas) and a late region (between Kakamas and Groblershoop) according to the main intake weeks of the table grapes in the various districts (De Villiers and Du Plessis, 1999). The various production districts along the river are shown in Fig. 2.11. It is clear that there is a big difference in the average temperatures from week 46 (mid November) to week 4 (mid January), which also corresponds to the maturation dates for the early and late regions (Table 2.5) respectively. If the average monthly temperatures of Augrabies and Upington are compared a difference of 1.0 to 1.2°C between mid November and mid January exists for the two regions.

Table 2.5 Subdivision of the Lower Orange River area into early, middle and late regions according to the main intake weeks of table grapes in the various districts (De Villiers and Du Plessis, 1999).

Region	Main intake weeks	Districts included
Early	Weeks 46-49	Between Onseepkans and Augrabies
Middle	Weeks 50-52	Between Augrabies and Kakamas
Late	Weeks 1-4	Between Kakamas and Groblershoop

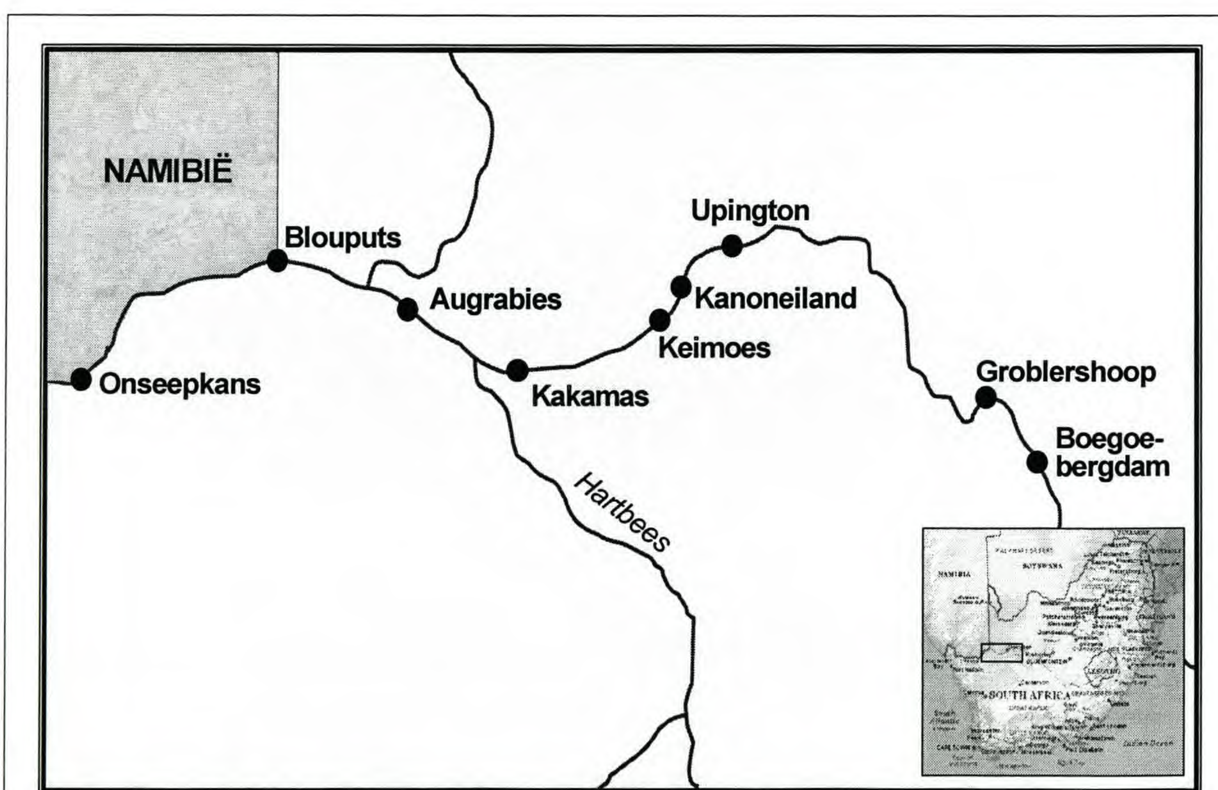


Fig. 2.11 Map showing the location of the various production districts along the Lower Orange River area.

2.3.2 TOPOGRAPHICAL AND CLIMATIC INFLUENCES

The table grape industry is an economic mainstay for the Lower Orange River area, but without irrigation the industry cannot exist, mainly because of the dry climate of this area. The climate not only influences the availability of water, but also the temperature and the type of soil and soil moisture content (De Villiers and Du Plessis, 1999), all impacting on the cultivation of grapes. The dry climate and the high mean summer temperatures of this area ensure early maturity, and consequently better prices on overseas markets when the demand is still high for seedless table grapes from the Southern Hemisphere (Saayman, 1988). The unique climate of the Lower Orange River area with its cold, yet sunny winter days and hot, dry summers combine with the rich soil to produce table grapes of the highest quality. This is some of the reasons why a bright future is foreseen for the table grape industry along the Lower Orange River area.

2.3.2.1 Topography

The Lower Orange River area is located on a plateau with the height above sea level decreasing gradually from east to west (De Villiers and Du Plessis, 1999). Table 2.6 indicate the latitude, longitude and altitude of the important table grape producing districts along the Lower Orange River. The altitude of the Lower Orange River decreases from 853 m at Groblershoop to 610 m above the Augrabies waterfall. Here, the altitude decreases with more than 100 m in the form of a deep ravine, which gradually descents in the direction of Onseepkans and the sea (De Villiers and Du Plessis, 1999).

Table 2.6 The latitude, longitude and altitude of the various table grape producing districts along the Lower Orange River (www.calle.com/world/southafrica, 2001).

District	Latitude	Longitude	Altitude (m)
Groblershoop	28S	21E	853
Upington	28S	21E	822
Keimoes	28S	20E	761
Kakamas	28S	20E	693
Augrabies	28S	20E	610
Blouputs	29S	21E	Not available
Onseepkans	28S	19E	339

The effect of topography on the temperature variability (above and below ground) can be considered one of the main factors affecting the quality of grapes. Temperature generally decreases with increasing altitude in the tropospheric layer. This temperature lapse rate varies with region and season, but the lapse rate can be accepted as being approximately 0.3°C for every 100 m above sea level for South Africa (Carey, 2001). According to this, the average annual temperature experienced by the various table grape-producing districts can also be linked to altitude. Average annual temperature is a very important parameter determining the harvesting date of table grapes in the various regions of the Lower Orange River area. A general decrease in annual summer temperature is experienced with a decrease in altitude from east to west in this area, highlighting the importance topography may have on the ripening of table grapes in the various maturation region of the Lower Orange River.

2.3.2.2 Climate

The phrase 'climate' refers to a complex interaction between a variety of factors such as radiation, temperature, humidity, wind speed, rainfall and evaporation. All these factors have important direct and/or indirect influences on growth, production and production costs of table grapes. A scheme showing the interaction of cultural practices with soil and climate conditions in affecting vine physiology is shown in Fig. 2.12. This figure emphasises that soil, climate and management factors can have 'direct' effects on vine physiology, as well as 'indirect' effects (Smart, 1999).

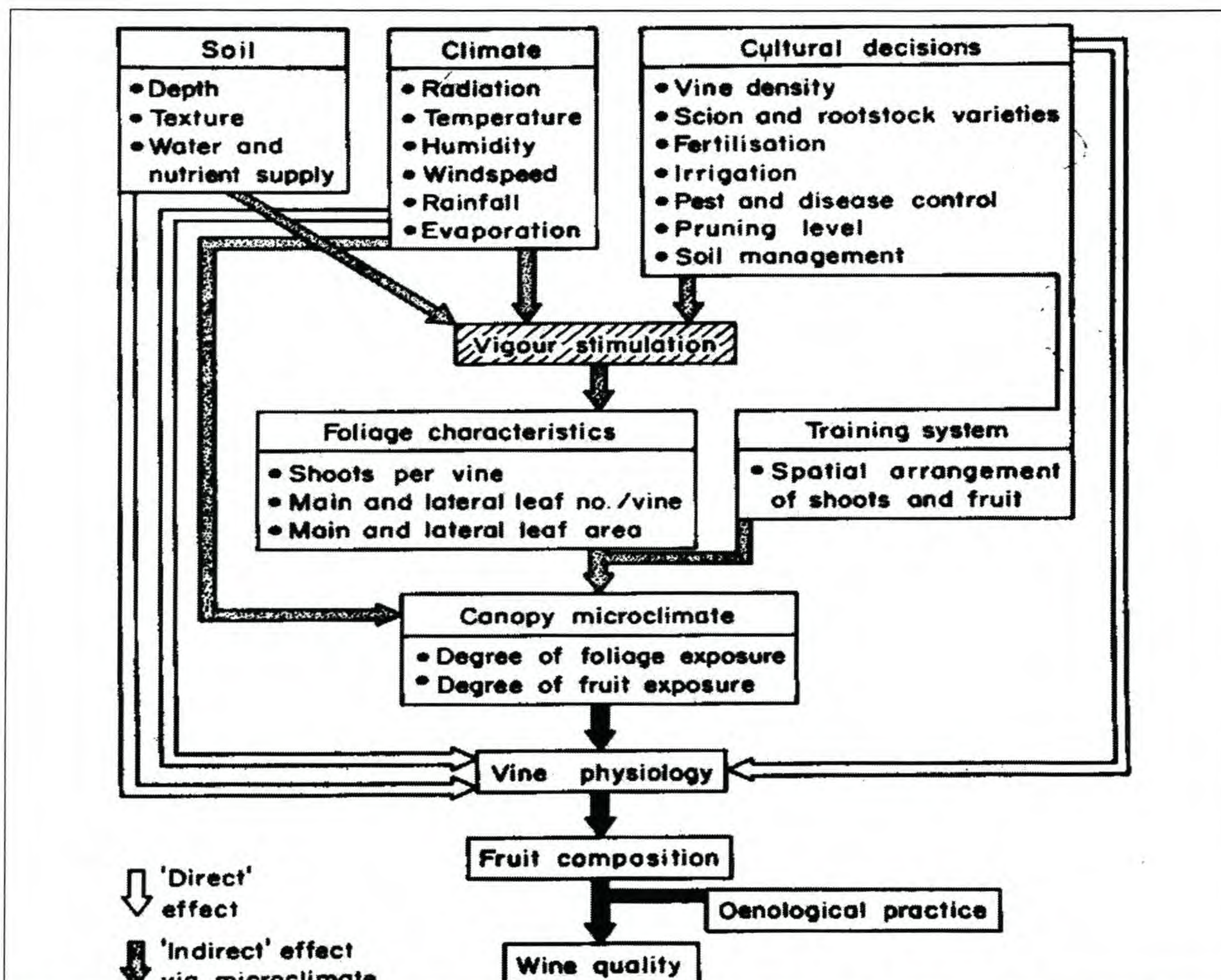


Fig. 2.12 Conceptual model to show how, soil, climate and cultural practices can effect wine quality via effects on canopy microclimate. This model also applies for table grape production but needs alteration for raisins (Smart, 1999).

The influence of climate includes biological, physical, and chemical effects with day-and night temperatures, length of the day and light intensity as very important factors (De Villiers and Du Plessis, 1999). Climatic effects influence vegetative and reproductive growth. The most serious consequence of high rainfall and humidity is an increased likelihood of disease, both above and below the ground (Jackson and Spurling, 2000) and hail is an ever-present hazard in inland areas (Saayman, 1988). According to Saayman (1994), there are indications that the inherent infertility and poor budburst characteristics of Sultana in certain years can be accentuated by the exceptional climate and soil characteristics of the Lower Orange River area. Temperature and rainfall are the most important of the climate variables effecting table grape production either directly or indirectly in the Lower Orange River area, with radiation, humidity, wind speed and evaporation having smaller effects.

Table 2.7 shows the average monthly minimum- and maximum temperature for Upington (late region) and Augrabies (boundary of middle and early region) over an eleven-year period (1990-2000) (South African Weather Service and www.1stweather.com, 2002). January is the warmest and June the coldest month of the year in this area. The average minimum and maximum temperatures for Augrabies are higher through the year than that of Upington. The assumption can consequently be made that the average daily temperature increases from the eastern to the western parts of the Lower Orange River area.

Table 2.7 Average monthly minimum and maximum temperatures of Upington and Augrabies for the period 1990-2000 (South African Weather Service and www.1stweather.com, 2002).

	UPINGTON AVERAGE MONTHLY MINIMUM AND MAKSIMUM TEMPERATURE [°C]		**AUGRABIES** AVERAGE MONTHLY MINIMUM AND MAKSIMUM TEMPERATURE [°C]	
Month	**Minimum**	**Maximum**	**Minimum**	**Maximum**
JAN	20.5	35.8	21.6	37.0
FEB	20.3	35.5	21.1	36.6
MAR	18.5	33.1	19.1	34.0
APR	13.5	29.0	14.6	29.6
MAY	8.6	25.0	9.5	25.1
JUN	4.6	21.4	4.7	21.4
JUL	4.5	21.0	4.5	21.3
AUG	6.4	23.7	6.8	23.9
SEP	10.0	27.7	11.2	28.4
OCT	13.8	30.4	14.3	30.8
NOV	16.2	32.6	16.5	33.2
DEC	18.9	34.9	19.5	36.0
AVE	**13.0**	**29.2**	**13.6**	**29.8**

Vine growth is primarily controlled by the annual temperature cycle of a region. It alone governs vine phenology, i.e. the timing of growth stages and fruit ripening. Sunshine hours directly influence berry sugar levels, but otherwise do not seem to limit except via temperature (Gladstones, 2000). In temperate zones grapevine buds enter endodormancy during summer and is removed during cold weather in autumn and early winter. Thereafter, the budburst will occur if the temperatures exceed certain threshold levels. After budburst, the growth of the shoots is very sensitive to temperature, both day and night. Warm temperatures, up to about 25ºC, will promote growth but temperatures of 30ºC and above are less conducive. Other climatic variables that may vary the overriding influence of temperature on shoot growth are light intensity (high light increases dry matter production), wind (moderate to strong winds inhibit shoot and leaf growth), and humidity (humid air promotes growth). The slowing of shoot growth during mid-summer is due to high temperatures and water-stress created by dry air and dry soils; prolonged shoot growth is a feature of regions and seasons with high air humidity and moist soils. Leaf fall varies with all of the preceding factors that affect shoot growth, but is hastened by low temperatures at the end of autumn (Jackson and Spurling, 2000)

As with vegetative growth, temperature is the overriding climatic factor influencing each of the many components that make up the reproductive development of the grapevine. However, other climatic variables do contribute in varying degrees. The reproductive cycle begins with the initiation of flower cluster primordia during the season before the fruiting year. The whole process is very sensitive to temperature and also to water stress and light impingement on the bud and subtending leaf, these having their effect later in spring. Temperatures during spring also affect the number of flowers formed on inflorescences and the timing of flowering. The temperature during the flowering period is very important. Low temperatures during flowering can cause poor pollen release, pollen germination and growth. Fruit set is especially sensitive to the weather; cold and cloudy conditions, high winds, and weather that create water stress in the vines all reduce berry set. The growth and development of grape berries are altered by climatic factors more in rate than degree. The rapid growth, which follows high temperatures, enables the production of early table grapes. Controlled-temperature experiments have shown that an increase of temperature from 20 to 30ºC has different effects on individual components of a berry. The major effect is the large decrease in malate concentration, while the increase in the sugar level is relatively small. The sugar content of berries increase more when high temperatures are imposed early during berry growth rather than during ripening (Jackson and Spurling, 2000). High average summer temperatures are one of the main factors, which enable the Lower Orange River area to produce early ripening table grapes.

The high summer and low winter temperatures in the Lower Orange River region do cause direct losses from time to time. Heat waves in summer cause direct damage to the canopy and bunches in the form of sunburn, which can be manifested on the berries as different forms of damage. High temperature burns occur when temperatures reach 35-40°C or above; unshaded berries scorch and the exposed side turns brown to black and part of, or the whole berry may shrivel and die. Lower temperatures can also cause burning, especially if previously shaded berries become exposed to sunlight. Berries exposed to continuous sun will display milder symptoms leading to the browning of the skin without cell-death and dehydration (Jackson and Spurling, 2000). Grapes are very sensitive to sunburn just before *veraison* when the acid content of the berries is typically high (Uys, 1995).

The occurrence of frost in vineyards in the Lower Orange River is well known. Frost damage usually occurs more in low-lying vineyards, especially in blocks that are close to the river. Frost does not only cause damage in the active growth stages of the vine, but also in the dormant phase under certain conditions. Buds and phloem tissue are the most prone to frost damage. Younger vines are typically more susceptible to frost damage than older vineyards, because the cork layer that protects the phloem is still not well developed in the former. In extreme circumstances it can lead to irreversible physiological damage or even the death of vines (Ferreira, 1995).

Another climatic factor that impacts strongly on the successful production of table grapes in the Orange River area is rainfall. The average monthly rainfall (mm) over an eleven-year period (1990-2000) for Groblershoop (early region), Upington (late region), Kakamas (boundary of late and middle region), Augrabies (boundary of middle and early region) and Onseepkans (early region) is illustrated in Table 2.8 (South African Weather Service and www.1stweather.com, 2002). The months October to May are the peak rainfall period in the Lower Orange River area with 90% of the annual rainfall occuring in this period. There is a definite drop in the annual rainfall from the eastern to the western parts of the Lower Orange River area. There are however no big differences in the annual average number of days when rain occurs between the different regions of the Lower Orange River area (De Villiers and Du Plessis, 1999).

The negative effects of rain on table grapes in the Lower Orange River area can either occur directly or indirectly. Heavy rain will often cause splitting and consequent deterioration of the berries, especially if it falls in the period between *veraison* and harvest. Heavy rain prior to harvest induces excessive uptake of water leading to berry splitting, as well as the undesirable dilution of berry juice, loose berries, berry rot and residue spots on the berries. Rain during flowering will reduce the ability of inflorescence to achieve sufficient berry-set. The combination of rain and low temperatures seems to be the most damaging at this time, since it negatively affects pollen release, pollen germination and vine growth (Jackson and Spurling, 2000).

Table 2.8 The average monthly rainfall data for Groblershoop, Upington, Kakamas, Augrabies and Onseepkans from 1990-2000 (South African Weather Service and www.1stweather.com, 2002).

Average monthly rainfall (mm) over an eleven year period (1990-2000)					
Month	**Groblershoop** (Late region)	**Upington** (Late region)	**Kakamas** (Boundary of late and middle region)	**Augrabies** (Boundary of middle and early region)	**Onseepkans** (Early region)
January	33.8	37.0	23.9	12.0	14.2
February	30.8	27.5	26.1	18.5	10.9
March	46.8	42.8	29.2	24.3	17.8
April	13.6	12.2	9.5	9.0	9.6
May	12.5	5.1	6.4	3.6	1.0
June	4.5	4.4	3.1	1.0	0.4
July	3.5	6.4	1.9	4.7	5.4
August	1.8	0.9	1.5	1.2	1.2
September	6.3	3.8	7.3	5.7	6.4
October	16.3	17.7	27.1	7.3	2.9
November	16.8	9.4	10.2	11.2	8.4
December	21.9	23.5	34.7	11.6	8.3
Total	**208.6**	**190.7**	**180.9**	**110.1**	**86.5**

The low average annual rainfall of the Lower Orange River with its high summer temperatures makes it the ideal region for the production of table grapes. Big losses due to rain do occur from time to time in this region, especially with the regular incidence of rain during the harvesting period. Hail damage occurs occasionally in the area. Hail can reduce leaf area, damage berries and, as a consequence, increase disease, in turn leading to reduced yield and quality. The use of hail nets in this area is becoming more and more popular. The high prices obtained for the early grapes, fully justifies the costly installation of the hail nets, which besides preventing hail damage, also allow the use of better aerated trellising systems (hail nets protect the canopy and bunches from sunburn) and provide protection against birds (Saayman, 1988).

2.3.2.3 Viticultural disorders linked to the extreme climate

The grapevine (*Vitis vinifera)* prefers long, warm, relative dry summers, cold wet winters, frost-free springs and low to medium fertile soils. Accordingly, periodic physiological disorders may occur in regions where this optimal growing condition, especially climate, does not prevail. As a result of this, growth arrest has been known in the Lower Orange area since the first vineyards were established on the low-lying silty soils. There is significant similarity between growth arrest and dieback of young vines, although the symptoms of the two phenomena may differ. Growth arrest is not regarded as a disease as no pathogens have been linked to the disorder (Van der Westhuizen *et al.*, 2001).

Accordingly, it is certain that growth arrest is a physiological phenomenon associated with the physiological state of the vine. The physiological state of a vine is affected by a combination of climate, soil and management practices. Symptoms of growth arrest may include some or a combination of the following: (i) Die-back within three to four years after planting; (ii) The dieback of canes during late winter, usually between pruning and budburst. It takes place in a downward direction from the pruning wounds. New, strong growing shoots typically develop after budburst from the region under the dead wood; (iii) the trunk of some vines may crack and die; (iv) Long oblate internodes are present; (v) Budburst of shoots are uneven, with dead and/or buds that are not growing; (vi) Budburst is poor in spring (if it takes place at all), or after initial budburst, growth does not continue; (vii) Buds that do burst are dark green with short internodes and no active shoot tips; (viii) Curled leaves and yellowing at the margin of the leaves occur; (ix) Leaves are distorted or rosaceous and the flower clusters are usually dark brown, necrotic or girdled; (xi) Affected vines may grow stronger than normal vines after the arrest period, but not yielding a crop (Van der Westhuizen *et al.*, 2001).

To understand growth arrest of vines, it is important to understand the growth and development cycle of the grapevine during the dormancy (rest phase) period under normal circumstances. For normal winter rest and budburst in the spring, accumulation of efficient nitrogen and carbohydrate reserves in the shoots, trunk and roots are essential in the post harvest period. Environmental temperatures do not only influence the formation, but also the movement of biochemical substances in the vine. Movement of nutrients is usually upwards to the shoot tips at high temperatures and downwards to the trunk and roots at low temperatures. In the post harvest period, this concept plays an important role in the accumulation of reserves in the vine. High night temperatures in the post harvest period increase respiration, which decreases the carbohydrate reserves in the plant (Van der Westhuizen *et al.*, 2001).

Important carbohydrate conversions take place in the wood during the dormant phase. With the commencement of the winter cold, starch is converted to sugars. At the end of winter the opposite takes place in the vine. During the coldest part of the season, the sugar contents of the tissue are high, protecting the vine cells from cold damage. The conversion of carbohydrates from starch to sugar commences earlier in normal vines than is the case with growth arrested vines. With growth-arrested vines, this conversion can take place during and/or after budburst. The phloem of *Vitis* spp. usually stays active for more than one season. If the phloem is damaged by winter cold, the movement of nutrients and biochemical substances are affected negatively over the short term. Cold resistance of shoots is accordingly directly dependent on the reserve status and carbohydrate conversion in the vines. Normal wood aging starts in December/January in the Southern hemisphere, with colouring and ripening of the shoots from their base. Active growth still takes place in the

Lower Orange River area during this period due to the high temperatures and summer rain. The active shoot growth is thus in direct competition with the accumulation of reserves in the shoots, trunk and roots (Van der Westhuizen *et al.*, 2001).

The post harvest synthesised starch is the first source of energy for budburst and growth in spring. Growth takes place during the first four to six weeks after budburst from reserves until efficient new leaves and roots are formed to provide in the nutrient needs of the vine. This usually takes place roundabout flowering of the vines. A vine uses ±50% of its starch reserves from budburst up to four weeks prior to that. Under normal circumstances, the accumulated reserves are enough to provide in the needs of the vines in terms of budburst, shoot and root growth for up to ten weeks. Abrupt cold and/or frost during April and May (vines still have leaves) forces the vine into an abrupt winter rest with the natural process of reserve accumulation not taking place. It is clear that the negative interaction between active aerial parts and passive root growth in spring leads to physiological abnormalities of the vine, also known as growth arrest in the Lower Orange River area (Van der Westhuizen *et al.*, 2001).

Comparing the average monthly minimum air temperatures of Upington with that of Stellenbosch, Vredendal and areas with similar problems overseas (California and Australia), the big temperature difference, as well as the rate of decreasing temperatures between winter and summer in Upington, is prominent. The tempo of decreasing temperatures from March till May for Upington is at least twice as high in comparison with the other regions. Vineyards on the fertile silty soils of the Orange River area still actively grow in autumn and are abruptly defoliated by frost in the active growth state of the vines, affecting carbohydrate accumulation negatively. The variation in climate conditions, but especially the commencement date of frost, is the ultimate factor determining if problems with growth arrest will be experienced in a particular year. High air temperatures during February, March and April will stimulate growth in the post harvest period, especially with adequate water supply to the plant. Rain in this period is a further contributing factor (Van der Westhuizen *et al.*, 2001).

Due to the low night temperatures in spring (August/September), the temperature of the silty, fine textured soils of the Lower Orange River stays low. This has retarding effects on root activity of vines. It is a fact that the most problems with growth arrest are experienced with very cold environmental and soil conditions. Accordingly, producers from Keimoes higher up the river to Groblershoop and Douglas, experience much more problems with growth arrest on the lower lying 'inner soils' than table grape producers on the 'outer soils' from Kakamas to Augrabies (Van der Westhuizen *et al.*, 2001).

2.3.3 SOILS AND IRRIGATION IN THE AREA

The irrigation area from Grobershoop to Onseepkans displays little deviation from the dominant soil form, but can be separated into two main groups: 'Outer soils' and 'inner soils'. The 'inner soils' is found immediately adjacent to the river. The 'inner soils' or alluvial soils are deposited by rivers over many centuries and are regularly found close to existing rivers. This soil form is common in the warmer irrigation areas of South Africa. The 'inner soils' are mainly the Dundee soil form which is composed of deep, dry sandy soil as well as deep, richly stratified, alluvial silt soil. This forms a green valley of fertile soil in the Lower Orange River area with excellent potential for table grape production (De Villiers and Du Plessis, 1999). This soil is, however, highly stratified and poses problems with the penetration of water and roots into the ground. Effective soil preparation is consequently very important to increase the productivity of the 'inner soils'.

The 'outer soils' comprises mainly of deep, red sandy soils that's limy, with medium to coarse sand. The silt and clay percentage can vary from zero to six percent. The underlying layers typically comprise rocks and granite. Granite soils are found widely in the region between Kakamas and Augrabies. With the necessary soil preparation and irrigation, it is converted into high potential land for table grape production (De Villiers and Du Plessis, 1999). It has been shown that the red sandy soils, commonly occurring outside the dark, fertile alluvial terraces along the river, enhance maturation of certain table grape cultivars so significantly that it can be supplied to the European market early in November (Saayman, 1988). There is a difference of approximately two weeks in the time of ripening between the inner, heavier and the outer, sandy soils (De Villiers and Du Plessis, 1999).

Phylloxera virtually destroyed all the vineyards of South Africa at the end of the 19^{th} century and is still a problem in the soils of the Lower Orange River area. Phylloxera is as a rule more destructive in heavier soil forms, although this problem is also experienced in the 'outer soils' of the Lower Orange River. Nematodes also cause problems in Lower Orange River area, especially in lighter more sandy soil forms, whereas *Phytophthora* (Loubser and Uys, 1997) is prevalent in the heavier, wet soils. The Orange River is the sole provider of water for table grape irrigation in this area. According to the Department of Water Affairs, the water of the Orange River is of high quality and monitored on a regular basis (De Villiers and Du Plessis, 1999). A very high evaporation figure is experienced in the Lower Orange River area because of the relative low humidity and high temperatures. The annual evaporation for Upington is 3728 mm – 20 times more than the average annual rainfall. The low rainfall and high evaporation in this area emphasise the importance of irrigation water from the Orange River. A variety of factors determine the water requirement of table grapes, such as climate and cultivar. A shortage of water in the flowering period affects fruit set and quality negatively, whereas excessive water leads to poor colouring, delayed maturation and excessive vegetative growth (De Villiers and Du Plessis, 1999). Water is predominantly applied via micro sprinklers (Weksler, 2000), but drip irrigation systems are also being used. A small portion of vineyards along the river is still being flood irrigated, but water use limitations will soon bring an end to this method. Both the quality and amount of water reserved for irrigation in the Lower Orange River area is at the moment sufficient for the agricultural use and other sectors. It is, however still water and not soil, that is the limiting factor in expansions along the Lower Orange River area (De Villiers and Du Plessis, 1999).

2.3.4 UNIQUE CULTIVATION AND POST HARVEST PRACTICES IN THE AREA

Farmers along the Lower Orange River have adapted their cultivation practices from the normal used in other table grape regions (with regards to canopy management, hormone treatments, etc.) to accommodate the unique climate and soils of this region to produce high quality table grapes.

2.3.4.1 Forced dormancy (rest phase)

Irregular and patchy budburst of grapevines, mainly in regions with mild winters, often creates significant economic and viticultural problems. The state of dormancy forms an important part of the annual cycle of deciduous woody plants in temperate climates. This cycle is characterised by the change of periods during which the plant is (i) in full leaf and with apical meristems in the course of producing new leaves, (ii) is in full leaf, but with either quiescent shoot tips (on shoots with terminal buds) or with abscised shoot tips (on shoots without terminal buds, as in *V. vinifera*), and (iii) is without leaves, i.e. dormant. Dormancy of buds is defined as "partial or growth dormancy", a term used for the dormancy of organs "which experience temporary cessation of growth, while metabolic processes including respiration continue" (Lavee and May, 1997).

Various terminologies have been used to describe the sequential changes occurring in buds from their major growth cessation to resuming growth in the following spring. The dormancy of buds was divided into three separate and physiological different periods: para-, endo- and ecodormancy. A more detailed and dynamic subdivision of the whole dormancy period in grapevine buds was proposed with the following sequence: pre-dormancy – entry into dormancy – dormancy – lifting of dormancy – post dormancy. However, dormancy of grapevine buds passes from one phase to the next in such a diffuse way as to make it unwise to relate the name of each phrase (para-, endo- and ecodormandy) to its physiology. Accordingly, it may be better to speak of pre-dormancy, dormancy and post dormancy, thus emphasising the dynamic processes of dormancy development and dormancy release. Fig. 2.13 is a schematic description of the dynamics of the annual growth cycle of the grapevine in relation to shoot growth and bud dormancy (Lavee and May, 1997).

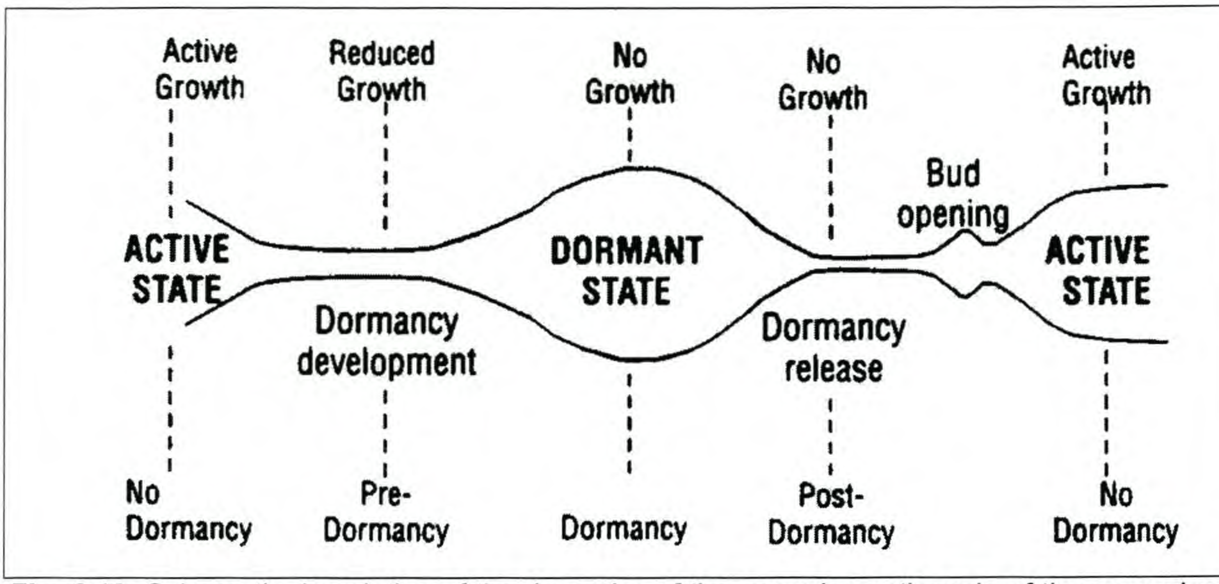


Fig. 2.13 Schematic description of the dynamics of the annual growth cycle of the grapevine in relation to shoot growth and bud dormancy (Lavee and May, 1997).

The onset of dormancy (pre-dormancy) corresponds to imposed dormancy and ecodormancy. As this dormancy starts to set in, the potential resumption of active bud growth by environmental stimuli is gradually reducing. Although the bud could still grow within rather wide limits of external conditions and inducers, growth usually does not proceed because of (i) physical or chemical conditions external to the bud, (ii) restriction by enclosing bract tissues, and (iii) correlative inhibition. Following the state of pre-dormancy, when growth is prevented mostly by correlative inhibition, a dynamic process is leading the buds to a phase when growth can no longer be induced by removing correlative inhibition. In general, this state of dormancy may be regarded as the evolutionary response of the perennial plant to conditions of temperate climate zones. Here, the environmental conditions prevent the survival of leafy tissues during part of the year. Differentiated stages of intensity of 'true dormancy' have been identified, namely (i) relative dormancy where growth can still proceed but only when external conditions are within a narrow, optimal range, (ii) true dormancy where growth is no longer possible whatever the external conditions, and (iii) induced dormancy which is genetically based cessation of growth that cannot be prevented or modified by external conditions. Growth inhibition is never absolute and some buds open without intervention of assumed chilling fulfilment or any artificial dormancy breaking, although usually after a long period of time. The amount of information gathered on the metabolic changes occurring in buds during dormancy is considerable. Their possible involvement in the progress of dormancy has been suggested. For some substances, the existence and extent of the involvement is well documented; for others, they are not yet proven and further investigation is needed to verify the validity of the hypotheses (Lavee and May, 1997). Physiological changes during dormancy won't be further discussed in this section.

Many studies have been conducted on the effect of chilling to release the buds of deciduous plants from the state of dormancy. It is generally accepted that chilling is essential to terminate this state of dormancy and to allow normal budburst. Certain studies have, however, showed that the requirement for chilling may not be obligatory to break dormancy in all grapevine varieties and that chilling has a quantitative rather than a qualitative effect. In its absence, and without other dormancy breaking measures, grapevine buds will show limited, uneven and delayed budburst. Many studies were performed to quantify the optimal amount and timing of low temperatures leading to dormancy release. In most fruit trees, high temperatures (above 20°C) following chilling reduce and even reverse the chilling effect. A multi-stage metabolic process based on stages reversible and non-reversible by heat was suggested (A↔B→C→...). The initial step involves a pathway induced by chilling (A→B), but found to be reversible (A←B) by high temperatures (>20°C). When B overshoots a critical level it is transferred further along the pathway. Whatever amount is below that level is degraded or converted back to the compounds typical of stage A. The specific reactions in this chain of events have not yet been characterised (Lavee and May, 1997).

As mentioned earlier, the moisture content of grapevine buds drop from 80% to about 50% as they enter the state of dormancy. When buds start to grow at the end of the post-dormancy period, the moisture content raises rapidly. The water relations of dormant buds have been studied using nuclear magnetic resonance (NMR) imaging. No water excitation in unchilled buds of apples could be found. After chilling, clear images due to water excitation appeared, and they were in direst relationship with the chilling requirements of the different varieties being satisfied. These images were interpreted as resulting from the transfer of bound water to a free form. Similar results were recently reported for grapevine buds of *Vitis* species during photoperiodic induction of dormancy although the results were not as clear-cut as in apples. An effect of supra-optimal high temperature on breaking dormancy in grapevines has been found. It appears as if the high temperatures may either prevent the onset of dormancy (as probably in the tropics) or replace the effect of chilling by activating an alternative pathway (Lavee and May, 1997).

These are important factors to consider in grape producing regions with high autumn and winter temperatures, such as the Lower Orange River area. Special measures should be taken to ensure a decent dormancy (rest) phase, resulting in good and even budburst in the following spring. Normal leaf abscission takes place in the middle to late maturing areas (area between Groblershoop and Augrabies) of the Lower Orange River due to decreasing temperatures in late autumn and early winter. The early maturing areas of the Lower Orange River (area between Augrabies and Onseepkans) have higher average winter day and night temperatures. The vines continue to grow strongly after harvesting and this may continue well into the winter period. The leaves have to be removed if natural leaf abscission does not take place (Anon., 1996a). Leaf fall varies with all of the preceding factors that affect shoot growth, but is hastened by lower temperatures and soil-water regimes at the end of autumn (Jackson and Spurling, 2000). As a first step to force the vines into dormancy, they receive less water from February onwards. Depending on the pruning date, the leaves are removed with a low concentrate herbicide that only attacks the green leaves (Anon., 1996a).

2.3.4.2 Evaporative cooling

In the subtropics (mean temperature of coldest month between 13 and 18°C, and occurrence of light frost) the day/night temperature variations are much greater in temperate regions and high day temperatures (>16 and especially >19°C) have an adverse effect on chilling accumulation. In the Blouputs valley of the Lower Orange River area, where early table grapes are produced two weeks before the Upington area, yield of Sultana Seedless grapes was reported to be much lower than at Upington in certain years (Allan and Hattingh, 1998). The best yields in the Lower Orange River have been attained around Upington (late region) where good growers can expect yields of 3000-4000 cartons per hectare. From the Blouputs valley to Onseepkans, below the Augrabies falls, the grapes mature earlier, but yields can be low following mild winters. In some years the yields in this early region can be only 25-40% of those at Upington. It was suggested that this could be due to insufficient winter chilling as a result of the adverse effects of high daytime temperatures in winter (Allan, 1999).

It has been shown that temperatures above 19°C in winter cancel the benefit of night temperatures below 12°C, which promote the accumulation of winter chilling and is essential for good bud break and flowering the following spring (Allan, 1999). Evaporative cooling (EC) of plants by overhead sprinkling has been shown to reduce temperatures of plants by up to 13°C. Intermittent sprinkling, during the heat of the day in winter, can supplement winter chilling by EC of the buds. Studies showed that overhead micro-sprinklers decreased the temperatures of exposed and shaded grape buds, in the Jordan Valley in Israel, from 30 and 25 to 15 and 13°C, respectively (Allan and Hattingh, 1998). Allan *et al.* (1994) showed that kiwifruit buds, at Pietermaritzburg, could be kept at a fairly constant temperature of around 17°C, during the heat of the day, by overhead sprinkling with short ON and OFF times (15 s ON and 1 min + OFF), when air temperatures were about 25°C and dry buds were around 32°C. Erez (1995) stated that whenever night temperatures reach 12°C or lower, chilling will accumulate if day temperatures are kept below 19°C. Dormex® application was shown to be crucial as a follow-up spray after EC, to give good bud break and flowering in kiwifruit (Allan *et al.*, 1994). The synergistic effect of EC for about six weeks, followed by Dormex® application, resulted in the production of greater crops of both low and high chill kiwifruit cultivars.

In May 1996 an experiment on EC of Sultana Seedless was initiated on a farm at the western end of the Blouputs valley. Variable ON/OFF times of sprinkling in three blocks were controlled at temperatures above 18°C by an electronic controller. The results were promising with earlier and improved bud break and 18% increase in the number of bunches produced during the early, high priced period in November (Allan and Hattingh, 1998). Effective EC can maintain bud temperatures at around 17-19°C during the day, and with night temperatures around 3-9°C. Much better chilling accumulation is achieved with this method. However, both in 1996 and in 1997, the winters were unusually cold, and yields of control plants were also fairly good. In contrast, the winter of 1998 was exceptionally mild, and the response to EC was outstanding. An average of eight bunches of grapes were produced per cane under EC compared to three bunches in the control plot. This allows much greater choice during the bunch thinning process to leave the best, well filled bunches to mature large grapes. Hydrogen cyanamide (Dormex®) is applied routinely early in July by grape growers to promote good bud break. The combination of EC and Dormex® raised bud break to over 80%, compared to 50% for Dormex® alone, and 0% without any treatment. As a consequence of the good results achieved with EC, this system is applied on a large scale on table grape farms in the Lower Orange River area (Allan, 1999).

While the cost of installing and operating an EC system are high, it appears that increased production, during the early season, high priced period, could justify this expenditure for a high value crop. The cost of installing an extra pipe, with min-sprinklers and pressure regulators, above the trellis rows for EC, is estimated to be about R10 000 per hectare, plus the cost of a suitable controller and booster pump if necessary. For accurate supplementation of winter chilling it is necessary to ensure even wetting of buds. The actual temperatures of both wet and dry buds should be measured throughout the time of intermittent overhead sprinkling, and additional amount of chilling accumulated should be calculated. Relatively short ON and OFF times, to maintain bud temperatures at a fairly constant temperature, are better and mini-sprinklers gave more even distribution of water than large, impact-type sprinklers (Allan and Hattingh, 1998).

2.3.4.3 Prevention of frost damage

Grapevines are very sensitive to frost damage from bud swell up to 45 days after budburst. Frost during this period can lead to major harvest losses, especially in the middle and late regions of the Lower Orange River where frost occurs regularly in this period. Frost damage can be eliminated with overhead irrigation during cold nights. The continued water from the overhead irrigation system prevents ice forming on the vines (Lochner and Jooste, 1997). It is very expensive to install, but saves table grape farmers in areas with a high incidence of frost, huge sums of money in the long run. Some farmers prevent frost damage by lighting oil in cans, which are distributed evenly through the vineyard. The smoke from the oil forms a layer eight to ten meters above the vineyard, trapping the warm air underneath it and preventing cold air from penetrating from above. This method can unfortunately only be used on a small scale and is not environmentally friendly (Lochner and Jooste, 1997).

2.3.4.4 Application of rest-breaking agents

Research pointed out that by using dormancy-breaking substances such as hydrogen cyanamide (HC) in mid winter, the late winter and early spring temperatures of the Lower Orange River area are adequate to maintain the advantage of early budding, consequently advancing the ripening date (Saayman, 1988). Although bud dormancy has been the subject of many physiological studies, little is known about the mechanisms of bud dormancy induction and release or their control. Release from endodormancy might begin with the perception of a signal by the plant, upon exposure to chilling temperatures or following the application of alternative dormancy breaking means. It would then be followed by transduction of this signal via a cascade of biochemical events to the stage where it releases repression of bud meristem activity. HC has been found to be the most useful dormancy-breaking agent for grapevines and other deciduous fruit, and its use provides bud materials having relative uniform response. The mechanism by which HC exerts its dormancy-breaking effect is not clear, but it has been shown to inactivate catalase in grape buds shortly after its application, leading to the accumulation of hydrogen peroxide and the development of oxidative stress (Or *et al.*, 2002).

Other than the role of catalases in controlling the level of hydrogen peroxide in the cell, little is known about their function during stress conditions. Recent findings indicate that heat shock leads to a reduction in catalase level and significant increase in hydrogen peroxide. Salicylic acid (SA), a signal for the activation of plant defence, has similar effects. Similarly, at least some of the effects of low-temperature stress in plant systems have been shown to be mediated by reactive oxygen species. Therefore, the generation of active oxygen species during stress, particularly hydrogen peroxide, has been hypothesised to be part of the signalling cascade leading to the plant response. The steps in the transduction pathway from HC-induced stress to dormancy release are unknown (Or *et al.*, 2002).

The degree of response of HC is usually related to the grape cultivar and depth of dormancy. Budburst in grapevines by HC was found to be dependent both on concentration and time of application. Late applications, especially at high concentrations, may result in damage to the buds and delay budburst (Lavee and May, 1997). Table grape producers of the Lower Orange River area routinely apply HC in early July, four to six weeks prior to budburst, to promote good bud break. In grapevines, a significant enhancement in time of budburst and an increase in the numbers that opened were achieved, particularly when evaporative cooling was combined with the applications of HC (Lavee and May, 1997). Dormex ® application insures more uniform growth of cultivars with uneven budburst problems and increases the number of bunches produced. This allows much greater choice during the bunch thinning process to leave the best, well filled bunches (Smit and Burnett, 1986).

2.3.4.5 Pre-cooling of table grapes

Seedless table grapes, like Sultana, are very sensitive to heat and handling during warm conditions. This can lead to quality defects, such as withered and dry stems. In the Lower Orange River region, summer day temperatures can reach up to 45°C. Producers have to do everything in their capability to avoid the negative effects of heat. Consequently, it's a general practice to harvest grapes early in the morning while the temperature is still low and start to cool the harvested grapes immediately. All the workers help with harvesting of the grapes in the cool early morning. Harvesting stops round nine 'o clock in the morning and all grapes have to be in the pre-cooling chamber by this time. Every table grape packaging house in the Lower Orange River is equipped with a pre-cooling chamber to decrease the temperature of the fruit before packaging. In addition, the grapes are picked in white crates, since it absorbs less heat than black crates (Anon., 1996b).

Two types of pre-cooling can be used: Conventional gas-cooling and evaporative cooling. Evaporative cooling is very effective in the warm, dry climate of the Northern Cape and is therefore generally used in pre-cooling chambers. The pre-cooling chamber is usually part of the table grape packaging house. In the outside walls of this chamber, special panels are built in with water circulating through them. Fans on the inside of the pre-cooling chamber suck air from the outside of the chamber over the panels to the inside. Evaporation of water on the panels takes place, causing the temperatures to drop inside the pre-cooling chamber. A maintained temperature of 16-17°C is optimum for pre-cooling chambers (Anon., 1996b). Cooling of the packinghouse itself is also the rule in the Lower Orange River area.

2.3.5 PROFITABILITY OF TABLE GRAPES IN THE VARIOUS REGIONS OF THE LOWER ORANGE RIVER AREA

With table grape cultivation along the Lower Orange River, the emphasis lies on the grapes ripening as early as possible in order to obtain the highest prices by supplying the overseas markets early in the season. The effect of temperature on the supply of table grapes from the various areas (early, middle and late) is very obvious if the maturation dates are compared and referenced to the temperature differences in the different regions. The difference between the early regions and late regions can be up to ten weeks (De Villiers and Du Plessis, 1999). The maturation date of table grapes in the Lower Orange River plays an important role in determining the price of the fruit on overseas markets. Figs. 2.14 and 2.15 depict the percentage supply and the price received per carton for each week (of the cultivars Sultana Seedless and Sugraone, respectively) and it is clear that huge differences exist between payments for the same cultivars in the three regions of the Lower Orange River.

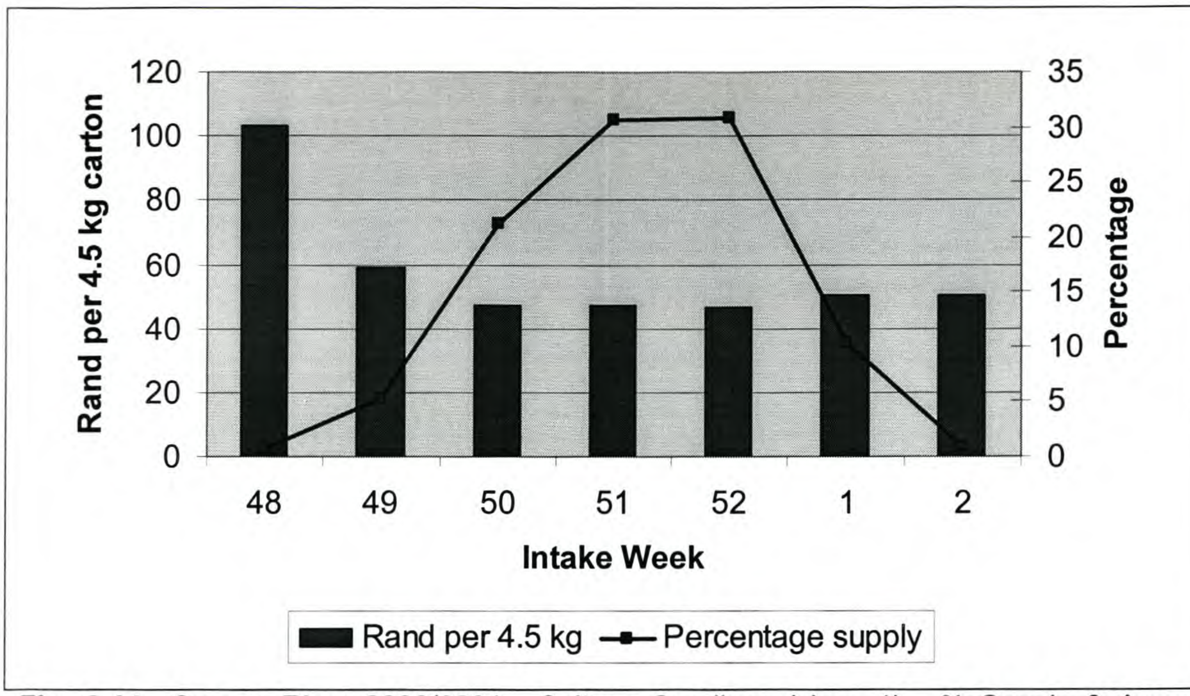


Fig. 2.14 Orange River 2000/2001: Sultana Seedless (class 1) - % Supply & Average payment (R/kg) (Frudata S.A., 2001).

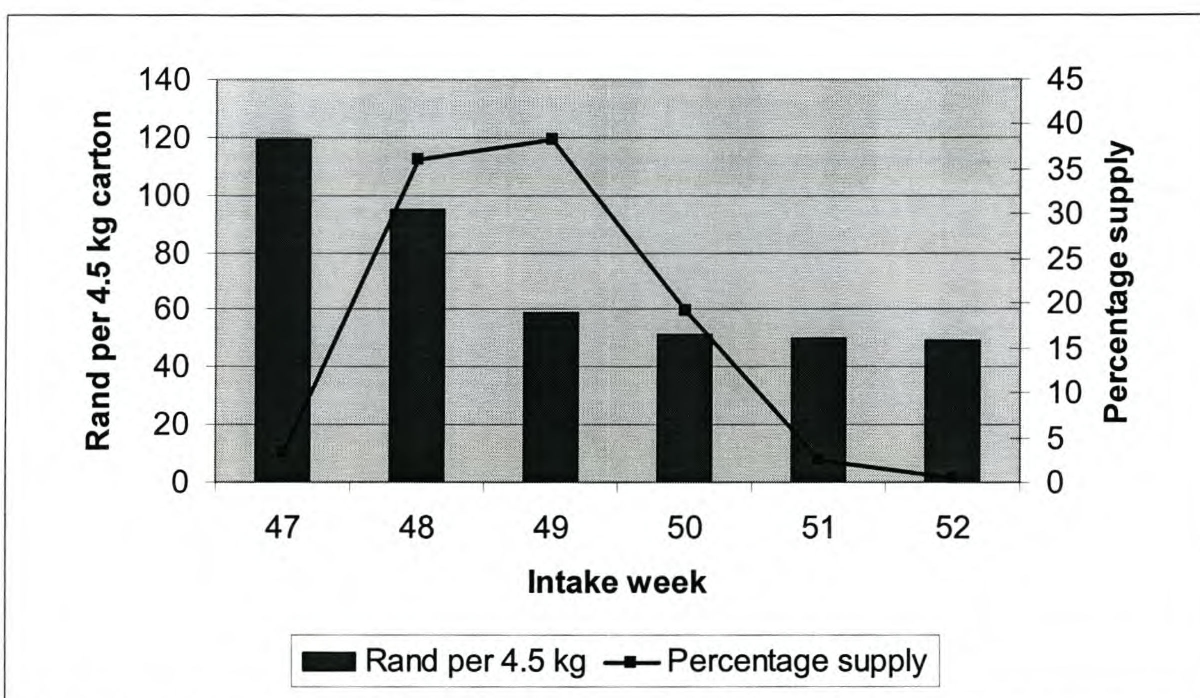


Fig. 2.15 Orange River 2000/2001: Sugraone (class 1) - % Supply & Average payment (R/kg) (Frudata S.A., 2001).

During intake weeks 46-49 (maturation date for the early region), the supply of table grapes is still low. The high demand for table grapes on the markets ensures very good prices of the fruit in this period. There is a dramatic drop in price from weeks 50-52 (maturation date for the middle region) onwards because there is an increase in the supply of grapes on the markets with a demand that stays the same. When the supply of a certain cultivar decreases later in the season, an increase in price may occur. This will only happen if there is a demand for that specific cultivar. After the price drop (weeks 50-52), the price stabilises, ensuring relatively constant prices for grapes received during intake weeks 1-4. The average price that is achieved during a certain intake week is determined not only by demand and supply, but also by the cultivar and quality of the product.

The early regions of the Lower Orange River has the advantage above the later regions in that it can supply grapes to the overseas and local markets early and ensure high prices for their product (De Villiers and Du Plessis, 1999). It doesn't however mean that their profitability is higher than the middle and late regions. As already explained in the section 2.3.4.2, the best yields have been attained around Upington (late region). The adverse effects of high daytime temperatures during winter in the early regions cause the yields in this area to be much lower than in the middle and late regions of the Lower Orange River (Allan, 1999). With their higher yields and lower prices, the middle to late regions can be more profitable than the early regions. Profitability is determined not only by harvesting date but also by cultivar (consumer preference), yield, input costs and quality of the product. To ensure good profits, a balance between these factors is of highest priority.

2.4 THE PREDICTED FOUR MAJOR WHITE SEEDLESS CULTIVARS OF THE FUTURE, THEIR CHARATERISTICS AND "BEST POSSIBLE PRACTICES"

Due to the present limited occurrence of Prime- and Regal Seedless, very little is known on how they will compare with the other popular cultivars such as Sultana Seedless and Sugraone regarding production aspects as well as long-term viability and cost-effectiveness. It is, however, expected that they will contribute extensively towards total exports from this region in the future. Although the contribution of the well-known white seedless cultivars such as Sultana Seedless and Sugraone is expected to decrease in the Lower Orange River area, these cultivars will still be the major shareholders of total exports from this region in the future. Sultana Seedless will probably continue to be the major white seedless cultivar of the Lower Orange River area.

2.4.1 SULTANA SEEDLESS

Sultana (Sultanina or Thompson Seedless) has been known in South Africa before 1926 and originated from Anatolia. In 1973 three clones of Sultana were imported from Australia with clone H5 being the best in the industry (Saayman, 1986). In its natural state, Sultana is a very vigorous, relatively infertile grape cultivar, yielding on average about 20-25 t/ha (Orth and Saayman, 1990). Bunches are large, conical shaped and compact, but the seedless berries attain a mean mass of only about 1.5 g. For export, a relatively loose bunch of 600 g to 700 g and a minimum berry size of about 3.3 g (varies from exporter to exporter) are required to be marketed as Sultana Seedless (or Thompson Seedless). To qualify for more prestigious categories, the berry size needs to be even bigger. To attain this berry size, the crop load must be regulated and the flower clusters and young bunches must be treated with the natural occurring plant hormone, gibberellic acid (GA), in a very precise manner. These measures must further be augmented by viticultural practices, which will lead to not only adequate berry size, but also the desired cosmetic, eating and keeping qualities of the grapes (Orth, 1990).

At present, Sultana Seedless vines established along the Lower Orange River are in most cases grafted onto rootstocks. Farmers in this region adapted this practice after they experienced problems with soil born pests such as phylloxera, nematodes and phytophthora that caused lower yields and quality of their table grapes. Ten rootstock cultivars are commonly used of which Richter 99, Ramsey, Richter 110 and 143 B-Mgt make up 91% of all plantings. As a rule Ramsey is used only on poor or extremely sandy soils as rootstock for Sultana Seedless (Loubser and Ellis, 1995). With its inherent vigour and excellent resistance to nematodes and phylloxera, this rootstock performs well on low potential soils. In combination with the vigorous growth of Sultana Seedless, Ramsey or Richter 99 may induce excessive growth on high potential, silty river soils, leading to too dense foliage, reduced fertility, a high incidence of fungal disease and a general lower quality. Richter 99 is recommended for Sultana Seedless on medium potential soil. On silty, high potential river soils, the rootstock 143 B-Mgt is generally recommended. It performs well on the "inner" silty soils of the Lower Orange River area (Loubser and Uys, 1997).

In the past the T-structured trellising system was widely used. Very dense canopies and infertility was experienced with Sultana Seedless when using this trellising system. As a result of the high temperatures and generally favourable growing conditions in the Lower Orange River, larger trellising systems is now commonly used to accommodate the vegetative growth of Sultana Seedless. Slanting-, Double Slanting- (Gable), Factory-, Trentina -and Roof trellising system are commonly used. These systems allow a leaf surface of approximately 85% of soil surface to make optimum use of sunlight, while still providing protection against sunburn (Loubser and Ellis, 1995). The Double Slanting (Gable) trellising system is however the most popular system used along the Lower Orange River area.

Sultana Seedless is one of the few table grape cultivars that require cane pruning. Cane pruning is necessary because the buds at the base of the cane are not sufficiently fruitful to produce a full crop. The most fruitful buds are those from the fifth through the twelfth position on the cane. Usually the canes are left 15 buds long, sometimes longer if the distance from the crown of the vine to the wire is so great that tying a shorter cane would be difficult. The number of canes retained varies from four to six depending upon the history of fruitfulness in any particular vineyard. Occasionally, more canes may be left with exceptionally low fruitfulness but eight canes per vine are near a maximum (Jensen and Peacock, 1997). More important than the number of canes is the quality of the canes. Sultana Seedless canes require a high light exposure to be fruitful. In addition to the usual four to six canes, spurs are left on the crown of the vine in order to produce canes for next year's crop. There is no set number to leave, usually two to four are chosen. The canes are tied to a wire by twisting around the wire and tying with twine or a paper coated wire (Jensen and Peacock, 1997). Evaporative cooling in areas with insufficient winter cooling from 60 days prior to pruning is recommended to ensure even and a high percentage budburst in spring. Hydrogen cyanamide is applied routinely at 3-5% (v/v) concentration during July to ensure early and even bud break. HC also ensures a higher budburst percentage (more bunches) and earlier maturity dates (Smit and Burnett, 1986). The HC is applied either by spraying (high volumes of up to 1300 L/ha) or by brushing the buds with a sponge.

Shoots of Sultana Seedless should be spaced on the trellis wires in order to ensure even spacing and good positioning of bunches. Fruit bearing shoots are tied down to the trellis wires. All excessive non-bearing shoots are removed to ensure adequate air and light penetration. Enough shoots should be left to protect bunches from sunburn and high temperatures which causes a lack of response to GA treatments. Only leaves in contact of bunches are removed (Orth, 1990).

A too heavy crop not only delays maturation of Sultana Seedless grapes but also reduces the berry enlargement effect of GA. With a mean budding percentage of 60%, a fertility of 0.5 bunches/bud and 8 canes/vine, a single vine can still bear at least 36 clusters (Orth, 1990). If cluster number is in excess of 36 per vine on medium to vigorous vines, or in excess of 24 on weaker vines, then flower cluster thinning is done. If there are excessive numbers of clusters, then the clusters chosen for removal are small ones, those excessively straggly or compact and those on weak shoots. When these are eliminated and there are still excessive clusters, then the clusters are simply spaced out. With thinning, clusters are straightened to hang freely. It is a fast and inexpensive way of cluster reduction (Jensen and Peacock, 1997). The recommended crop load is 20 bunches/vine or 36 000 bunches/ha for Sultana Seedless. Only one cluster per shoot should be retained, usually the basal one, as the apical clusters tend to be of inferior quality. Strict crop control is necessary to ensure superior grape quality according to Orth and Saayman (1990).

Sultana Seedless set a fairly tight cluster. When the berries are enlarged by girdling, GA treatment and thinning, clusters can become very compact. GA applied during bloom will decrease set, usually about 30% although the benefit varies from year to year. The GA spray has additional effects on berry shape and weight. The berries are elongated and enlarged by this treatment (Jensen and Peacock, 1997). Sultanina usually flowers unevenly on the same vine and also between vines. To compensate for this, more than one GA cluster thinning is required in order to catch all the clusters at the correct stage. The first thinning treatment of 10-ppm GA must be applied when the mean flowering percentage of the top part of all clusters is about 50%. A second treatment of 10-ppm is applied (Fig. 2.16) when the mean flowering percentage reach 80% (Wolf *et al.*, 1991). This second treatment is usually 4-7 days after the first treatment depending upon the uniformity of bud break and the temperature during bloom (Jensen and Peacock, 1997). Fig. 2.17 shows the effect of time of GA treatment on the numerous responses shown by grape bunches and berries (Cirami *et al.*, 1999). As can be seen from Fig. 2.17, correct timing of GA applications is essential to acquire the anticipated thinning effect of the flower clusters. Clusters can either be sprayed with hand held spray guns, directed spray booms, spraying machines or applied by dipping of the bunches in a GA solution. A spray volume of at least 2000 litres/ha is recommended for spraying machine applications. Dipping can save large quantities of GA, but this method is more laborious and may take too long to complete in large vineyards within the short, critical thinning period during flowering. GA treatments should be carried out during the cool period of the day or at night to ensure longer periods of contact (Orth, 1990).

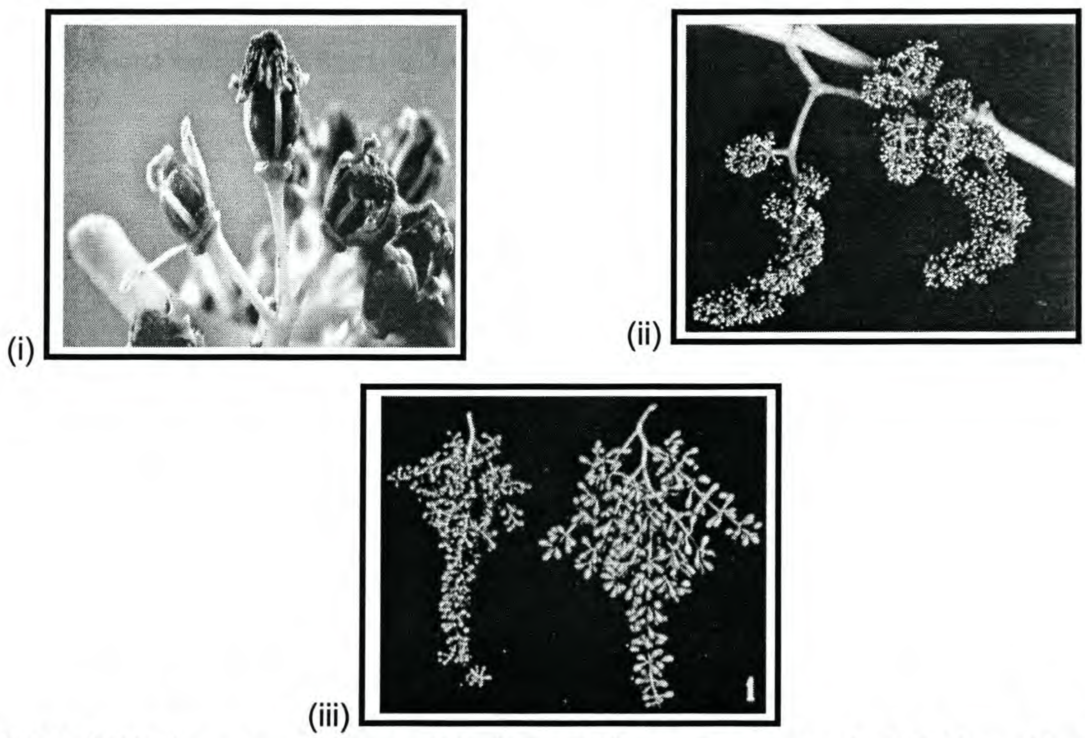


Fig. 2.16 (i-iii) The use of GA for thinning and berry enlargement of Sultana Seedless (Wagener, 1984). (i) Beginning of capfall. (ii) 80% capfall. (iii) The effect of GA application during flowering; treated (left) cluster on the right.

Approximately 10 to 14 days after full bloom, 3/4 of the ovaries fall off, a process called shatter. When shatter has been completed, fruit set has been reached. The ovule has been pollinated, fertilised and is now called a berry. Usually, the berry diameter is 4-5 mm at this point although this diameter can vary depending on the time that shatter occurs, sometimes being slightly larger than 4-5 mm. Not all clusters reach this stage at the same time. From a commercial standpoint, the fruit-set stage (also sometimes called the completion of shatter) has been reached when 95% of the clusters have completed shatter (Jensen and Peacock, 1997).

GA applied after berry set is mainly responsible for ultimate berry size, but again, the correct timing and concentrations are of utmost importance (Figs. 2.17-2.18). Depending on climate and experience, a maximum of three sizing applications should be made (Orth, 1990). The first application of 30-ppm GA must be applied when the mean berry diameter of about 50% of the berries in the top part of the bunches has reached 4-5 mm. This is followed by a second 30-ppm GA application, 4-5 days later, when about 75% of berries concerned have reached a diameter of 4-5 mm. A third 30-ppm application is done after another 4-5 day period when all berries have reached or passed the 4-5 mm diameter stage (Wolf *et al.*, 1991). A total of 90-ppm GA for berry sizing should not be exceeded. Proper and prolonged wetting must be ensured by using the correct spraying equipment or bunch dipping technique and by selecting cool periods during the day or night. A wetting agent can be added to further promote wetting, but at the minimum concentration that will ensure wetting. Higher concentrations GA than what is prescribed are detrimental as far as the incidence of loose berries is concerned. Too high concentrations and too late applications can cause stiff, unsightly and brittle pedicels and corky lesions. Other negative side effects are prolonged spots on the apical parts of berries, reduced cold storage qualities and lower sugar concentrations (Orth, 1990).

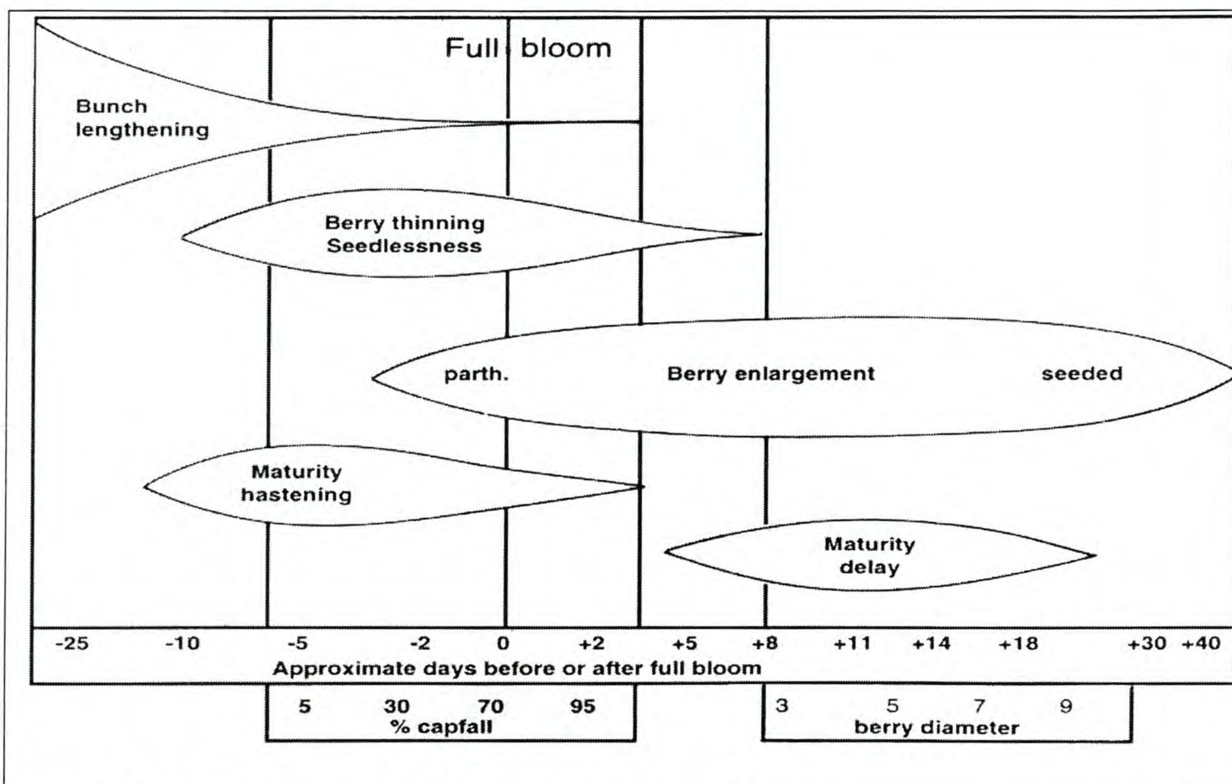


Fig. 2.17 Effect of timing of GA treatments on the numerous responses shown by grape bunches and berries (Cirami *et al.*, 1999)

For packaging and marketing reasons, the ideal bunch size is 600 g (Fig. 2.19). To attain this, each bunch should be trimmed to 4-6 laterals only, depending on the original size of the bunch. This must be done immediately after the last sizing GA application, so the remaining part of the bunch benefit fully from the vine's nutrient resources, without competition from bunch tips. If the shoulder laterals are too long, they should also be shortened. The necessity of further bunch thinning should also be assessed at this stage, using the norm already proposed.

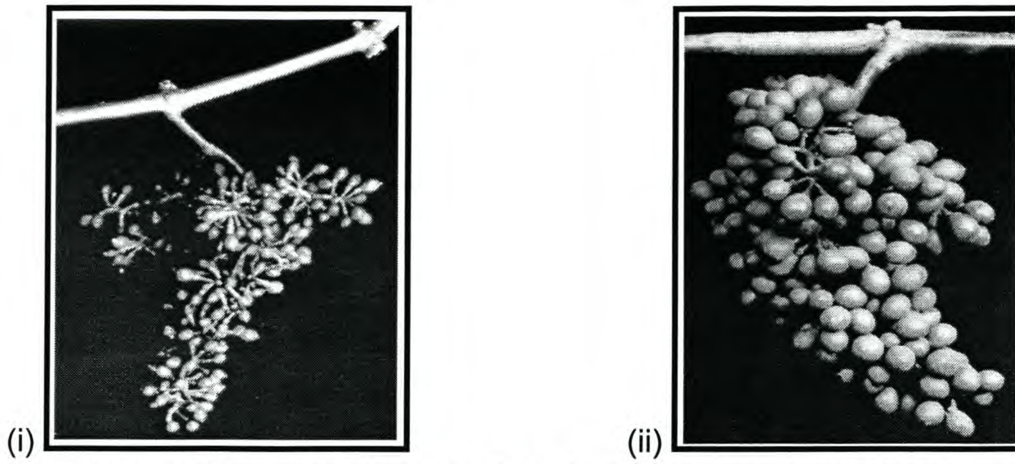


Fig. 2.18 Correct timing of GA applications is important to ensure necessary berry enlargement of Sultana Seedless (Wagener, 1984). (i) Correct stage for application. (ii) Too late stage for GA application for berry enlargement.

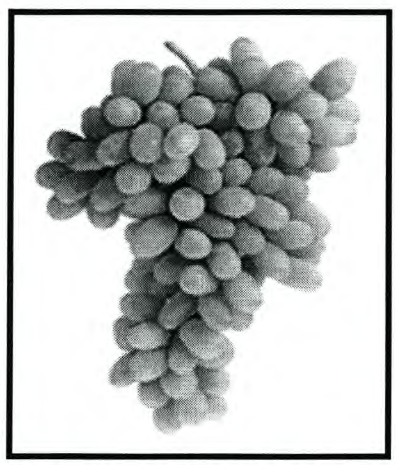


Fig. 2.19 The ideal Sultana Seedless bunch for export (www.grapepictures.com).

Interruption of phloem translocation of photosynthates to the root system is known to improve carbohydrate availability to bunches, thereby enhancing sugar accumulation of seeded grapes and berry size of seedless grapes (Novello *et al.*, 1999). Sultana Seedless vines are girdled after set to increase the berry mass and to strengthen the attachment of the berry to the cap stem. Girdling alone will increase berry mass approximately 30%. Girdling may be done on either the bases of the individual canes or on the trunk, the results being equivalent. Most growers' trunk girdle because the operation is faster for most vineyards and because any fruit produced on the head of the vine is also subjected to the girdling event (Jensen and Peacock, 1997). Girdling may reduce rates of gas exchange per unit leaf area, which has been attributed to a feedback effect of increased carbohydrate concentrations in leaves or to the inhibiting effect of leaf ABA accumulation on stomatal conductance. The reduction of stomatal conductance and leaf transpiration rate in girdled vines was associated with higher leaf water potential; the latter has been suggested to have positive effects on berry size. Girdling also has negative effects on some berry characteristics, *e.g.* decrease of malic acid concentration in must, reduction of fruit palatability, and decrease of total soluble solids and delaying ripening (Novello *et al.*, 1999). It is a dramatic and risky practice and is only recommended in cases of excessive vigour and failure to achieve adequate berry size with correctly applied procedures as described (Orth, 1990). A summary of recommended practices for the cultivation of Sultana Seedless is provided in Table 2.9.

Table 2.9 Summary of the cultural practices used to produce Sultana Seedless (compilation of information presented).

Period	Action	Remarks
June-July	Pruning	• Cane pruning system • ±8 canes/vine • ±15 buds/cane • Leave spurs as necessary
July	Hydrogen cyanamide (HC)	• 3-5% (v/v) HC • Applied at high spraying volumes (±1300l/ha) or with sponge method after pruning • Use of wetting agent recommended
August-September	Suckering and tying of shoots	• Remove all excessive non-bearing shoots when 10-20 cm long • Leave shoots in bearer positions for next year • Space and tie fruit bearing shoots down on the wires when 80-100 cm long
September-October	Leaf removal	• Remove leaves in contact with bunches before flowering • Removal of leaves increase spray covering , light penetration and air circulation • Can also be applied after berry set
September-October	Crop load	• Remove inferior clusters and young bunches to end up with ±20 bunches/vine • Keep only one cluster/shoot • Keep basal cluster
September-October	Cluster thinning	• Gibberellic acid (GA) application during flowering • Two applications since Sultana Seedless flowers unevenly • 1st Application: 10 ppm GA at 50% flowering • 2nd Application: 10 ppm GA at 80% flowering • Apply with spraying (±2000l/ha) or by dipping technique • Apply during cool periods of day or at night • Correct timing and concentration of GA application essential • Use of wetting agent not recommended
October-November	Berry sizing	• GA application after flowering • 3 sizing applications • 30 ppm when 50% of berries in top part of bunch reached 4-5 mm berry size • 30 ppm when 80% of berries reached 4-5 mm berry size • 30 ppm when 100% of berries of bunch reached 4-5 mm berry size • Apply with spraying (±2000l/ha) or by dipping technique • Apply during cool periods of day or at night • Correct timing and concentration of GA application essential • Do not exceed recommended concentration • Use of wetting agent recommended
October-November	Girdling	• Apply after set to increase berry set and counteract loose berry inducing tendency of GA • Apply trunk girdle only in case of excessive vigour and failure to reach adequate berry size
October-November	Bunch trimming	• Trim bunches to 4-6 laterals only • Do immediately after last GA sizing • Shoulder laterals should be shortened if too long
November-December	Bunch manipulation	• Remove unwanted berries as early as possible before bunches become to tight
December-January	Harvesting	• During early morning periods

Table grapes are considered ripe when they have attained an attractive appearance and are pleasant to eat. As grapes ripen, the flavour and colour characteristics of the variety develop and the berries soften. Grapes do not ripen after picking, so an acceptable level of palatability must be reached at the time of harvest. The importance of harvesting grapes at the best stage of maturity is recognised. Legal minimum standards for maturity based on total soluble solids concentration of the berries and titratable acidity have been established, but these standards vary considerably for different varieties. Sultana Seedless for example, has excessively high acidity early in the season and can be unpalatable even though the sugar concentration meets the minimum requirements. Judging the minimum acceptable level of maturity is always a problem with early ripening varieties as there is a strong desire by growers to harvest as early as possible. However, if unripe grapes are allowed to be sold, an adverse reaction by consumers may depress subsequent sales until recognisable ripe fruit reaches the market. Conversely, over ripe berries are prone to handling injuries, disease and shrivelling due to water loss. The tendency for berries to separate from their pedicels is also increased in some varieties when the fruit is over ripe (Tugwell and Dahlenburg, 2001)

According to László and Saayman (1990), a provisional sugar concentration of 18% (v/v) is proposed for the optimum harvesting stage for Sultanina as table grape. At present the minimum maturity standard for this cultivar is a minimum sugar concentration of 18% (v/v), or a minimum sugar concentration of 16.5% (v/v) provided that a minimum sugar:acid ratio of 19:1 is also attained. Harvesting of Sultana Seedless table grapes along the Lower Orange River area commenced from week 48 (early regions) onwards up to week 7 (late regions) during the 2001/2002 season (ORPA, 2002). The past season (2001/2002), dispensation was granted by the Department of Agriculture to use a berry diameter instead of the number of berries per kilogram as method for berry size determination. According to the Export Standards and Requirements for table grapes, a Sultana bunch qualifies to be exported as class 1, large, extra large and extra-extra large, if the minimum diameter (mm) of the berries is 15, 16, 18 and 20 mm, respectively, for the different classes (Makhafola, 2001).

The most important physiological and other problems of Sultana as table grape are berry cracking, sunburn, wilting of berries and bunch stems as well as problems with loose berries.

The use of GA on Sultana Seedless increases the incidence of loose berries and also leads to a decrease in fruitfulness. The use of very high concentrations of GA increases the problem of loose berries (Wolf *et al.*, 1991). Berry drop caused by GA applications has been related to the hardening and thickening of pedicels. Cellulose accumulation and lignification of the pedicel are processes associated with berry drop in Sultana Seedless. Hardening of the rachis and pedicel are related to pedicel thickening, which in turn, originates from the increase in the number of secondary xylem cells and their lignification. It has also been reported that GA generates histological changes in the pedicel and that these changes correspond to increases in the number of cells of the cortex, xylem and pith (Perez and Gomez, 1998). The use of new plant growth regulators (especially cytokines) as an alternative for GA on Sultana may have positive effects on berry sizing without inducing abscission, berry crack and declining bud eye fruitfulness. Cytokine's main effect is on a cell division level, whereas the mode of action of GA is directed towards a growth increase of mature tissue. The use of alternative plant growth regulators instead of, or in combination with GA, is still in a testing phase and is not yet being commercially used on a large scale. Promising results have been attained but still needs to be verified (Lombard, 2001).

Annual losses of export income due to berry abscission and crack are high due to the genetic predisposition of Sultana, especially after rain. As little as 10 mm rain at the stage when the grapes are ripe enough for harvesting can cause a total loss. The most typical cracks on large berries are circular cracks around pedicle attachments and cracks around the style ends of berries. Smaller berries on poorly developed bunches can also show longitunal cracks. These berries have less room for expansion of the skin during water uptake. In addition, the smaller berries are softer with weaker skin and are therefore also more susceptible to cracking according to Uys and Calitz (1997). Berries take up water through the vascular bundles in the pedicle and the water is released in the flesh. Where circular cracks at the pedicle attachment and cracks around the style end of the berry occur, the vascular bundle spacing is denser and as a result there will be increased water supply to the cells of the adjacent flesh (pulp) when water moves into the berry through the vascular bundles. If the water does not spread through the rest of the flesh fast enough, there will be an increase in berry volume at the place where the water collects. This will cause pressure on the adjacent berry skin, which will ultimately lead to berry crack at that place. It is very important to stop packaging of Sultana Seedless after rain because of the above-mentioned problem. Packaging can resume when berry conditions return to the pre-rain situation (Uys and Calitz, 1997).

Sultana Seedless is the major cultivar contributor to total table grape exports from the Lower Orange River area. During the 2001/2002 season over eight million (4.5 kg) cartons of Sultana Seedless was produced (ORPA, 2002). According to ORPA (2001), 3241 hectares of Sultana Seedless was already planted in this area in 2001. The cultivar, Sultana Seedless, is the backbone of the table grape industry of South Africa and the Lower Orange River area. Although new cultivars with promising characteristics is starting to make an impact on the cultivar profile of the Lower Orange River, Sultana Seedless will still be the prominent table grape cultivar in the area for many years to come. It is predicted that 9.1 million (4.5 kg) cartons of Sultana Seedless will be produced in the Lower Orange River in the 2005/2006 season.

2.4.2 SUGRAONE (SUPERIOR SEEDLESS®)

Sugraone is a cross between Cardinal and an unnamed seedless selection made by John M. Garabedian in California, USA. Plant breeders' rights for this cultivar were registered in South Africa in October 1992. Sun World International currently holds the worldwide rights on this cultivar and has appointed the South African Plant improvement Organisation (SAPO) exclusively to distribute certified propagation material in South Africa to licensed nurseries and producers. Sun World has also licensed a number of marketers to export Sugraone grapes, obtained from licensed producers, under the licensed trade name Superior Seedless® (Anon., 2002).

The South African fruit industry and Sun World, the proprietors of Sugraone, have been tangled up in a court battle over the rights to grow and distribute the grape. This was after the South African government granted Sun World Plant Breeder's Rights for the grapevine in 1992 and a specially appointed appeal tribunal confirmed those rights in 1996 (Anon. 1999a). Sun World alleged that Unifruco was infringing its plant breeder's rights by using the Sugraone grape, also known as Festival Seedless. In a judgment delivered on June 25, 1998, the high court of South Africa denied Unifruco's attempt to limit litigation. As a result Sun World could seek damages against Unifruco for sales dating back to 1992. The grapevine was smuggled into South Africa where it was planted and grown without Sun World's authorisation. It is believed that at least 700 ha of Sugraone have been planted throughout the Orange River and the Western Cape producing regions without authorisation. Independent DNA analyses have clearly established that Festival Seedless and Sugraone are one and the same cultivar. The company instituted legal action against a number of parties who are believed to have infringed Sun World's rights by either propagating, or exporting Sugraone grapes. A settlement offer was reached in 1998. It included an once-off past royalty, a commitment to not multiply existing vines, an agreement to pay ongoing fruit production royalties and to work through Sun World approved licensed exporters. Also on offer was access to new clean certified and virus tested Sugraone grapevines for licensed production under its standard licensing terms (Anon, 1998).

Sugraone ripens seven to ten days before Sultana Seedless enabling the cultivar to fill a strategic and important market window. The seedless berries are large, oval to slightly obovoid with a greenish-yellow skin. The slight muscat flavour and acidity as well as the crisp texture, result in a good eating cultivar. Sugraone berries are firm and have good storage ability and shelf life. Sugraone is a vigorous, relatively infertile grape cultivar with normal production in the warmer areas of South Africa. Yields between five and 20 tons/ha (average ten tons/ha) have been reported in South Africa (Anon, 2002).

Since Sugraone is a vigorous, relatively infertile grape cultivar (similar to Sultana Seedless), the choice of rootstock for Sugraone in the Lower Orange River area is much the same as for Sultana Seedless (see section 2.4.1). The main rootstocks for Sugraone in this region are Richter 99 and Richter 110, with only a small area grafted on Ramsey (Weksler, 2000). All Sugraone plantings in California are on own root. Widespread plantings of Sugraone on own root is still found in the Lower Orange River, but most new or resettlement plantings of Sugraone are grafted on rootstocks. Ungrafted Sugraone vines are very susceptible to high levels sodium chloride, waterlogged soils and high nematode counts. Sugraone tends to grow best in sandy, sandy-lime and good irrigated soil under constant, warm temperatures. Larger trellising systems (as is the case with Sultana Seedless) are commonly used to accommodate the vegetative growth of Sugraone and to ensure good sunlight penetration, which is essential for good bud fertility for this relative infertile cultivar. Slanting-, Double Slanting (Gable)-, Factory-, Trentina- and Roof trellising systems are commonly used (Loubser and Ellis, 1995). The Double Slanting (Gable) trellising system is the most popular system used along the Lower Orange River area.

The cultivar Sugraone has several positive characteristics and it can obtain good prices on European markets. In the Berg River producing region of South Africa, Sugraone produces an extremely low yield. There is hardly any Sugraone left in the Paarl area with approximately 30 hectares divided between 15 growers. Sugraone in the region was pulled out in recent years due to low yields of around 1500-2000 cartons per hectare (Weksler, 2000). The low yield is ascribed to poor bud fertility, but the true reasons for the problem is unknown. Producers apply several short-term practices to improve yield of Sugraone vineyards. Sugraone is pruned on the multiple Guyot-system. Depending on the spacing width, trellis system, vine growth and availability of canes, six to twelve canes per vine are left with pruning. Several producers prune according to a bud fertility analysis, which is done prior to pruning in laboratories. A study was done by Avenant (1998) to determine whether shoot diameter and the presence of lateral shoots on bearing shoots increase fertility. The pruning level which will overcome and/or improve the fertility problem and accompanying low yield of Sugraone in certain vineyards, without adversely affecting growth, yield and quality in the long term was also investigated (Table 2.10-2.11).

Table 2.10 The effect of pruning level on the growth, budding and bud fertility of Sugraone (mean of 1997/97- and 1997/98 seasons, Sonneskyn 2, Paarl) (Avenant, 1998).

Parameter	Pruning Level (canes/vines)					Significance level	CV (%)
	4	6	8	10	12		
Shoot diameter (mm)	12.69 a	12.40 b	11.64 b	11.0 c	10.71 c	0.001	3.4
Number of lateral shoots	5.40 a	4.74 ab	4.24 c	3.65 cd	2.92 d	0.001	16.8
Shoot mass (kg/vine)	3.91a	4.40 a	4.30 a	4.22 a	3.61 a	0.396	18.9
Yield:shoot mass ratio*	1.08 c	1.48 bc	2.54 b	3.74 a	4.10 a	0.001	35.6
Canopy density (lln)**	1.91 a	1.92 a	1.98 a	2.098 a	2.055 a	0.443	10.2
Budding % (spurs)	93.8 a	84.7 b	82.6 b	84.2 b	81.4 b	0.046	8.4
Budding %(canes)	72.7 a	72.7 a	72.8 a	70.3 a	64.9 a	0.133	8.4
Fertility (bunches/vine)	8.92 c	15.33 b	18.50 ab	21.67 a	22.50 a	0.001	27.8
Fertility (bunches/cane)	2.21 a	2.57 a	2.32 a	2.19 a	1.92 a	0.415	25.1
Fertility (bunches/spur)	0.022 a	0.013 a	0.022 a	0.053 a	0.033 a	0.143	137.8
Fertility (bunches/sprouted bud	0.218 a	0.252 a	0.227 a	0.237 a	0.222 a	0.784	21.7

Values followed by the same letters horizontally do no differ significantly (p£0.05). Means separated by LSD (p£0.05).
CV (%) – Coefficient of variance
*Only 1996/97 season
**lln – leaf layer number

Table 2.11 The effect of pruning level on average yield, quality and berry composition of Sugraone (mean of 1997/97- and 1997/98 seasons, Sonneskyn 2, Paarl) (Avenant, 1998).

Parameter	Pruning Level (canes/vines)					Significance level	CV (%)
Crop mass (kg/vine)	3.93 c	7.78 bc	9.50 ab	11.08 ab	11.87 a	0.004	38.5
Export grapes (boxes/ha)**	530 b	1504 a	1754 a	2091 a	2291 a	0.006	47.9
Packable grapes (boxes/ha)**	949 c	1907 bc	2325 b	2709 ab	2918 a	0.003	38.6
Export quality (%)	59.7 a	78.6 a	76.2 a	74.1 a	72.7 a	0.054	15.1
Bunch mass (g)	523 a	600 a	633 a	608 a	597 a	0.194	13.3
Berry mass (g)	6.24 a	6.65 a	6.70 a	6.57 a	6.66 a	0.249	5.8
Sugar concentration (°B)*	17.60 a	17.25 ab	16.70 bc	16.20 c	16.25 c	0.001	3.2
Acid concentration (g/l)*	5.683 a	5.883 a	6.000 a	5.933 a	6.083 a	0.166	4.7
pH*	3.450 a	3.403 a	3.367 a	3.378 a	3.372 a	0.051	1.5
Sugar acid ratio*	31.01 a	29.34 ab	27.85 bc	27.42 bc	26.83 c	0.003	6.3

Values followed by the same letters horizontally do no differ significantly (p£0.05). Means separated by LSD ($p<0.05$).
CV (%) – Coefficient of variance
*Only 1996/97 season
**5 kg

According to this study, the pruning level can be applied effectively to manipulate shoot diameter and lateral shoot development of Sugraone. Despite an increase in shoot diameter and the number of lateral shoots per bearing shoot with an increase in pruning level, actual fertility or yield was not significantly affected. It is, however, recommended that that bearing shoots that is retained during pruning should be at least 10 mm in diameter. Generally the increase in pruning level caused an increase in the number of bunches per vine as well as yield, whereas growth and yield were not adversely affected. According to the study by Avenant (1998), seasonal effects, rather than pruning level, mainly affect yield. It appears as if in a low fertility season, vines with higher pruning levels do not compensate by inducing more bunches. This conclusion casts doubt on the advantage of the present bud fertility analysis service for Sugraone and modification of pruning and bud load according to the analysis results.

According to recommended practices from successful Sugraone producers and technical advisors, between eight and twelve 15-bud canes should be left in the crown of the vine, with only the thick canes being used. Large diameter laterals are left as fruiting shoots and six to eight two-bud spurs per vine should be left in the head area (Anon., 2001a). Often, two heads per vine is developed with each head being divided to a high and a low part. Generally, growth on the higher part is more vigorous, resulting in the weakening of the lower part due to apical dominance. It is recommended that after harvest, the upper part of the head on both sides of the vine should be removed, as well as the far ends of the vines. This should be done in order to strengthen the centre and balance the growth (Weksler, 2000). It may require large cuts to maintain the crown of the vine below the trellis wires. Evaporative cooling should start 60 days prior to pruning in areas with insufficient winter cooling (especially the early regions of the Lower Orange River) in order to reap the full reward of this action (as mentioned in a previous section). It is recommended that heavy irrigation should be applied one week prior to pruning to leach salts from the root area as well as to sufficiently wet the soil in the root area. In low chill areas, the best results are achieved with late pruned Sugraone vines. Exact timing varies between years and between areas. In some areas late July pruning tends to increase yields by 10-15% over middle to late pruning dates. Canes are tied horizontally on the first two wires of the trellis system. In low chill areas, HC is applied at 3-5% (v/v) with a wetting agent immediately after pruning. Application of HC, when the buds are already active, may result in bud damage (Anon., 2001a). According to Weksler (2000), the exact timing should be fine-tuned in each sub-area of the Lower Orange River area depending on the relevant chilling units. On average, it seems that the range is from 10-25 July. HC applications after July 25 in the Blouputs region (early area) improve the fertility in vineyards where HC is applied by spraying as opposed to brushing.

When the shoots are 10-20 cm long and all clusters are visible, sterile shoots are removed, taking care not to remove shoots that will be used for pruning in the winter. At a later stage, when shoots are 80-100 cm long, shoots are bent to either side of the gable trellis and tied to allow for a better light penetration. Leaf removal in certain areas is done prior to bloom and during bloom to allow for good light penetration, spray coverage, and air circulation. In other areas, removal of leaves commences after fruit set. Pre-bloom leaf removal, in areas where practiced, reduces over-shattering of flowers and berries (Anon, 2001a). The application of GA for thinning should be practiced with great care since it can lead to the over-shattering of flowers. It should only be used in vineyards with problems with very compact bunches, small and uneven bunches and to ensure less hand thinning. If thinning is necessary, GA with a concentration of 1-1.5-dpm in 1000 litres of water per hectare is applied during full bloom. The crop load should be determined just after set. The recommendation is to limit the crop to 20-25 ton in the early regions. Small bunches, late bunches and bunches in the head of the vine should be removed first.

For packaging and marketing reasons, the ideal bunch size is 600 g (Fig. 2.20). To attain this, each bunch end should be trimmed accordingly after set, depending on the original size of the bunch. Leaf removal usually takes place prior to GA treatments for berry size. A single application of 15-20-dpm GA is applied at six to eight mm berry size through the bunch dipping technique and by selecting cool periods during the day or night. Sprayings techniques of GA applied to Sugraone induce infertility of buds. GA application, whether to the vine, inflorescences or bunches, is cultivar dependent and incorrect applications can cause serious damage. Only some cultivars, like Flame Seedless or Sultana Seedless, can absorb GA sprays without visible damage to bud formation. This might be related to the time of floral differentiation (Orth, 1990). In the case of Sugraone, bud differentiation occurs much earlier than Sultana Seedless. This means that all buds, including basal buds, develop primordia earlier. These buds are more susceptible to damage due to GA sprays at that time than Sultana Seedless. This can lead to a reduction in the number and size of bunch primordia, delayed budburst, reduced budburst percentage and number of inflorescences per bud. Accordingly, bunch mass and total crop yield can be affected by the previous year's GA sprays (Orth, 1990a). In order to prevent bud burst and fertility problems, it is recommended that GA treatments of Sugraone be applied by the dipping technique. A wetting agent can be added to further promote wetting, but at the minimum concentration that will ensure wetting. Girdling takes place on six to eight mm berry size. Girdling should take place only on vines with a trunk diameter of at least 35 mm, since it is a very dramatic action. In certain areas it is necessary to protect the bunches with special methods against sunburn and birds. Two weeks prior to harvesting, all the small and late bunches should be removed (Anon, 2001b). A summary of the recommended practices for the successful cultivation of Sugraone is provided in Table 2.12.

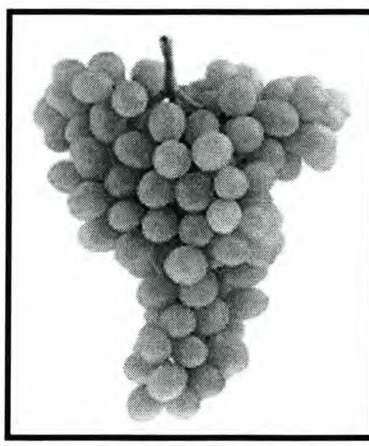


Fig. 2.20 Ideal Sugraone bunch for export (www.saplant.co.za).

László and Loubser (1995) determined the optimum harvesting stage for Sugraone using the same methods as with Sultana Seedless. According to László and Loubser (1995), a sugar concentration of 16-17% (v/v) is proposed as the optimum harvesting stage for Sugraone to ensure good taste and apperance. At present the minimum maturity standard for this cultivar is a minimum sugar concentration of 16% (v/v) provided that a minimum sugar:acid ratio of 25:1 is attained or a minimum sugar concentration of 15.5% (v/v) provided that a minimum sugar:acid ratio of 20:1 is attained. Harvesting of Sugraone table grapes along the Lower Orange River area commenced during week 47 (early regions) onwards up to week 4 (late regions) during the 2001/2002 season (ORPA, 2002). The past season (2001/2002), dispensation was granted by the Department of Agriculture to use a berry diameter instead of the number of berries per kilogram as method for berry size determination. According to the Export Standards and Requirements for table grapes, a Sugraone bunch qualifies to be exported as class 1, large, extra large and extra-extra large, if the minimum diameter (mm) of the berries is 16, 18, 20 and 22 mm, respectively for the different classes (Makhafola, 2001).

Table 2.12 Summary of the cultural practices used to produce Sugraone (compilation of the information presented).

Period	Action	Remarks
June-July	Pruning	• Cane pruning system • ±8-12 canes/vine in head of vine • ±15 buds/cane • Leave 6-8 spurs in head of vine • Use only thick canes • Late pruning can have positive effects on fertility
July	Hydrogen cyanamide (HC)	• 4% (v/v) HC • Applied at high spraying volumes (±1000-1300l/ha) or with sponge method
August-September	Suckering and tying of shoots	• Remove all excessive non-bearing shoots when 10-20 cm long • Leave shoots in bearer positions for next year • Space and tie fruit bearing shoots down on the wires when 80-100 cm long
September-October	Leaf removal	• Remove leaves in contact with bunches • Pre-flowering leaf removal increases spray covering, light penetration, air circulation and prevents over shattering • Leaf removal can also be applied after berry set
September-October	Cluster thinning	• Gibberellic acid (GA) application during flowering may lead to over-shattering • Apply 1-1.5 ppm GA in 1000l spraying solution in cases of compact bunch problems
October-November	Bunch trimming	• Remove bunch end according to recommended export bunch size after set
October-November	Berry sizing	• GA application after set • 1 sizing application • 15-20 ppm GA applied at 6-8 mm berry size • Directed at bunches to prevent damage to buds • Correct timing and concentration of GA application essential • Use of wetting agent recommended
October-November	Girdling	• Apply after set to increase berry at 6-8 mm berry size • Trunks must be at least 6-8 mm in diameter
October-November	Crop control	• Restrict crop to 20-25 ton in early regions • Do crop control after set • Remove small, late and bunches in the crown
November-December	Bunch manipulation	• Remove unwanted berries as early as possible before bunches become to tight • Protect bunches against birds, rain, sunburn, etc. as necessary
November-January	Harvesting	• During early morning periods

The most important physiological problems of Sugraone are the poor fruitfulness of the cultivar and poor set of bunch shoulders. Trimming of the bunch shoulders and the removal of unwanted clusters prior to flowering will ensure better fruit set. Tipping and topping prior to flowering will also ensure better set. To prevent poor fertility, rootstock choice is important, as well as vine development, training and trellising as well as pruning (as discussed earlier in this section) (Loubser and Ellis, 1995). Spraying of GA onto the canopy of Sugraone should also be prevented since this further enhances bud infertility. Although bunch dipping is very laborious and may take long to complete in large vineyards, this method is recommended to ensure the long-term fertility of Sugraone. This method, however, saves a lot of GA. Sugraone is less susceptible to berry splitting than Sultana Seedless, but problems may be experienced during wet harvesting seasons. Sugraone is also less susceptible to sunburn, wind damage and *Botrytis* than Sultana Seedless (Loubser and Ellis, 1995).

Sugraone is a major cultivar contributor to total table grape exports from the Lower Orange River area. During the 2001/2002 season over 3.8 million (4.5 kg) cartons of Sugraone was produced (ORPA, 2002). The average Sugraone yield per region in the Lower Orange River area is around 2000-2500 cartons per hectare. Certain producers have achieved yields of up to 6000 cartons per hectare. According to table grape experts, the Sugraone yields in this region may increase by approximately 2000 cartons per hectare if the needs of the specific variety in terms of fertilisation, irrigation, canopy management, pruning and training are met (Weksler, 2000). In 2001, a total of 1017 hectares of Sugraone was already planted in the Lower Orange River area (ORPA, 2001). According to future yield predictions, some 3.7 million (4.5 kg) cartons Sugraone will annually be produced in this area during the 2005/2006 season (ORPA, 2002).

2.4.3 REGAL SEEDLESS

Regal Seedless is a mid-season, white, seedless grape obtained from a complex hybrid crossing in 1988. The cross was selected by the breeders of the ARC-Fruit, Vine and Wine Research Institute's table grape-breeding program in 1991 and was previously known as NVB 91-84. It was evaluated at experimental farms in Paarl (Bellevue) and Hex River Valley, as well as various co-operative experimental plots at producers' farms in the Paarl, Hex River Valley, Riebeeck Kasteel and Lutzville. Plant Breeder's rights for the cultivar were granted to the ARC-Fruit, Vine and Wine Research Institute in 1997 and were released for cultivation as Regent Seedless. The name was, however, changed in May 1999 to Regal Seedless since an overseas wine cultivar was already registered under the name Regent (Avenant and Ellis, 1998).

Regal Seedless has the potential to develop into an economically important cultivar. It was released mainly as a supplementary cultivar to Sultanina, the major white, seedless grape. It ripens almost two weeks before Sultanina and the two cultivars would therefore complement each other well. Sultanina is, in contrast to Regal Seedless, subject to several important cultivation problems (as already mentioned), such as berry cracking and the need for GA applications to ensure quality. Regal Seedless performs well in both the winter rainfall and the Lower Orange River area. It is also expected to perform well in the Northern summer rainfall regions, because it is not more prone to berry cracking than the other important cultivars produced in this area. Regal Seedless has good storage ability and is recommended for export (Avenant and Ellis, 1998).

Regal Seedless is very fertile with inherent large berries and requires minimal bunch preparation. The vigour of the vine is strong with the majority of the clusters well filled. Sometimes a few bunches are prone to poor set. The bunches are medium large and medium to densely filled. The mass of the bunches varies between 450-900 g (average mass of 790 g) and the peduncle is short to medium in length. The berries are medium to large with an average mass of 7.3 g per berry.

The berries are obovate with a green to yellow-green colour and the flesh of the berries has medium firmness and juiciness with a neutral flavour. The berries are uniform and covered with a weak bloom. Soft rudimentary seeds are present. The yield of Regal Seedless is approximately 20 ton/ha with pack out percentages of approximately 90%. This cultivar is not more susceptible to vine diseases than other commercial cultivars, with a moderate to good berry crack resistance (Avenant and Ellis, 1998).

Vigour with Ramsey as rootstock is strong, but the spacing between the vines has to be wide to ensure enough space for cordon development. At present very little information is available as to the best rootstock combination for Regal Seedless for a certain soil type. Research projects are underway in the Hex River Valley and Paarl to evaluate various rootstock combinations for Regal Seedless, aimed at ensuring good yields, quality and affinity. Good affinity with Jacquez, Ramsey, Richter 99, Richter 110 and 101-14 Mgt (only evaluated on these rootstocks) was obtained for a period of six years (Avenant, 1999). Ramsey is by far the most popular rootstock at present for Regal Seedless in the Lower Orange River area since most new plantings of Regal Seedless is taking place on the lighter 'outer soils'.

As a result of the high temperatures and generally favourable growing conditions in the Lower Orange River, larger trellising systems is now used to accommodate the vegetative growth of the vines and to ensure good sunlight penetrations. The Double Slanting (Gable) trellising system is commonly used for Regal Seedless. The recommendation for vine spacing is 3.0 x 1.5 m up to 3.0 x 2.0 m. Depending on the vine spacing and trellising systems, the vines can be trained as single-or double-split cordons. Since Regal Seedless is very fertile, it is recommended that the vines (3.0 x 2.0 m) should be pruned with 18 short bearers per vine. Late pruning ensures better set; this practice is recommended since the cultivar is subject to poor set in certain years (Avenant, 1999). This ensures around seven to eight buds per m^2 trellising area. Short bearers are recommended since they ensure more fully filled bunches than half long bearers (Vlok, 2001).

To improve berry set, cluster shoulders can be shortened before flowering and shoots can be topped. These practices are normally unnecessary, because bunches set well due to the high fertility. In some seasons, the bunch shoulders in particular, are prone to poor set. By removing the bunch shoulders, a good bunch appearance can be obtained. Crop control should be done just after berry set (Avenant, 1999) and only one bunch per shoot should be left. A crop load of 22-26 bunches per vine (3.0 x 1.5 m) is recommended for a yield of 5500-6500 cartons per hectare (depending on vigour) according to Vlok (2001). A too high crop load can have an effect on the taste of Regal Seedless. Due to the fact that the bunches are fairly big, the remaining bunches should be shortened to 150 mm (Vlok, 2001). According to Avenant (1999), 5.5-6 bunches per m^2 trellising area can be left to ensure good quality and berry size for Regal seedless (Fig. 2.21). Since Regal Seedless is very fertile, care must be taken against too high crop loads, which will effect quality and berry size negatively.

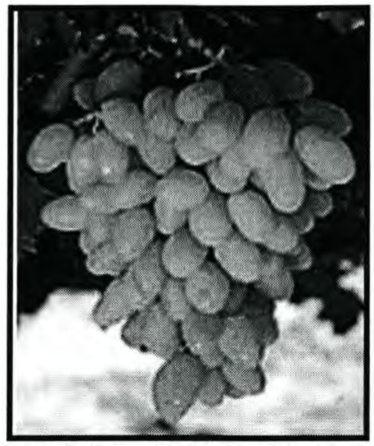


Fig. 2.21 Ideal Regal Seedless bunch for export (www.arc.agric.za).

Minimal thinning is required, except in cases where tipping and topping of shoots and bunch shortening were applied together. GA should not be applied to Regal Seedless at all since it increases the occurrence of loose berries after cold storage to unacceptable levels and it affects the taste of the grapes negatively. Due to the cultivar's natural berry size, GA treatment for sizing is not required. Regal Seedless react well to girdling for berry sizing and an increase of 25% is obtained with girdling at 4-5 mm berry size. Girdling should, however, not be practiced on Regal Seedless since it effects the taste of the cultivar negatively (Avenant, 1999). Girdling also has negative effects on some berry characteristics, *e.g.* a decrease in malic acid concentration in must, a reduction in fruit palatability, and a decrease of the total soluble solids, as well as a delay in ripening (Novello *et al.*, 1999). Due to the natural berry size of Regal seedless, girdling is not necessary and the problem with poor set of bunches can be prevented with tip and top actions as well as shoulder and bunch shortening before flowering (Avenant, 1999).

Good canopy management is essential to cultivate Regal Seedless successfully. The clusters have to be well aerated to ensure good set. Leaf removal around the bunches should be done prior to flowering, but care should be taken not to remove too much leaves at an early stage. This can lead to poor berry development. Good canopy management also ensures good sunlight penetration, aeration and penetration of spraying agents for disease control. Optimal canopy density is achieved with the correct planting density, rootstock choice, pruning, irrigation, fertilisers and canopy management. All excessive shoots on the trunk, cordon and bearers should be removed (Avenant, 1999).

The eating quality of Regal Seedless improves over time (Avenant, 1999). According to Burger and Khumalo (2001) Regal Seedless should be harvested at a minimum of 18ºB (refractometer), but should not be harvested much later since the taste quality declines from this point onwards. Dr. G.J. Strydom, formerly of the ARC-Fruit, Vine and Wine Research Institute, conducted research during 1999 to 2001 to determine the physiological ripeness stage of Regal Seedless. The main aim of this study was to measure certain physical and biochemical quality variables and to determine their turning points, which can be seen as the physiological ripeness stage of Regal Seedless. Since quality problems like loose berries, berry split after packaging, sulphur dioxide damage, taste, aroma and bad colour cause huge financial losses every year, harvesting at physiological ripeness would ensure the best quality grape and storage ability. Samples of Regal Seedless were taken at intervals during ripening, starting from 26 days after full bloom until harvest. Certain physiological processes were monitored, including sugars, acids, phenols and pH. Grapes were harvested at five different stages of ripeness, kept under cold storage for four weeks and thereafter evaluated for certain quality standards (Strydom and Le Grange, 2001). A summary of recommended practices for the successful cultivation of Regal Seedless is provided in Table 2.13.

Table 2.13 Summary of the cultural practices used to produce Regal Seedless (compilation of the information presented).

Period	Action	Remarks
June-July	Pruning	• Short bearer pruning system recommended (better filled bunches) • ±18 short bearers/vine • 2 buds/short bearer • Late pruning ensures better set and is recommended
July	Hydrogen cyanamide (HC)	• 3-5% (v/v) HC • Applied at high spraying volumes (±1000-1300l/ha) or with sponge method
August-September	Suckering and tying of shoots	• Remove all excessive non-bearing shoots when 10-20 cm long • Space and tie fruit bearing shoots down on the wires when 80-100 cm long
September-October	Leaf removal	• Remove leaves around bunches prior to flowering • Pre-flowering leaf removal increases spray covering, light penetration, air circulation and prevents over shattering
September-October	Cluster thinning	• No gibberellic acid (GA) application required
October-November	Cluster trimming	• Cluster shoulders should be shortened before flowering to increase set (in combination with topping of shoots)
October-November	Berry sizing	• No GA applications is recommended since it can have a negative effect on the taste of Regal Seedless and increase the incidence of loose berries after cold storage • Due to the cultivar's natural berry size, GA treatment for sizing is not required
October-November	Girdling	• Not recommended since it can have negative effects on the taste of Regal Seedless
October-November	Crop control	• Do crop control just after set • Crop load of 22-26 bunches/vine recommended • Remove bunches with poor set first • Remove bunch the bunch nearest to the main trunk since the top 2-3 shoulders set poorly • Leave only 1 bunch/shoot • Do crop control as early as possible
October-December	Bunch manipulation	• Remove bunch shoulders with poor set • Shorten the bunches to ±15 cm • Do berry thinning as necessary • Remove unwanted berries as early as possible before bunches become to tight
November-January	Harvesting	• During early morning periods

The change in physiological reaction over time was used to determine physiological ripeness of Regal Seedless. The total phenol concentration (mg/l) is the only norm that showed a definite turning point during the ripening period. The sugar and acid development of Regal Seedless was according to the norm for table grapes. The pH development of Regal Seedless was also normal with no sudden turning points. As expected, the bunch mass increased from 26-75 days after full bloom staying constant thereafter and decreasing slightly from 91 days after full bloom (Fig. 2.22). This turning point is close to the turning point of the total phenolic content (83 days after full bloom) and may indicate the point of physiological ripeness of Regal Seedless. As can be seen in Fig. 2.23, there was an initial increase in total phenols (mg/l) up to 50 days after bloom (*veraisón)* but a decrease followed up to the first harvesting date (83 days after full bloom). A sharp increase of the total phenol concentration followed from 83 days after full bloom up to the last harvesting date (112 days after full bloom). The lowest concentration of total phenols was measured at just over 16ºB total soluble solids and a titratable acid of 10. This may be the optimum ripeness point of Regal Seedless. Evaluations after cold storage showed little difference between the different stages of ripeness. However, there was an increase in loose berries, berry split, sulphur dioxide damage and browning of harvested grapes at later stages. According to Strydom and Le Grange (2001), Regal Seedless at a sugar content of 16ºB had an acceptable taste and he recommended that Regal Seedless should not be harvested at higher sugar concentrations than 18ºB because of the increase in phenol concentration and the effect this has on taste (Strydom and Le Grange, 2001).

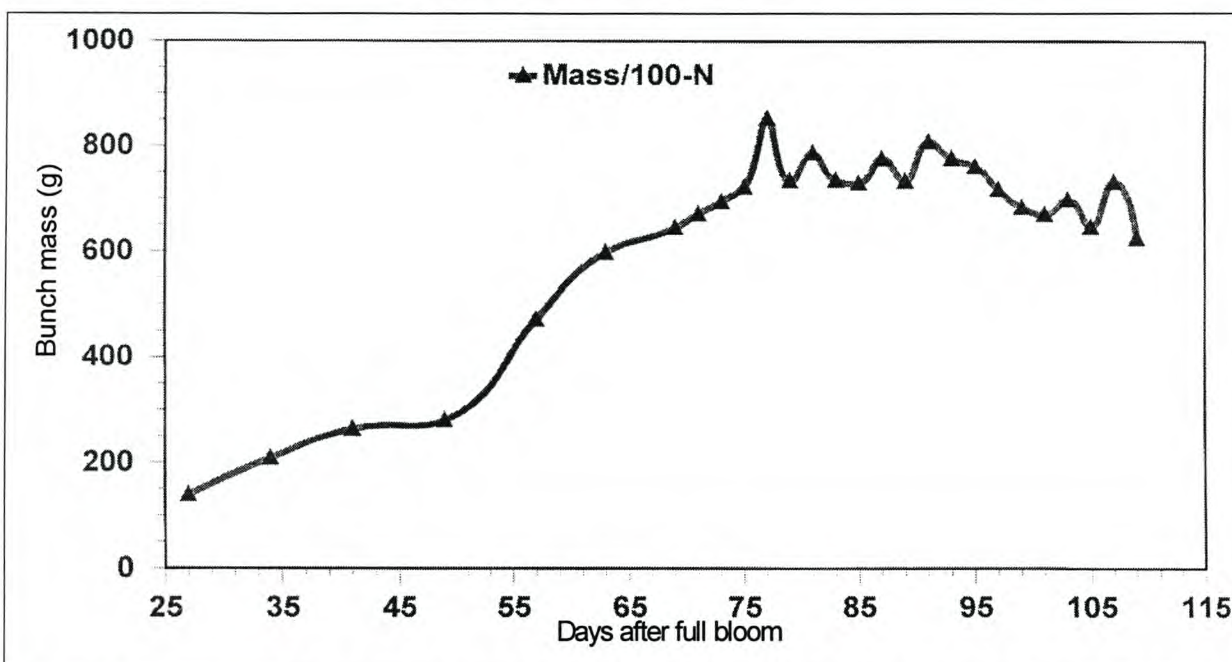


Fig. 2.22 The change in bunch mass of Regal Seedless from 26 to 109 days after full bloom (Strydom and Le Grange, 2001)

At present the minimum maturity standard for this cultivar is a minimum total soluble solids of 16.5% (v/v), or a minimum sugar:acid ratio of 25:1. Harvesting of Regal Seedless table grapes along the Lower Orange River commenced from week 48 (early regions) onwards up to week 2 (late regions) during the 2001/2002 season (ORPA, 2002). According to the Export Standards and Requirements for table grapes, a Regal Seedless bunch qualifies to be exported as class 1, large, extra large and extra-extra large, if the minimum diameter (mm) of the berries is 16, 18, 20 and 22 mm respectively, for the different classes (Makhafola, 2001). The berry peduncles of Regal Seedless are very brittle. Regal Seedless should be handled very carefully during harvesting and packaging (Avenant, 1999).

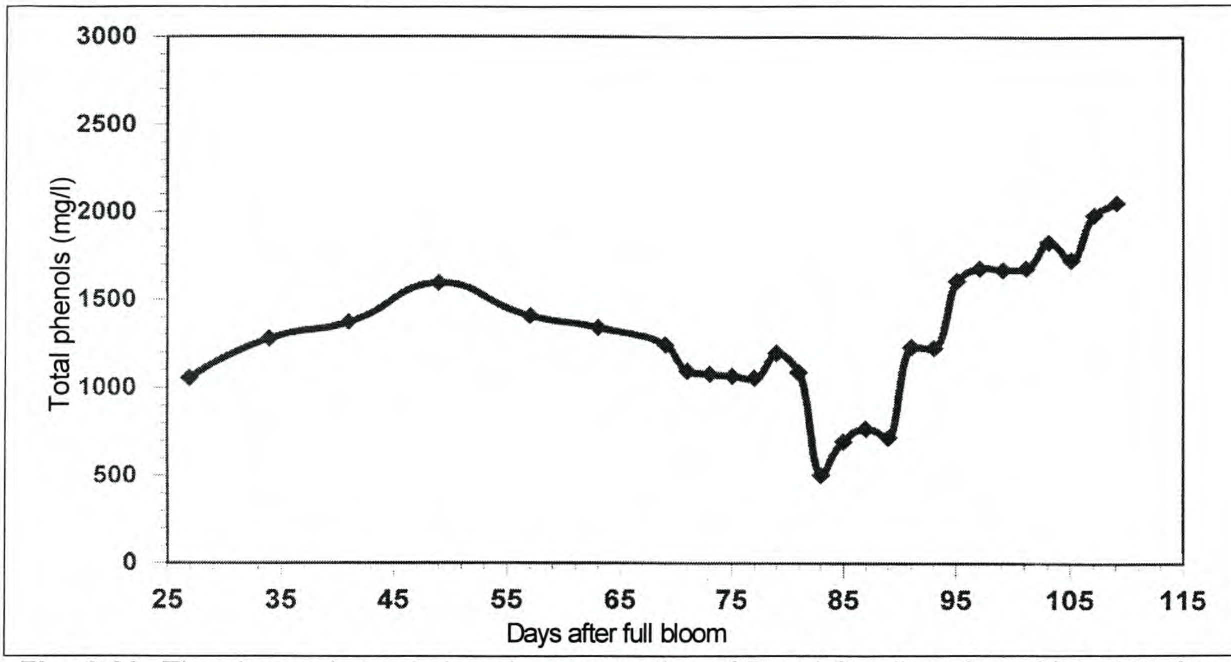


Fig. 2.23 The change in total phenol concentration of Regal Seedless from 26 to 109 days of full bloom (Strydom and Le Grange, 2001).

The most important physiological problem of Regal Seedless is the poor taste of the grapes (linked to the phenolic content) when certain cultivation practices are used and when grapes are not harvested in the period of optimum ripeness (16-18°B). Phenolic compounds cover a large variety of substances containing one or more hydroxylated rings in their structures. They are, next to carbohydrates, the most abundant in plants. They have a variety of structures from simple phenolic derivatives to complex polymers such as lignin and tannins. In grapes and wine they contribute significantly to colour, taste, flavour and body. The flavanoids are C-15 phenolic compounds, which include anthocyanins. With the exception of a few, they appear in the form of glycosides, i.e. they are bound to sugar, the most common of which is D-glucose. The major phenols in grape constituents are anthocyanins, benzoic acids, cinnamic acids, flavonols and tannins. There are spatial, seasonal and cultivar variations in the amount and kind of phenolics in grape berries. The skin is the most important single source of phenolics (Singleton and Esau, 1969). Shading of bunches leads to decreased anthocyanin content and a reduction in total phenolics in the berries. This is an important effect of light on grape composition since phenolics affect the colour and flavour of wine and table grapes (Jackson and Spurling, 2000). In light of this, canopy management may have a major effect on the development of phenolic compounds in Regal Seedless. The prevention of high quantities of phenolic compounds through the right cultivation practices may be the solution to the problem of poor taste of Regal Seedless.

A project by the ARC-Fruit, Vine and Wine Research Institute's commenced in 2001 to evaluate the effect of cultivation practices on the taste of Regal Seedless. Cultivation practices such as soil type, rootstock, crop load and canopy management is being evaluated. The effect of these practices on taste will be determined by doing measurements on total phenols, sugar and acid content as well as pH. Since this was the first year of this project, only the effect of canopy management at various stages of the phenological cycle as well as the effect of different ripeness stages on the taste of Regal Seedless was evaluated. The canopy management experiment included different leaf removal treatments and top actions at various stages of the phenological cycle. The leaf removal treatment consisted of a control, 25% leaf removal and 50% leaf removal at 12 mm berry size, start of *veraisón* and 14 days after *veraisón.* No significant differences in total polyphenol content, berry mass and juice quality existed between the different treatments (Table 2.14). Neither the level of leaf removal nor the time of removal showed any tendencies towards polyphenol content of Regal Seedless. The sugar content of the grapes decreased with an increase in the level of leaf removal, with the effect being smaller the closer leaf removal was done to maturity. Top actions were done at 12 mm berry size, start of *veraisón* and 14 days after *veraisón.* No significant differences in polyphenol content, berry mass and juice quality existed between the different times of top treatment (Table 2.15). The pH was, however, significantly higher with top at 12 mm berry size.

Table 2.14 The effect of leaf removal and timing of removal on the polyphenol content, berry mass and light intensity of Regal Seedless (2000/2001 season, Welgevonden, Riebeeck Kasteel) (Avenant and Morkel, 2001).

Treatment		**Poliphenol content (%)**	**Berry mass (g)**	**Light intensity under canopy (umolm^{-2}s^{-1})**	**Light intensity as percentage of full sun (%)**
Time of leaf removal treatment	12 mm berry diameter	1276 a	6.60 a	117.0 a	5.56a
	Veraison	1252 a	6.42 a	77.3 b	3.68 b
	2 weeks after *veraison*	1279 a	6.52 a	45.9 c	2.18 c
Leaf removal treatment	Around bunches (control)	1255 a	6.53 a	72.0 a	3.42 a
	25% leaves	1312 a	6.54 a	68.2 a	3.25 a
	50% leaves	1240 s	6.47 a	100.0 a	4.76 a
Average		1269	6.513	80.1	3.81
Interaction	Time x Leaf removal	0.351	0.165	0.018	0.018
CV%		12.1	5.6	48.5	48.5

Values followed by the same letters vertically do no differ significantly at p≤0.05 (t-KBV).
CV – Coefficient of variance

Table 2.15 The effect of leaf removal and timing of removal on the juice quality of Regal Seedless (2000/2001 season, Welgevonden, Riebeeck Kasteel) (Avenant and Morkel, 2001).

Treatment		Sugar concentration (°B)	Acid concentration (g/l)	pH	Sugar-acid ratio
Time of leaf removal treatment	12 mm berry diameter	20.65 a	3.38 a	4.45 a	61.8 a
	Veraison	20.71 a	3.39 a	4.37 a	61.6 a
	2 weeks after *veraison*	21.00 a	3.41 a	4.42 a	62.1 a
Leaf removal treatment	Around bunches (control)	21.34 a	3.33 a	4.49 a	64.6 a
	25% leaves	20.93 a	3.43 a	4.38 a	61.2 a
	50% leaves	20.09 a	3.41 a	4.36 a	59.6 a
Average		20.79	3.394	4.401	61.8
Interaction	Time x Leaf removal	0.406	0.726	0.637	0.559
CV%		7.1	8.3	4.7	12.0

Values followed by the same letters vertically do no differ significantly at p≤0.05 (t-KBV).
CV – Coefficient of variance

As with the study conducted by Strydom and Le Grange (2001), it was found that the total polyphenol content of Regal Seedless declines from *veraisón,* but against expectation, increases again from 16ºB. According to a tasting panel, Regal Seedless has good eating quality at 18ºB. The tasting test also showed that the tannin-like taste decreases with an increase in sugar content, with the lowest point at 18ºB after which it increases again. The eating quality of the grapes does not reflect the increase in tannins, probably because the high sugar content disguises it. The lowest polyphenol content is between 16-18ºB (Table 2.16). It was previously recommended that a ripeness norm of 16-18ºB be used since the possibility exists of poor berry taste due to high polyphenol quantities if harvesting commences after 18ºB (Avenant and Morkel, 2001; Strydom and Le Grange, 2001). Confirmation of these results is necessary and further investigation into cultivation practices that may affect the taste of Regal Seedless is very important. This project is scheduled to continue up to 2005 (Avenant and Morkel, 2001).

Regal Seedless is not yet a major cultivar contributor to total table grape exports from the Lower Orange River, but this cultivar has the potential to become of great economical importance in this area. Regal Seedless requires low labour inputs, ripens earlier than Sultana Seedless and treatments with GA is unnecessary (lower input costs). However, producers will have to comply with the recommended cultivation practices to ensure the viability of this cultivar on overseas markets. During the 2001/2002 season 166 000 (4.5 kg) cartons of Regal Seedless was produced in the Lower Orange River area (ORPA, 2002). In 2001 a total of 226 hectares of Regal Seedless was already planted (ORPA, 2001). According to future yield predictions, some 1.35 million (4.5 kg) cartons Regal Seedless will annually produced in area during the 2005/2006 season (ORPA, 2002).

Table 2.16 The connection between tasting tests, juice quality and polyphenol content of Regal Seedless (2000/2001 season, Nietvoorbij, Stellenbosch) (Avenant and Morkel, 2001).

Osmotic potential of sugar solution (atm)	Tasting panel		Juice quality parameters				Poliphenol content (g/l)
	Eating quality (mark out of 10)	Tannin character (mark out of 10)	Sugar (°B)	Acid (g/l)	pH	Sugar-acid ratio	
13	-	-	11.7	15.6	3.90	7.5	2938
14	-	-	11.6	15.0	N/A	7.7	2821
15	-	-	11.8	14.6	3.04	8.1	2939
16	1.93	5.72	13.6	10.2	3.27	13.3	2350
17	1.26	5.91	14.0	8.5	3.42	16.5	1880
18	2.81	4.83	14.6	7.5	3.33	19.5	1704
19	2.93	4.36	15.4	6.9	3.34	22.3	1586
20	3.94	4.29	16.3	6.7	3.42	24..3	1645
21	6.04	3.92	18.2	5.5	3.46	33.1	1763
22	6.47	3.54	17.9	5.1	3.74	35.1	1880
23	6.99	4.21	19.1	4.9	3.52	39.0	1998
24	6.20	4.64	20.6	4.9	3.88	42.0	1998
25	7.45	4.22	21.0	4.7	3.70	44.7	2056

2.4.4 PRIME SEEDLESS

Prime Seedless is the earliest white seedless table grape cultivar in South Africa. Prof. Spiegel Roy bred this cultivar at the Volcani Institute in Israel (which also holds the Plant Breeder's Rights). Mr. Aat Hoekstra (Hoekstra Fruit Farms) from Paarl imported this cultivar from Israel. After testing by the Directorate of Plant-and Quality control and 'warm water treatment' of the material it was released for commercial table grape farming. Vine royalties as well as fruit production royalties are applicable on this cultivar. Hoekstra Fruit Farms are the registered sole distributor of Prime Seedless in South Africa, Namibië and Zimbabwe and is also responsible for the collection of royalties. The first Prime Seedless was produced and exported from Hoekstra Fruit Farms in the 1997/1998 season (Welgemoed, 1998).

Prime Seedless is fertile with medium vigour. Due to the fertility of the basal buds, it can be pruned with short-or half long bearers. The berries are round and of medium size for a seedless cultivar and GA are applied to increase the berry size. Bunches are well filled without being compact and the berries have a good taste and storage ability. Prime seedless ripens seven to ten days before Sugraone and Flame Seedless. Prime Seedless is harvested from week 45 in the Lower Orange River area and very high prices are achieved for early Prime Seedless table grapes on overseas markets. Cultivation of Prime Seedless in early regions (like the Lower Orange River) has a definite advantage above other regions (Berg River area) where Prime Seedless matures later (lower prices). Since Prime Seedless does not grow very vigorously, Ramsey is recommended as a rootstock (Welgemoed, 1998).

Suckering of thin shoots, double shoots and shoots without bunches take place at 20 cm shoot length. Suckering of lateral shoots commences at 60 cm shoot length and at the same time spacing and tying of the remaining shoots takes place. Normally no manipulations take place prior to bloom except the removal of bunches in poor positions. However, in the case of very big and long bunch shoulders, the upper bunch shoulder tips or entire upper shoulder are removed. Manipulation of the crop load takes place after set. Only one bunch per shoot thicker than a pencil is left and the bunches are shortened to scissor length. The recommended crop load is 6.5 bunches per m² trellising area. The bunches are dipped into 10-ppm of GA and the vines girdled when the berries reach a size of 5-6 mm diameter. If the bunches is very uneven, it is recommended that two GA applications should take place. If the vines are strong enough to girdle, a single application of 10-ppm GA is satisfactory. Two applications of 10-ppm GA with the dipping technique at five to six millimetre berry diameter are recommended for young Prime Seedless vines. The reason for this is the fact that young vines are more susceptible to loose berries than older vines. The effect of total spraying on the fertility of Prime Seedless has not yet been determined. Dipping of individual Prime Seedless bunches into GA is at the moment the safest option. Thinning of compact bunches and uneven berries takes place at eight to ten mm berry size. At 20 mm berry diameter final thinning and bunch preparation should take place and the bunches should be protected against birds from *veraisón* (Mouton, 2001). According to Mouton (2001) the thinning cost of Prime Seedless compares very positive with the most other table grape cultivars. Producers along the Lower Orange River area experienced high labour inputs for bunch thinning during the 2001/2002 season, but the climate may have contributed in this regard. A summary of recommended cultivation practices for the successful cultivation of Prime Seedless is provided in Table 2.17.

At present the minimum maturity standard for this cultivar is a minimum total soluble solids of 16% (v/v). Harvesting of Prime Seedless table grapes along the Lower Orange River commenced from week 46 (early regions) onwards up to week 52 (late regions) during the 2001/2002 season (ORPA, 2002). According to the Export Standards and Requirements for table grapes, a Regal Seedless bunch qualifies to be exported as class 1, large, extra large and extra-extra large, if the minimum diameter (mm) of the berries is 16, 18, 20 and 22 mm respectively, for the different classes (Makhafola, 2001).

Prime Seedless is not yet a major cultivar contributor to total table grape exports from the Lower Orange River area, but this cultivar has the potential to become of great economical importance in this area, especially because it matures early and ensures very high prices on overseas markets. Since Prime Seedless is quite a new cultivar to this area, the best cultivation practices for this cultivar still needs to be developed. Research in this department is essential to cut on labour and financial inputs, but also to ensure high yields and quality of Prime Seedless. During the 2001/2002 season 145 000 (4.5 kg) cartons of Regal Seedless was produced in the

Lower Orange River are (ORPA, 2002). In 2001 a total of 383 hectares of Regal Seedless was already planted (ORPA, 2001). According to future yield predictions, some 2.16 million (4.5 kg) cartons Regal Seedless will annually be produced in this area during the 2005/2006 season (ORPA, 2002).

Table 2.17 Summary of the cultural practices used to produce Prime Seedless (compilation of the information presented).

Period	Action	Remarks
June-July	Pruning	• Short or half-long bearer pruning system
July	Hydrogen cyanamide (HC)	• 3-5% (v/v) HC • Applied at high spraying volumes (±1000-1300l/ha) or with sponge method
August-September	Suckering and tying of shoots	• Remove all excessive non-bearing and poor developed shoots when 10-20 cm long • Remove lateral shoots up to the bunch when 60 cm long • Space and tie fruit bearing shoots down on the wires when 60 cm long
September-October	Leaf removal	• Remove leaves around bunches prior to flowering • Pre-flowering leaf removal increases spray covering, light penetration, air circulation and prevents over shattering • Leaf removal can also take place after set if necessary
September-October	Cluster thinning	• No gibberellic acid (GA) application required for thinning
October-November	Cluster removal or trimming	• Usually no actions prior to flowering except the removal of clusters in poor positions • In the case of very big and long cluster shoulders, the upper cluster shoulder tip or entire upper shoulder are removed
October-November	Berry sizing	• 10 ppm GA applied in combination with girdling at 5-6 mm berry diameter for mature vines • 2 application of 10 ppm GA applied at 5-6 mm berry diameter recommended for young vines or if the bunches are very uneven • Use dipping technique for application of GA
October-November	Girdling	• Girdle when GA sizing takes place • Apply only if the trunk is thicker than 3.5 cm in diameter
October-November	Crop control	• Do crop control just after set • Only 1 bunch/shoot • 6.5 bunches per m² trellising area recommended
October-December	Bunch manipulation	• Shorten the bunches to ±8 cm after set • Do berry thinning from 8-10 mm berry size • Remove uneven berries as early as possible before bunches become to tight • Do final berry removal at ±20 mm berry size
October-November	Protect bunches	• Cover bunches to protect them from bird damage
November-January	Harvesting	• During early morning periods

2.5 CONCLUDING REMARKS AND FUTURE PROSPECTS

The establishment and cultivation of table grapes along the Lower Orange River area has increased dramatically the last few years. At present over 5000 hectares of table grapes is being cultivated in this area with more future expansions foreseen. This constitutes a big leap forward from the initial 10 000 cartons which were produced in this region in 1981 to the 14.46 million cartons which were exported during the 2001/2002 season. At this point in time the market for early seedless grapes is still good, but it may come under pressure on account of the large quantities being produced. This can have a huge financial impact on this region, but according to Van

Niekerk (1999) the phenomenal growth in this area will have the biggest effect on management and labour structures.

The South African table grape industry has come a long way since the first shipment of South African fruit arrived in England. Now, more than one hundred years later, South Africa is the one of the largest producers of table grapes in the world, competing successfully on international markets with all the big table grape producing nations of the world. The industry faced hard times more than once in it's past, making the successes and failures lessons learnt through time. This is very much true of the Lower Orange River area as table grape production region in South Africa.

There still exits great potential for expansion of table grape farming in the Lower Orange River area. Careful planning of new plantings is, however, essential and new markets should be identified to broaden the marketing potential for table grapes from this area. The producer's portfolio has to keep pace with the tastes and preferences of consumers as they change in order to keep being competitive on international markets. New cultivars are the lifeblood of the table grape industry. Producers along the Lower Orange River have to keep up to speed with locally developed and foreign cultivars that are seedless, resistant to berry crack, have low labour inputs, good cold storage capabilities and special characteristics such as muscat flavour, colour and taste. The early identification and planting of a promising cultivar according to the taste and preferences of consumers provide one with a tremendous advantage for present and future markets above your competitors. Research is also essential to ensure the long-term viability of the table grape industry in South Africa as well as the continuous education of people to equip them with the necessary skills to keep the South African (and Lower Orange River area) table grape industry on the forefront of international markets.

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Chapter 3

RESEARCH DESIGN

Site selection and primary description of experimental plots

RESEARCH DESIGN

3.1 INTRODUCTION

The financial outlay of table grape production, from the initial establishment of the vineyards through to the subsequent annual production costs, involves significant sums of money. The correct choices regarding the most profitable cultivar(s) for a specific area involves a plethora of factors, adding to the complexity of the decision. In an effort to extract relevant data regarding four early, white seedless table grape cultivars considered of extreme importance for the future cultivar profile of the Lower Orange River area of South Africa, a comparative study was initiated regarding certain production aspects of these cultivars.

The first step in the study involved selection of the experimental sites as well as establishing a database of historical and cultivation data of the cultivars on the experimental sites.

3.2 MATERIAL AND METHODS

3.2.1 SITE SELECTION

An effort was made to select experimental plots from the whole of the Lower Orange River production area from Groblershoop in the east to Blouputs in the west. This should provide a representative sample of typical early, medium and late harvesting dates in the Orange River area. This study started in January of 2001 and all information gathered from the chosen sites was for one full growing season only.

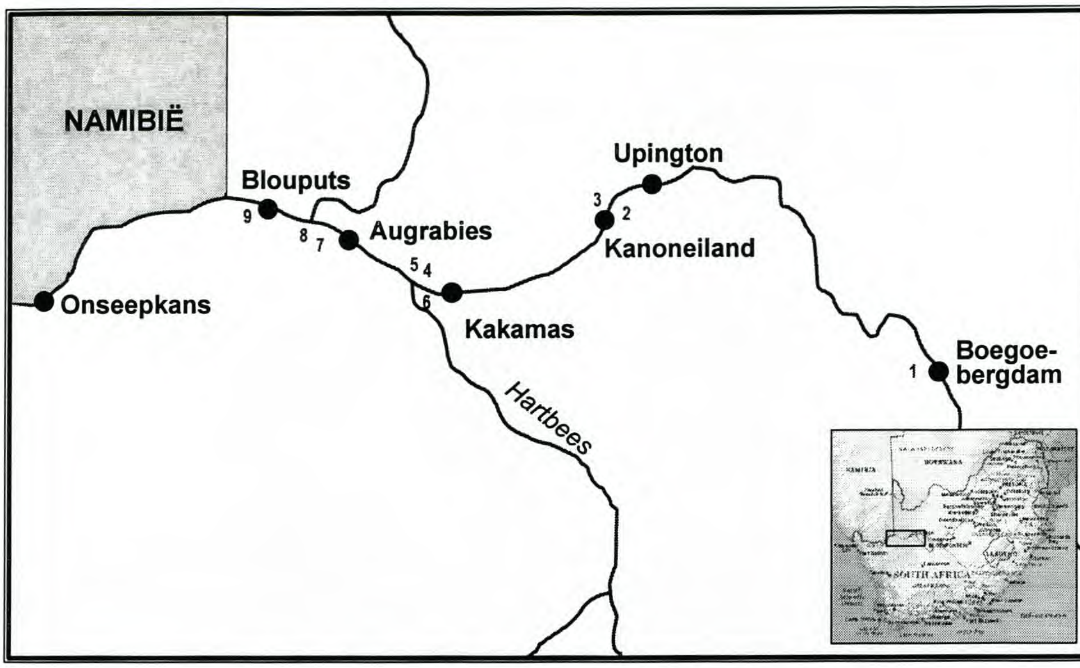
3.2.2 PRIMARY OR BASE DESCRIPTION PER CULTIVAR AND EXPERIMENTAL PLOT

The aim of this initiative was to obtain as much historical and new data on each unit and block studied as possible to give perspective to results obtained from it. Important factors that could influence potential yields and quality were identified. The information needed for the primary (or base) description per cultivar and experimental plot were gathered with the help of a questionnaire (see Table A.1 in the Addendum A). This was completed with the collaboration of the various producers or production managers of each experimental plot. A shortened database questionnaire was also prepared and distributed with the help of ORPA (Orange River Producer Alliance) to all their members regarding general cultivation practices and input costs specifically on the chosen four table grape cultivars that would serve as control/comparison with the results from the experimental plots that formed part of the study. This questionnaire was distributed early in 2002 and would have been used to compile information related to the 2001/2002 table grape season in the Lower Orange River area. The questionnaire consisted of basic questions regarding labour input (man-hours) and cost per manipulation, output yields, etc. regarding the four cultivars in the study. Only eight of the questionnaires were received back from a total of 160 that were distributed. Inquiries into the poor response revealed that many of the producers were unable to provide the required information, relating back to the obvious lack of a good record keeping system on most of the table grape-farming units in the Lower Orange River area. No data will be presented from this survey.

3.3 RESULTS AND DISCUSSION

Eight experimental plots each for Sultana Seedless and Sugraone that covered most of the Lower Orange River area were identified. Both younger and older experimental blocks for Sultana Seedless and Sugraone were included in this study. Due to the fact that Regal-and Prime Seedless were only recently introduced to this area, experimental plots for these cultivars which were already bearing fruit, was difficult to obtain. It was possible to identify only three experimental plots for Regal-and Prime Seedless each, which were already bearing fruit and where the producers were willing to be part of the project. Unfortunately, no experimental plots for Regal-and Prime Seedless, which were already bearing fruit, could be identified in the late maturing region (between Kakamas and Groblershoop). Two experimental plots for Regal-and Prime Seedless each was, however, identified in the early maturing region (as specified in chapter two) (between Onseepkans and Augrabies) and one experimental plot each in the middle-maturing region (between Augrabies and Kakamas). A total of 22 experimental plots on nine different farms formed part of this study. Fig. 3.1 and Table 3.1 provide specific information regarding the localities of each of the experimental plots. Producer and farm names are not revealed since all information was treated as confidential.

The primary descriptions per cultivar and experimental plot presented (Tables 3.2-3.4) are compiled from information gathered from the 2000/2001 and 2001/2002 table grape season along the Lower Orange River area. All the information presented such as dates, application volumes etc. in the primary description for each experimental plot may vary from season to season, due to climatic variations and changes in the cultivation practices and accordingly all dates are presented with a one-week interval. Practices described are not recommendations, but represent production procedures and methods used on each of the experimental plots in the study area. Establishment and cultural practices vary by grower and region for the four cultivars within the Lower Orange River area and could be significant. All information presented was in accordance with data provided by the producers or production managers of each experimental plot.



Numbers 1 to 9 refer to production unit numbers in Table 3.1

Fig 3.1 Map showing the location of the various production units along the Lower Orange River area.

3.4 CONCLUDING REMARKS

The experimental plots for Sultana Seedless and Sugraone were chosen to ensure representation of the various maturing regions of the Lower Orange River area. Experimental plots with mature and younger vines of Sultana Seedless and Sugraone were also included in the study for comparisons with the Regal- and Prime Seedless experimental plots consisting of young vines. It was only possible to identify three experimental plots for Regal- and Prime Seedless each, which were already bearing fruit. Nevertheless, data collected from these sites should provide early indications of what can be expected in terms of productivity, labour- and cost input for these new additions to the cultivar profile of the Lower Orange River. The primary description of the various experimental plots provides an extensive case study of the establishment cultural practices (including factors such as pruning and training, planting distance, etc.) and production cultural practices (including factors such as rest breaking, gibberellic acid application, etc) used for the cultivation of these four cultivars.

Table 3.1 General information regarding the various experimental plots for the four cultivars included in the study.

SULTANA SEEDLESS					
Production unit number	**Planting date**	**Rootstock**	**Size of experimental block (ha)**	**Area**	**Maturation region**
1	1993	143B	0.78	Groblershoop	Late
2	1996	Ramsey	4.99	Kanoneiland	Late
3	1996	143B	4.63	Kanoneiland	Late
4	1999	Ramsey	3.40	Kakamas	Middle
5	1997	Ramsey	5.00	Kakamas	Middle
7	1994	Ramsey	5.80	Augrabies	Early
8	1995	Ramsey	1.87	Augrabies	Early
9	1992	R99	0.96	Blouputs	Early
SUGRAONE					
Production unit number	**Planting date**	**Rootstock**	**Size of experimental block (ha)**	**Area**	**Maturation region**
1	1994	Own root	0.31	Groblershoop	Late
2	1996	R110	4.00	Kanoneiland	Late
3	1997	R110	3.05	Kanoneiland	Late
4	1999	Own root	3.30	Kakamas	Middle
5	1998	Own root	5.00	Kakamas	Middle
7	1999	Own root	1.10	Augrabies	Early
8	1993	R99	2.89	Augrabies	Early
9	1992	Own root	1.48	Blouputs	Early
REGAL SEEDLESS					
Production unit number	**Planting date**	**Rootstock**	**Size of experimental block (ha)**	**Area**	**Maturation region**
6	1998	Ramsey + own root	4.50	Kakamas	Middle
7	1999	Ramsey	5.70	Augrabies	Early
9	1999	R110	2.10	Blouputs	Early
PRIME SEEDLESS					
Production unit number	**Planting date**	**Rootstock**	**Size of experimental block (ha)**	**Area**	**Maturation region**
4	1999	Ramsey	3.00	Kakamas	Middle
7	1999	Ramsey	5.70	Augrabies	Early
9	2000	Ramsey	1.37	Blouputs	Early

Table 3.2 Primary description of Sultana Seedless for each experimental plot on the various production units.

SULTANA SEEDLESS									
		Production unit 1	Production unit 2	Production unit 3	Production unit 4	Production unit 5	Production unit 7	Production unit 8	Production unit 9
Area		Groblershoop	Kanoneiland	Kanoneiland	Kakamas	Kakamas	Augrabies	Augrabies	Blouputs
Maturation region		Late	Late	Late	Middle	Middle	Early	Early	Early
Annual rainfall (mm)		180-230	170-220	170-220	120-170	120-170	100-150	100-150	90-140
Hail occurrence		Sometimes	Sometimes	Sometimes	None	None	Sometimes	Sometimes	Sometimes
Frost occurrence (damage)		None	Sometimes	None	None	Sometimes	Sometimes	Sometimes	None
Heat waves		Sometimes	Sometimes	Sometimes	Sometimes	Sometimes	Sometimes	Sometimes	Sometimes
Size of block (ha)		0.78	4.99	4.63	3.40	5.00	5.80	1.87	0.96
Rootstock		143B	Ramsey	143B	Ramsey	Ramsey	Ramsey	Ramsey	R99
Planting date		1993	1996	1996	1999	1997	1994	1995	1992
Planting distance (m)		3.3 X 1.8	3.3 X 1.8	3.35 x 2.0	3.0 x 1.8	3.0 x 1.6	3.0 x 1.8	3.3 x 2.0	3.3 x 1.8
Vines/ha		1684	1684	1492	1851	2083	1851	1515	1684
Soil type		Sandy loam	Hutton-glen.	Sandy loam	Sandy loam	Granite/gneiss	Gneiss	Sandy loam	Gravely sand
Effective soil depth (mm)		700	1200	600-900	1200-1500	700	650	1500	700
Method of irrigation		Flood	Micro	Flood	Micro	Drip	Drip	Drip	Micro
Irrigation scheduling		Fixed cycle	Neutron probe	Profile holes	Profile holes	Crop factor	Neutron probe	Neutron probe	Fixed cycle
Training-and trellising system		Gable	Gable	Gable	Gable	Gable	Gable	Gable	Gable
Pruning system		Long bearers	Long bearers	Long bearers	Long bearers	Long bearers	Long bearers	Long bearers	Long bearers
Starting date of winter pruning	Clean pruning	None	1-7 Jun.	None	None	None	1-7 Jun.	18-25 May	1-7 May
	Final pruning	21-28 Jun.	11-18 Jul.	23-30 Jun.	1-7 Jun.	1-7 Jun.	4-11 Jun.	24-31 Jun.	3-10 Jun.
Number of bearer shoots/vine		12	12	12	6-8	12	12	12	12
Number of buds/bearer shoot		20	36	16-20	18	18 and more	16	14	14-18
Hydrogen cyanamide application	Starting date	21-28 Jul.	15-22 Jul.	20-27 Jul.	20-27 Jul.	4-11 Jul.	12-19 Jul.	10-17 Jul.	3-10 Jul.
	Concentration (v/v)	5%	4%	4%	5%	4%	5%	5%	4%
	Method	Spray	Sponge	Sponge	Sponge	Spray	Spray	Sponge	Sponge
Action and commencement date of spring and summer canopy- and bunch manipulations	Suckering	17-24 Sept.	21-28 Sept.	23-30 Sept.	9-16 Sept.	7-14 Sept.	14-21 Sept.	7-14 Sept.	1-7 Sept.
	Tying of shoots	3-10 Oct.	1-7 Oct.	10-17 Oct.	1-7 Oct.	20-27 Sept.	14-21 Sept.	10-17 Sept.	7-14 Sept.
	Leaf removal	7-14 Oct.	7-14 Oct.	28 Sept-4 Oct.	13-20 Oct.	28 Sept-5 Oct.	16-23 Sept.	23-31 Sept.	7-14 Sept.
	Yield regulation	7-14 Nov.	23-30 Oct.	22-29 Oct.	28 Oct.-4 Nov.	17-24 Oct.	13-20 Oct.	10-17 Oct.	8-15 Oct.
	Girdling	18-25 Oct.	27 Oct.-3 Nov.	20-27 Oct.	3-10 Nov.	16-23 Oct.	28 Oct-4 Nov.	1-7 Oct.	3-10 Oct.
	Bunches	7-14 Nov.	27 Oct.-3 Nov.	10-17 Nov.	3-10 Nov.	19-26 Oct.	3-10 Nov.	20-27 Oct.	8-15 Oct.

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Table 3.2 Continued

SULTANA SEEDLESS										
			Production unit 1	Production unit 2	Production unit 3	Production unit 4	Production unit 5	Production unit 7	Production unit 8	Production unit 9
Hanging of cover bags			None	None	None	None	None	None	None	None
Top actions	Times done		4	3-4	3	2	2	2	3	2-3
Gibberellin treatments for thinning	Starting date		10-17 Oct.	8-15 Oct.	15-22 Oct.	7-14 Oct.	1-7 Oct.	27 Sept-4 Oct.	25 Sept-2 Oct.	20-27 Sept.
	No. of applications		2	5	2	5	4	2	5	3
	Total concentration		20 ppm	30 ppm	50 ppm	50 ppm	30 ppm	20 ppm	50 ppm	40 ppm
Gibberellin for enlargement	No. of applications		4	4	4	3	5	4	4	3
	Total concentration		130 ppm	100 ppm	110 ppm	100 ppm	140 ppm	90 ppm	120 ppm	90 ppm
General (Only yes or no and the starting date of action)	Summer pruning	Yes/No	No	No	No	No	Yes	No	Yes	Yes
		Date	-	-	-	-	Middle Feb.	-	24-31 Jan.	1-7 Feb.
	Hydro-cooling	Yes/No	No	No	No	Yes	No	No	No	Yes
		Date	-	-	-	1-7 May	-	-	-	17-24 May
	Bark-removal	Yes/No	Yes	Yes	Yes	No	Yes	Yes	No	Yes
		Date	22-29 Aug.	27 Jul.-2 Aug.	19-26 Jul.	-	9-16 Sept.	15-22 Jul.	-	10-17 Aug.
Harvesting (Young vines at certain units – see planting date)	Start of harvesting		Week 52 – Week 1	Week 51 – Week 52	Week 52 – Week 1	Week 51- Week 52	Week 50 – Week 51	Week 50 – Week 51	Week 51 – Week 52	Week 49 – Week 50
	Cartons per ha	'00/ '01	3800	2800	2500	1600	2800	1700	4500	3500
		'01/ '02	3500	4800	4300	1600	4200	6600	6600	3600
Phenological cycle: General commencement dates	Dormancy		Middle June	Middle June	Middle June	Middle June	Middle June	Middle June	Middle June	Middle June
	Budburst		23-30 Aug.	21-28 Aug.	21-28 Aug.	17-24 Aug.	15-22 Aug.	10-17 Aug.	10-17 Aug.	5-12 Aug.
	Flowering		10-17 Oct.	8-15 Oct.	15-22 Oct.	8-15 Oct.	2-9 Oct.	27 Sept-3 Oct.	25 Sep-2 Oct.	18-25 Sept.
	Fruit set		23-30 Oct.	27 Oct.-3 Nov.	24-31 Oct.	22-29 Oct.	14-21 Oct.	1-7 Oct.	1-7 Oct.	28 Sept-5 Oct.
	Veraisón		20-27 Nov.	15-22 Nov.	21-28 Nov.	15-22 Nov.	10-17 Nov.	10-17 Nov.	15-22 Nov.	1-7 Nov.
Incidence of diseases and insects (Infection levels as none, moderate or heavy)	Mildew		None	Moderate	None	Moderate	Moderate	Moderate	Heavy	None
	Powdery mildew		Moderate	Moderate	Moderate	None	Moderate	Moderate	Moderate	None
	Botrytis		Moderate	Moderate	Moderate	Moderate	Moderate	Heavy	Moderate	None
	Mealy-bugs		Moderate	Moderate	None	Moderate	Moderate	Heavy	Moderate	None
	Ants		None	Moderate	None	Heavy	Moderate	Heavy	Moderate	Moderate
	Snout beetles		None	None	None	None	None	None	Moderate	None
	Leaf hoppers		Moderate	Moderate	Moderate	None	None	Moderate	Moderate	None
	Thrips		Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Heavy	Moderate
	Fruit Flies		Heavy	Moderate	Moderate	None	None	None	Moderate	None

Table 3.3 Primary description of Sugraone for each experimental plot on the various production units.

SUGRAONE									
		Production unit 1	Production unit 2	Production unit 3	Production unit 4	Production unit 5	Production unit 7	Production unit 8	Production unit 9
Area		Groblershoop	Kanoneiland	Kanoneiland	Kakamas	Kakamas	Augrabies	Augrabies	Blouputs
Maturation region		Late	Late	Late	Middle	Middle	Early	Early	Early
Annual rainfall (mm)		180-230	170-220	170-220	120-170	120-170	100-150	100-150	90-140
Hail occurrence		Sometimes	Sometimes	Sometimes	None	None	Sometimes	Sometimes	Sometimes
Frost occurrence (damage)		None	Sometimes	None	None	Sometimes	Sometimes	Sometimes	None
Heat waves		Sometimes	Sometimes	Sometimes	Sometimes	Sometimes	Sometimes	Sometimes	Sometimes
Size of block (ha)		0.31	4.00	3.05	3.30	5.00	1.10	2.89	1.48
Rootstock		Own root	R110	R110	Own root	Own root	Own root	R99	Own root
Planting date		1994	1996	1997	1999	1998	1999	1993	1992
Planting distance (m)		3.3 x 2.0	3.3 x 2.0	3.35 x 1.5	3.0 x 1.8	3.0 x 1.6	3.0 x 1.5	3.0 x 2.0	3.6 x 1.8
Vines/ha		1515	1515	1990	1852	2083	2222	1667	1543
Soil type		Sandy loam	Glen Rosa	Rocky lime	Sandy loam	Granite	Granite	Sand	Loam
Effective soil depth (mm)		700	1200	600-900	1500	700	700	1500	700
Method of irrigation		Flood	Micro	Micro	Micro	Drip	Drip	Drip	Micro
Irrigation scheduling		None	Neutron probe	Profile holes	Profile holes	Crop factor	Neutron probe	Neutron probe	Fixed cycle
Training-and trellising system		Gable	Gable	Gable	Gable	Gable	Gable	Gable	Gable
Pruning system		Long bearers	Long bearers	Long bearers	Long bearers	Long bearers	Short bearers	Long bearers	Long bearers
Starting date of winter pruning	Clean pruning	None	5-12 Jun.	None	None	None	20-27 May	14-21 May	6-13 May
	Final pruning	23-30 Jun.	2-9 Jul.	23-30 Jun.	7-14 Jun.	14-21 Jun.	1-7 Jun.	1-7 Jun.	11-18 Jun.
Number of bearer shoots/vine		12	12	12	6-8	8 + 4 spurs	8	12	12
Number of buds/bearer shoot		20	36	16-20	16	18 and more	2-3	14	14-16
Hydrogen cyanamide application	Starting date	15-21 Jul.	9-16 Jul.	11-18 Jul.	16-23 Jul.	2-9 Jul.	1-7 Jul.	7-13 Jul.	6-13 Jul.
	Concentration (v/v)	5%	4%	4%	5%	4%	5%	4%	4%
	Method	Spray	Sponge	Sponge	Sponge	Spray	Spray	Sponge	Sponge
Action and commencement date of spring and summer canopy- and bunch manipulations	Suckering	21-28 Sept.	23-30 Sept.	20-27 Sept.	22-29 Sept.	2-9 Sept.	2-9 Sept.	1-7 Sept.	1-7 Sept.
	Tying of shoots	1-7 Oct.	28 Sept-4 Oct.	9-16 Oct.	28 Sept-5 Oct.	14-21 Sept.	2-9 Sept.	10-17 Sept.	17-24 Sept.
	Leaf removal	21-28 Oct.	2-9 Oct.	15-22 Oct.	17-24 Oct.	2-9 Oct.	14-21 Sept.	7-14 Oct.	17-24 Sept.
	Yield regulation	4-11 Nov.	26 Oct.-2 Nov.	28 Oct.-4 Nov.	6-13 Nov.	17-24 Oct.	8-15 Oct.	7-14 Oct.	1-7 Oct.
	Girdling	4-11 Nov.	26 Oct.-2 Nov.	11-18 Nov.	3-10 Nov.	20-27 Oct.	None	7-14 Oct.	15-22 Oct.
	Bunches	4-11 Nov.	26 Oct.-2 Nov.	19-26 Nov.	10-17 Nov.	18-25 Oct.	10 –17 Oct.	7-14 Oct.	19-26 Oct.

Table 3.3 Continued

SUGRAONE										
			Production unit 1	Production unit 2	Production unit 3	Production unit 4	Production unit 5	Production unit 7	Production unit 8	Production unit 9
Hanging of cover bags			None	None	None	None	None	None	None	Yes
Top actions	Times done		4	3-4	1	2	1	2	3	2-3
Gibberellin treatments for thinning	Starting date		29 Oct.-4 Nov.	24-31 Oct.	20-27 Oct.	27 Oct.-3 Nov.	15-22 Oct.	14-21 Oct.	14-21 Oct.	19-26 Oct.
	No. of applications		-	1	-	-	-	-	-	-
	Total concentration		-	5 ppm	-	-	-	-	-	-
Gibberellin for enlargement	No. of applications		1	2	2	2	3	2	2	2
	Total concentration		20 ppm	20 ppm	20 ppm	20 ppm	40 ppm	10 ppm	20 ppm	20 ppm
General (Only yes or no and the starting date of action)	Summer pruning	Yes/No	No	No	No	No	Yes	Yes	Yes	Yes
		Date	-	-	-	-	Middle Feb.	Start of Feb.	11-18 Feb.	10-17 Jan.
	Hydro-cooling	Yes/No	No	No	No	Yes	No	No	No	No
		Date	-	-	-	1-7 May	-	-	-	-
	Bark-removal	Yes/No	Yes	Yes	Yes	No	Yes	No	No	Yes
		Date	23-30 Aug.	27 Jul.-3 Aug.	29 Jul.-5 Aug.	-	10-17 Sept.	-	-	17-23 Aug.
Harvesting (Young vines at certain units – see planting date)	Start of harvest		Week 50 – Week 51	Week 49 – Week 50	Week 49 – Week 50	Week 49 – Week 50	Week 48 – Week 49	Week 48 – Week 49	Week 49 – Week 50	Week 47- Week 48
	Cartons per ha	'00/ '01	4500	3000	2500	1100	3300	1000	4500	3800
		'01/ '02	4050	5800	2500	1700	4700	3300	6000	3400
Phenological cycle: General commencement dates	Dormancy		Middle June	Middle June	Middle June	Middle June	Middle June	Middle June	Middle June	Middle June
	Budburst		17-23 Aug.	14-21 Aug.	14-21 Aug.	12-19 Aug.	10-17 Aug.	8-15 Aug.	8-15 Aug.	1-7 Aug.
	Flowering		5-12 Oct.	3-10 Oct.	1-7 Oct.	1-8 Oct.	25 Sept-2 Oct.	27 Sept-3 Oct.	25 Sep-2 Oct.	17-25 Sept.
	Fruit set		23-30 Oct.	24-31 Oct.	20-27 Oct.	15-22 Oct.	11-17 Oct.	1-7 Oct.	1-7 Oct.	23-30 Sept.
	Veraisón		15-22 Nov.	12-19 Nov.	12-19 Nov.	12-19 Nov.	10-17 Nov.	7-14 Nov.	7-14 Nov.	24-31 Oct.
Incidence of diseases and insects (Infection levels as none moderate or heavy)	Mildew		None	Moderate	None	Moderate	Moderate	Moderate	Heavy	None
	Powdery mildew		Moderate	Moderate	Moderate	None	Moderate	Moderate	Moderate	None
	Botrytis		Moderate	Moderate	Moderate	Moderate	Moderate	Heavy	Moderate	None
	Mealy-bugs		Moderate	Moderate	None	Moderate	Moderate	Heavy	Moderate	None
	Ants		None	Moderate	None	Heavy	Moderate	Heavy	Moderate	Moderate
	Snout beetles		None	None	None	None	None	None	Moderate	None
	Leaf hoppers		Moderate	Moderate	Moderate	None	None	Moderate	Moderate	None
	Thrips		Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Heavy	Moderate
	Fruit Flies		Heavy	Moderate	Moderate	None	None	None	Moderate	None

Table 3.4 Primary description of Regal- and Prime Seedless for each experimental plot on the various production units.

		REGAL SEEDLESS			PRIME SEEDLESS		
		Production unit 6	Production unit 7	Production unit 9	Production unit 4	Production unit 7	Production unit 9
Area		Kakamas	Augrabies	Blouputs	Kakamas	Augrabies	Blouputs
Maturation region		Middle	Early	Early	Middle	Early	Early
Annual rainfall (mm)		120-170	100-150	90-140	120-170	100-150	90-140
Hail occurrence		Sometimes	Sometimes	Sometimes	None	Sometimes	Sometimes
Frost occurrence (damage)		None	Sometimes	None	None	Sometimes	None
Heat waves		Sometimes	Sometimes	Sometimes	Sometimes	Sometimes	Sometimes
Size of block (ha)		4.50	5.70	2.10	3.00	5.70	1.37
Rootstock		Ramsey+Own	Ramsey	R110	Ramsey	Ramsey	Ramsey
Planting date		1998	1999	1999	1999	1999	2000
Planting distance (m)		3.3 x 2.0	3.0 x 1.5	3.3 x 1.8	3.0 x 1.8	3.2 x 1.5	3.0 x 1.5
Vines/ha		1515	2222	1684	1852	2083	2222
Soil type		Granite	Gravel	Sandy loam	Sandy loam	Gravel	Silt loam
Effective soil depth (mm)		1200	700	700	1500	700	700
Method of irrigation		Drip	Drip	Micro	Micro	Drip	Micro
Irrigation scheduling		Fixed cycle	Neutron probe	Fixed cycle	Profile holes	Neutron probe	Fixed cycle
Training-and trellising system		Gable	Gable	Gable	Gable	Gable	Gable
Pruning system		Long bearers	Short bearers	Short bearers	Semi-long	Short bearers	Short bearers
Starting date of winter pruning	Clean pruning	None	21-28 May	None	None	19-26 May	None
	Final pruning	23-30 Jun.	18-25 Jun.	23-30 Jun.	27 May-3 Jun.	26 May-2 Jun.	23-30 Jun.
Number of bearer shoots/vine		8	8	4	8	8	4
Number of buds/bearer shoot		16	2-3	2	10	2-3	2
Hydrogen cyanamide application	Starting date	1-7 Jul.	6-13 Jul.	1-7 Jul.	12-19 Jul.	4-11 Jul.	3-10 Jul.
	Concentration (v/v)	5%	5%	4%	5%	5%	4%
	Method	Spray	Spray	Sponge	Sponge	Spray	Sponge
Action and commencement date of spring and summer canopy- and bunch manipulations	Suckering	11-18 Sept.	16-23 Sept.	13-20 Sept.	8-15 Sept.	2-10 Sept.	8-15 Sept.
	Tying of shoots	11-18 Sept.	16-23 Sept.	16-23 Sept.	15-23 Sept.	10-17 Sept.	16-23 Sept.
	Leaf removal	None	24-31 Sept.	16-23 Sept.	1-7 Oct.	17-24 Sept.	16-23 Sept.
	Yield regulation	None	24-31 Sept.	None	17-24 Sept.	17-24 Sept.	9-16 Oct.
	Girdling	None	None	None	None	None	None
	Bunches	1-7 Nov.	10-17 Nov.	23-30 Oct.	3-9 Nov.	24-31 Oct.	1-7 Oct.

Table 3.4 Continued

			REGAL SEEDLESS			PRIME SEEDLESS		
			Production unit 6	Production unit 7	Production unit 9	Production unit 4	Production unit 7	Production unit 9
Hanging of cover bags			None	None	None	Yes	Yes	Yes
Top actions	Times done		None	2	1	1-2	2	1
Gibberellin treatments for thinning	Starting date		None	None	None	11-18 Oct.	1-7 Oct.	6-13 Oct.
	No. of applications		-	-	-	-	-	-
	Total concentration		-	-	-	-	-	-
Gibberellin for enlargement	No. of applications		None	None	None	2	2	2
	Total concentration		-	-	-	30 ppm	20 ppm	30 ppm
General (Only yes or no and the starting date of action)	Summer pruning	Yes/No	Yes	Yes	None	No	Yes	No
		Date	14-21 Jan.	Start of Feb.	-	-	Start of Feb.	-
	Hydro-cooling	Yes/No	No	No	Yes	Yes	No	Yes
		Date	-	-	21-28 May	1-7 May	-	20-27 May
	Bark-removal	Yes/No	No	No	No	No	No	No
		Date	-	-	-	-	-	-
Harvesting (Vines are very young, accordingly lower yields)	Start of harvest		Week 50 – Week 51	Week 50 – Week 51	Week 48 – Week 49	Week 47- Week 48	Week 46 – Week 47	Week 46 – Week 47
	Cartons per ha	'00/ '01	900	1000	500	2000	1000	0
		'01/ '02	1700	3200	2100	2800	1550	2000
Phenological cycle: General commencement dates	Dormancy		Middle June	Middle June	Middle June	Middle June	Middle June	Middle June
	Budburst		10-17 Aug.	10-17 Aug..	5-12 Aug.	10-17 Aug.	5-12 Aug.	1-7 Aug.
	Flowering		1-7 Oct.	27 Sept-3 Oct	21-28 Sept.	27 Sept-3 Oct.	26 Sept-2 Oct.	17-25 Sept.
	Fruit set		5-12 Oct.	1-7 Oct.	28 Sept-5 Oct.	5-12 Oct.	1-7 Oct.	23-30 Sept.
	Veraisón		10-17 Nov.	10-17 Nov.	27 Oct.-3 Nov.	1-7 Nov.	27 Oct.-3 Nov.	20-27 Oct.
Incidence of diseases and insects (Infection levels as none, moderate or heavy)	Mildew		None	Moderate	None	Moderate	Moderate	None
	Powdery mildew		Moderate	Moderate	None	None	Moderate	None
	Botrytis		None	Heavy	None	Moderate	Heavy	None
	Mealy-bugs		Moderate	Heavy	None	Moderate	Heavy	None
	Ants		Heavy	Heavy	Moderate	Heavy	Heavy	Moderate
	Snout beetles		None	None	None	None	None	None
	Leaf hoppers		Moderate	Moderate	None	None	Moderate	None
	Thrips		Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	Fruit Flies		Moderate	None	None	None	None	None

ADDENDUM A

Table A.1 An example of the questionnaire used to gather the information needed for the primary (or base) description per cultivar and per experimental plot which were completed with the collaboration of the various producers or production managers of each experimental plot. Information regarding the farm name and block manager is fictitious.

Primary description questionnaire			
Farm name			XYZ-farming
Cultivar			Sultana Seedless
Block number/name			18
Block manager			Mr. J. du Toit
Rootstock			R99
Origin of vines			Wellington
Planting date			1996
Size of block			5.0 ha
Vines/ha			1684
Plant spacing			3.3 m x 1.8 m
Trellising system			Gable
Row direction			North-south
Soil	Soil type		Hutton-Glenrosa
	Soil preparation		Cross-rip
	Soil depth		1200 mm
Irrigation- and scheduling	Method of irrigation		Micro
	Method of scheduling		Neutron probe
Monitoring	Soil analysis		Annually
	Leaf analysis		Annually
	Other		None
Vine pruning	Pruning system		Long bearers
	Start of pruning (date)	*Summer pruning*	None
		Pre-pruning	1-7 Jun
		Main-pruning	1-7 Jul
	Number of bearers/vine		12
	Number of buds/bearer		26

Primary description questionnaire (continued)			
Rest Breaking	Hydrogen cyanamide	*Date of application*	23-30 Jul
		Number of applications	1
		Concentration of applications	5% (v/v)
		Method of application	Sponge
	Other rest breaking agents used		None
Spring and Summer actions	Canopy management (Indicate the commencement date of first action and times the action was applied)	Suckering rootstock shoots	2 times (23-30 Sept)
		Suckering of shoots	With leaf removal
		Suckering lateral shoots + anchors	3 times (10-17 Oct)
		Leaf removal	3 times (10-17 Oct)
		Tying of shoots to wire	3 times (according to vigour)
		Tip and top actions	None
	Gibberellin treatments for sizing	*Date of application*	15-22 Oct
		Number of applications	2
		Concentration of applications	10 parts per million
		Method of application	Spraying by tractor
	Girdling	*Date of action*	24-31 Oct
	Bunch manipulation	*Shortening of bunches*	1 action (1-7 Nov)
		Removal of uneven berries	With shortening of bunches
		Thinning of compact bunches	1 action (1-7 Dec)
	Yield regulation	*Time of yield regulation*	After set
		Bunches/vine	26
Harvesting	Commencement of harvesting	Week 51-52	
	Average cartons/ha	3800	

Primary description questionnaire (continued...)		
General information	Commencement of dormancy	Middle June
	Commencement of budburst	21-28 Aug
	Commencement of flowering	15-22 Oct
	Commencement of set	24-31 Oct
	Commencement of veraison	21-28 Nov
	Commencement of harvest	16-23 Dec
	Commencement of leaf fall	Middle May
Diseases, pests and insects	Powdery mildew (*Oiiduim*)	None
	Downy mildew	Moderate
	Botrytis cinerea	Moderate
	Phomopsis viticola	None
	Mealy-bugs	Moderate
	Ants	Moderate
	Snout beetles	None
	Leaf-hoppers	None
	Thrips	Moderate
	Fruit fly	Moderate

Chapter 4

RESEARCH RESULTS

Comparative analysis of the input costs linked to the cultural production practices of four white seedless table grape cultivars cultivated in the Lower Orange River area

RESEARCH RESULTS

4.1 INTRODUCTION

Grapes are produced throughout the world and production is expanding. Competition between grape producing countries for the top markets is consequently increasing. Unlike most agricultural commodities, increased competitiveness in table grape production is not simply a function of higher yields and lower production costs per ton. Improving table grape quality is often more important than improving yields.

Adoption of new technologies in the table grape industry worldwide has increased grape quality and driven growth of the industry. Combined with modern business and production practices it is making international competition in the table grape markets fierce. Continued growth and sustainability of the South African (and Lower Orange River area) table grape industry depend upon continued research-based advances in the technology of table grape production. The need for information on basic grapevine physiology, production systems and input costs for the various table grapes cultivars has been identified as being critical to the development of improved pest management programs, improved product quality as well as enhanced production sustainability (Anon., 2002).

The increasing input costs and price volatility of table grape production in South Africa are some of the most important factors determining the financial survival of a table grape producer. Given the complex business and dynamic environment that the table grape producer finds himself in, attempts must be made to ensure yield- and price stability as far as possible while the production cost structure receives constant attention. The strategic vision of every table grape farming unit is not only to survive financially, but also to ensure sustainable growth through the optimisation of production by lowering cost of production, marketing and the efficient use of the farming resources of which labour is the most important (Morgan, 2002).

The cost of labour is the single highest contributing factor to total production cost of table grapes. Salaries and wages can contribute over 50% of the total production cost. In view of this, labour input should receive special attention in production cost studies. It is evident that a table grape cultivar that requires less labour inputs than another may have a definite financial advantage in the production cost category. Labour availability to perform the necessary manipulations for the successful cultivation of a table grape cultivar is also a very important factor to consider before new plantings are made. To comparatively analyse the labour input for more than one cultivar, a breakdown of the production cultural practices of each cultivar into the major actions/manipulations (such as pruning, canopy management, bunch manipulations, etc) and awarding a “man-hour value” for the completion of each action is a handy way to highlight labour input/cost differences between cultivars. From this type of data it is possible to clearly see the “positives” and “negatives” of each cultivar as well as in comparison to other cultivars in terms of labour input.

In view of the recent introduction of Regal- and Prime Seedless to the Lower Orange River area, no information exists regarding the input costs linked to the cultural production practices of these cultivars. The purpose was to compare the input costs per main manipulation/action (such as pruning, canopy management, bunch manipulation, etc), especially in terms of labour input (man-hours needed per manipulation) for the cultivars Sultana Seedless, Sugraone, Regal-and Prime Seedless. This approach is rare in the South African environment since most economical impact studies in the grapevine industry rely on combined mean values for input costs. The aim is to identify trends in terms of the relative cost-effectiveness, especially in terms of labour and the long-term potential of these four cultivars in the Lower Orange River area.

4.2 MATERIAL AND METHODS

Relevant information regarding production input costs was obtained from the producers and the production units as specified in Table 3.1. Each producer received a folder containing all the information relevant to his production unit, together with forms to extract the information (see Table B1-B3 in Addendum B) per manipulation. The producers had the choice to fill out these forms or to provide us with their own information, as it exists in their system. A communication system was set up with all the producers/managers through whom they received reminders and some guidelines when and how to complete the various forms, or provide the necessary information required. A complete data set was compiled and reconciled for each experimental plot, after which analyses commenced.

All labour inputs were determined for each of the four cultivars as man-hours spent per manipulation. The average hourly wage for seasonal workers in the Lower Orange River area was determined as R2.68 per man-hour using the data on hourly wages paid at each of the production units. The average hourly wages for seasonal workers in this region was multiplied with the man-hours spent per manipulation to determine the labour cost of a specific manipulation for each of the four cultivars. Information from the experimental plots yielded average man-hours and labour cost per cultivar and cultural production manipulation. Several of the other components contributing to total production cost [including hydrogen cyanamide (HC) and gibberellic acid (GA) application] were made applicable to all four cultivars from information gathered from other sources (previous research, recommended practices programs, etc.). General production cultural practices like insect and disease management, fertilisation and vineyard floor management (weed control) were not considered in this study. The step-by-step procedure involved the following:

(i) **Calculating the input costs in terms of labour for pruning (and tying of canes where applicable)**: Pruning is done during the winter from middle May to the end July in the Lower Orange River area. One or two of the production units in this study also performed summer pruning in the post harvest period (middle January to the end of February), ensuring less man-hours spent on pruning during the winter months. The summer pruning on these plots was, however, calculated as winter pruning to simplify calculations. The cost for each experimental plot was determined only in terms of direct labour cost and excludes any costs of materials used or any extraordinary cost.

(ii) **Calculating the input costs in terms of labour regarding canopy management**: Canopy management commences shortly after budburst (middle August to middle September) with the removal of suckers and sterile shoots from the vine trunks and crowns in the Lower Orange River area. In this study canopy management included suckering of unwanted shoots, -lateral shoots, -anchors, -unwanted flower clusters, tying and positioning of shoots, leaf removal, positioning of flower bunches and adjustment of the crop load. All flower clusters were seen as part of the canopy until set had occurred and crop load adjustment or yield regulation (removal of unwanted flower bunches or bunches) were included under canopy management in this study. The cost for each experimental plot was determined only in terms of direct labour cost and excludes any costs of materials used or any extraordinary cost.

(iii) **Calculating the input costs in terms of labour regarding bunch manipulations**: Bunch manipulations commence at various stages during the growing season depending on the cultivar and its inherent characteristics. In this study, bunch manipulations included shortening of the bunch to the correct size, tipping and removal of bunch/flower cluster shoulders, removal of uneven berries and bunch thinning. It excluded crop control (included with canopy management in this study) and flower cluster thinning or enlargement of berries with hormones (will be handled separately). Bunch manipulation for the four cultivars included in this study usually commenced after set, but manipulation of flower clusters during flowering to ensure better set (Regal Seedless) do take place if necessary. The cost per manipulation for each experimental plot was determined only in terms of direct labour cost and excluded any costs of materials used or any extraordinary cost.

(iv) **Calculating the input costs for the application of rest-breaking agents:** HC is applied to all four cultivars on a routine basis in the Lower Orange River area. It was presumed for this study, that the tractor application of HC at a constant concentration for mature Sultana Seedless, Sugraone, Regal- and Prime Seedless would have the same labour input and cost. Accordingly, the man-hours and cost of HC application was not determined for the cultivars individually from the experimental plots. Instead a standard application of 5% (v/v) Dormex® applied by tractor to all four cultivars is presumed and the cost and man-hours for this action presented.

(v) **Calculating the input costs for GA application:** The man-hours and cost of GA application for thinning and sizing were not determined for the various experimental plots and cultivars due to the divergent use of GA for the same cultivar by the different production units. In view of this, the man hours and cost for this action was calculated from recommended practices for each cultivar to give an indication of what can be expected in terms of labour input and cost.

(vi) **Other relevant production cultural practices:** Girdling and protection of grape bunches were the only other cultural production practices that were considered in the study.

(vii) **Statistical analysis**: The data were investigated for significant differences (P≤ 0.10) between the cultivars for input costs in terms of labour for pruning, canopy management and bunch manipulation. Analysis of variance was performed with the SAS System.

4.3 RESULTS

4.3.1 PRUNING (AND TYING OF CANES WHERE APPLICABLE)

Table 4.1 depicts the results gathered from the individual experimental plots for Sultana Seedless, Sugraone, Regal- and Prime Seedless. Table 4.2 shows the analysis of variance of the information gathered for the four cultivars. The test for differences between the man-hour means for the pruning action of the cultivars was not significant (P=0.863) (and tying of the canes where applicable). However, according to Bartlett's test, heterogeneity of variance occurred (P=0.0131). Figure 4.1 depicts the average man-hours spent on this action for the various cultivars as well as the variation within the man-hours spent based on the data from the different experimental plots.

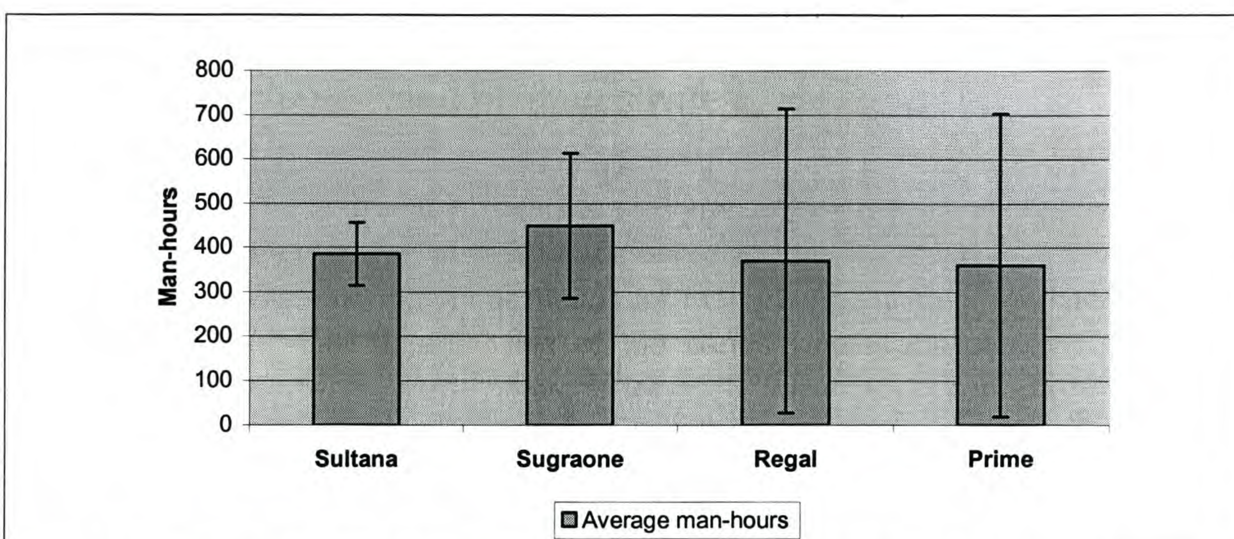

Fig 4.1 Average man-hours spent on pruning and tying of the canes for the four table grape cultivars based on data extracted from different experimental plots along the Lower Orange River during the 2001/2002 season. The statistical analysis was generated with the SAS system (Error bars indicate the standard deviation).

Table 4.1 Man-hours and cost per hectare for pruning and tying of the various cultivars.

Production unit number	Area	Pruning system	Bearer shoots/ vine	Buds/ bearer shoot	Planting year	Man-hours per ha	Cost (R) per ha
SULTANA SEEDLESS							
Production unit number	**Area**	**Pruning system**	**Bearer shoots/ vine**	**Buds/ bearer shoot**	**Planting year**	**Man-hours per ha**	**Cost (R) per ha**
1	Groblershoop	Long	12	20	1993	438	1173.84
2	Kanoneiland	Long	12	36	1996	274	734.32
3	Kanoneiland	Long	12	16-20	1996	397	1063.96
4	Kakamas	Long	6-8	18	1999	289	774.52
5	Kakamas	Long	12	18+	1997	436	1168.48
7	Augrabies	Long	12	16	1994	373	999.64
8	Augrabies	Long	12	14	1995	476	1275.68
9	Blouputs	Long	12	14-18	1992	398	1066.64
Average						**385**	**1032.14**
SUGRAONE							
Production unit number	**Area**	**Pruning system**	**Bearer shoots/ vine**	**Buds/ bearer shoot**	**Planting year**	**Man-hours per ha**	**Cost (R) per ha**
1	Groblershoop	Long	12	20	1994	425	1139.00
2	Kanoneiland	Long	12	36	1996	285	763.80
3	Kanoneiland	Long	12	16-20	1997	603	1616.04
4	Kakamas	Long	6-8	16	1999	237	635.16
5	Kakamas	Long	8+4 spurs	18+	1998	426	1141.68
7	Augrabies	Short	8	2-3	1999	744	1993.92
8	Augrabies	Long	12	14	1993	401	1074.68
9	Blouputs	Long	12	14-16	1992	475	1273.00
Average						**450**	**1204.66**
REGAL SEEDLESS							
Production unit number	**Area**	**Pruning system**	**Bearer shoots/ vine**	**Buds/ bearer shoot**	**Planting year**	**Man-hours per ha**	**Cost (R) per ha**
6	Kakamas	Long	8	16	1998	291	779.88
7	Augrabies	Short	8	2-3	1999	746	1999.28
9	Blouputs	Short	4	2	1999	74	198.32
Average						**370**	**992.49**
PRIME SEEDLESS							
Production unit number	**Area**	**Pruning system**	**Bearer shoots/ vine**	**Buds/ bearer shoot**	**Planting year**	**Man-hours per ha**	**Cost (R) per ha**
4	Kakamas	Semi	8	10	1999	246	659.28
7	Augrabies	Short	8	1-3	1999	746	1999.28
9	Blouputs	Short	4	2	2000	91	243.88
Average						**361**	**967.48**

Table 4.2 Statistical analysis of the data received for the pruning and tying of the canes action from the various experimental plots for the four cultivars.

Source of variation	DF	Mean square	P-value
Cultivar	3	9448.774	0.8632
Error	18	38440.64	
Total	21		

4.3.2 CANOPY MANAGEMENT

The results gathered from the individual experimental plots for the canopy management action for Sultana Seedless, Sugraone, Regal- and Prime Seedless are shown in Table 4.3. Table 4.4 shows the analysis of variance of the information gathered for the four cultivars. The test for differences between the man-hour means for this action of the cultivars was significant (P=0.0628). However, according to Bartlett's test, no heterogeneity of variance occurred (P=0.521). The average man-hours spent on canopy management of the various cultivars as well as the variation within the man-hours spent based on the data from the different experimental plots are depicted in Figure 4.2.

Table 4.3 Man-hours and cost per hectare for canopy management of the various cultivars.

SULTANA SEEDLESS				
Production unit number	**Area**	**Planting year**	**Man-hours per hectare**	**Cost (R) per hectare**
1	Groblershoop	1993	1052	2819.36
2	Kanoneiland	1996	700	1876.00
3	Kanoneiland	1996	864	2315.52
4	Kakamas	1999	753	2018.04
5	Kakamas	1997	934	2503.12
7	Augrabies	1994	705	1889.40
8	Augrabies	1995	1193	3197.24
9	Blouputs	1992	1082	2899.76
	Average		**910**	**2439.81**
SUGRAONE				
Production unit number	**Area**	**Planting year**	**Man-hours per hectare**	**Cost (R) per hectare**
1	Groblershoop	1994	1064	2851.52
2	Kanoneiland	1996	840	2251.20
3	Kanoneiland	1997	1312	3516.16
4	Kakamas	1999	684	1833.12
5	Kakamas	1998	1106	2964.08
7	Augrabies	1999	686	1838.48
8	Augrabies	1993	1248	3344.64
9	Blouputs	1992	1109	2972.12
	Average		**1006**	**2696.42**
REGAL SEEDLESS				
Production unit number	**Area**	**Planting year**	**Man-hours per hectare**	**Cost (R) per hectare**
6	Kakamas	1998	240	643.20
7	Augrabies	1999	751	2012.68
9	Blouputs	1999	743	1991.24
	Average		**578**	**1549.04**
PRIME SEEDLESS				
Production unit number	**Area**	**Planting year**	**Man-hours per hectare**	**Cost (R) per hectare**
4	Kakamas	1999	777	2082.36
7	Augrabies	1999	806	2160.08
9	Blouputs	2000	956	2562.08
	Average		**846**	**2268.17**

Table 4.4 Statistical analysis of the data received for the canopy management action from the various experimental plots for the four cultivars.

Source of variation	DF	Mean square	P-value
Cultivar	3	136308.4	0.0628
Error	18	46831.86	
Total	21		

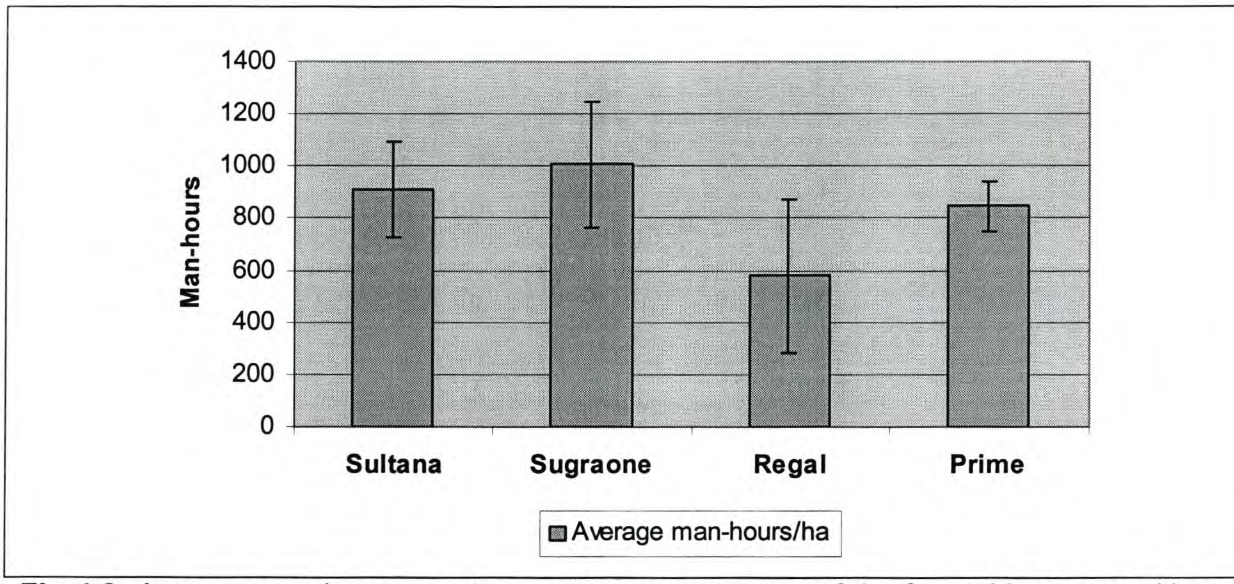

Fig 4.2 Average man-hours spent on canopy management of the four table grape cultivars based on data extracted from different experimental plots along the Lower Orange River during the 2001/2002 season. The statistical analysis was generated with the SAS system (Error bars indicate the standard deviation).

4.3.3 BUNCH MANIPULATIONS

Table 4.5 depicts the results gathered from the individual experimental plots for Sultana Seedless, Sugraone, Regal- and Prime Seedless. Table 4.6 shows the analysis of variance of the information gathered for the four cultivars. The test for differences between the man-hour means for the bunch manipulation action of the cultivars was significant (P=0.08). However, according to Bartlett's test, no heterogeneity of variance occurred (P=0.2749). Figure 4.3 depicts the average man-hours spent on bunch manipulation of the various cultivars as well as the variation within the man-hours spent based on the data from the different experimental plots.

Table 4.5 Man-hours and cost per hectare for bunch manipulations of the four cultivars.

SULTANA SEEDLESS					
Production unit number	**Area**	**Planting year**	**Bunches per vine**	**Man-hours per hectare**	**Cost (R) per hectare**
1	Groblershoop	1993	24-28	535	1433.80
2	Kanoneiland	1996	24	396	1061.28
3	Kanoneiland	1996	24	536	1436.48
4	Kakamas	1999	14	201	538.68
5	Kakamas	1997	22	88	235.84
7	Augrabies	1994	26	68	182.24
8	Augrabies	1995	28-32	434	1163.12
9	Blouputs	1992	24	546	1463.28
Average				**351**	**939.34**
SUGRAONE					
Production unit number	**Area**	**Planting year**	**Bunches per vine**	**Man-hours per hectare**	**Cost (R) per hectare**
1	Groblershoop	1994	24-28	785	2103.80
2	Kanoneiland	1996	28	743	1991.24
3	Kanoneiland	1997	20-24	813	2178.84
4	Kakamas	1999	16	635	1701.80
5	Kakamas	1998	22	848	2272.64
7	Augrabies	1999	10	130	348.40
8	Augrabies	1993	28-32	1091	2923.88
9	Blouputs	1992	24	1353	3626.04
Average				**800**	**2143.33**
REGAL SEEDLESS					
Production unit number	**Area**	**Planting year**	**Bunches per vine**	**Man-hours per hectare**	**Cost (R) per hectare**
6	Kakamas	1998	N/A	120	321.60
7	Augrabies	1999	10	80	214.40
9	Blouputs	1999	14	909	2436.12
Average				**370**	**990.71**
PRIME SEEDLESS					
Production unit number	**Area**	**Planting year**	**Bunches per vine**	**Man-hours per hectare**	**Cost (R) per hectare**
4	Kakamas	1999	16	600	1608.00
7	Augrabies	1999	10	181	485.08
9	Blouputs	2000	14	1246	3339.28
Average				**676**	**1810.79**

Table 4.6 Statistical analysis of the data received for the bunch manipulation action from the various experimental plots for the four cultivars.

Source of variation	**DF**	**Mean square**	**P-value**
Cultivar	3	319921.5	0.08
Error	18	120675.5	
Total	21		

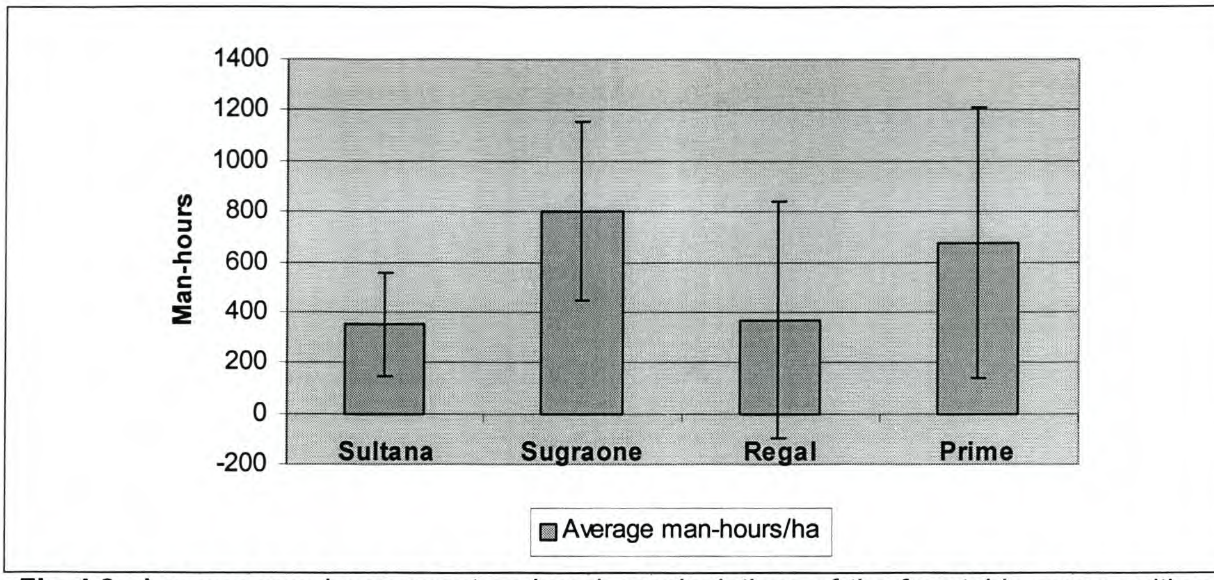

Fig 4.3 Average man-hours spent on bunch manipulations of the four table grape cultivars based on data extracted from different experimental plots along the Lower Orange River during the 2001/2002 season. The statistical analysis was generated with the SAS system (Error bars indicate the standard deviation).

4.3.4 APPLICATION OF REST BREAKING AGENTS

HC is applied to all four cultivars on a routine basis in the Lower Orange River area. A standard application of 5% (v/v) Dormex® applied by tractor to all four cultivars was presumed; the cost and man-hours for this action is presented in Table 4.7 to give an indication of the labour input and cost for a standard HC application in the Lower Orange River area.

Table 4.7 The cost of HC application (spraying by tractor) at a concentration of 2.5% (v/v) and 5% (v/v) with an adjuvant (prices supplied by UAP Crop Care for 2001) to a vineyard in the Lower Orange River area.

Concentration of rest breaking agent applied		2.5 %	5%
Concentration of adjuvant applied		0.5%	0.5%
Time of application		Start of July	Start of July
Trade name	**Rest-breaking agent**	Dormex®	Dormex®
	Adjuvant applied	LI700 (UAP)	LI700 (UAP)
Spraying volume/ha		750 L	750 L
Man-hours /ha		1	1
Cost per litre	**Rest-breaking agent**	R60.00	R60.00
	Adjuvant applied	R58.60	R58.60
Volume applied per hectare	**Rest-breaking agent**	18.75 L	37.5 L
	Adjuvant applied	0.75 L	0.75 L
Total cost per hectare	**Rest-breaking agent**	R1125.00	R2250.00
	Adjuvant applied	R43.95	R43.95
	Labour (R5.00/hour)	R5.00	R5.00
Total cost of action		**R1173.95**	**R2298.95**

4.3.5 GIBBERELLIC ACID (GA) APPLICATION

Table 4.8 illustrates the possible man-hours and cost of GA application for Sultana Seedless according to the recommended practices of VALENT BIOSCIENCES™, the producers of ProGibb® 4%. All GA applications as presented in Table 4.8 were for spraying by tractor and only the man-hours of the tractor driver (with an hourly wage of R5.00) was included. The cost of the gibberellic acid application as presented in Table 4.8 did not include the running cost of the tractor and spraying pump.

Table 4.8 The man-hours and cost of gibberellic acid application (spraying by tractor) according to recommended practices by VALENT BIOSCIENCES™ for Sultana Seedless cultivated in the Lower Orange River area.

	Flower cluster thinning		Berry enlargement		
	1st Appl.	2nd Appl.	1st Appl.	2nd Appl.	3rd Appli.
Timing of action	Half of all the bunches are at 50% flowering	Half of all the bunches are at 80% flowering	50% of berries are 4-5 mm in diameter	75% of berries are 4-5 mm in diameter	100% of berries are 4-5 mm in diameter
Trade name of GA	ProGibb® 4%	ProGibb® 4%	ProGibb® 4%	ProGibb® 4%	ProGibb® 4%
Volume GA per 100L of water	32 ml	32 ml	96 ml	96 ml	96 ml
Parts GA per million	10	10	30	30	30
Spraying volume/ha	1500 L	1500 L	1500 L	1500 L	1500 L
Volume GA applied/ha	0.48 L	0.48 L	1.44 L	1.44 L	1.44 L
Cost of GA per litre	R250.00	R250.00	R250.00	R250.00	R250.00
Cost of GA per application/ha	R120.00	R120.00	R360.00	R360.00	R360.00
Trade name of wetting agent	-	-	Bladbuff	Bladbuff	Bladbuff
Volume wetting agent/ha (100ml/100L)	0	0	1.5 L	1.5 L	1.5 L
Cost of wetting agent per litre	0	0	R21.00	R21.00	R21.00
Cost of wetting agent per application/ha	0	0	R31.50	R31.50	R31.50
Man-hours for action/ha	1	1	1	1	1
Labour cost (hourly wage: R5.00)	R5.00	R5.00	R5.00	R5.00	R5.00
Total cost per application/ha	R125.00	R125.00	R396.50	R396.50	R396.50
Final total cost/ha	**R1439.50**				

Table 4.9 illustrates the possible man-hours and cost of GA application for Sugraone in the Lower Orange River area according to the recommended practices by Sun World. All GA applications as presented in Table 4.9 are reflecting input costs linked to the dipping technique of GA, since this method is recommended for

Sugraone. All man-hours presented were an average from the experimental plots that used the dipping technique for GA application. The recommended practice prescribed by Hoekstra Fruit Farms for GA application to young Prime Seedless for berry enlargement is exactly the same as for Sugraone, except that the first application of GA must take place when most of the berries have reached 5-6 mm diameter. As with Sugraone, the second application must take place within a week of the first application. GA application for flower bunch thinning of Sugraone and Prime Seedless is not recommended practices. It may, however, be used in Sugraone vineyards where severe problems occur regarding compact bunches, small and uneven bunches as well as to ensure less hand thinning. Accordingly, the man-hours and cost of GA application for Prime Seedless will be nearly the same as for Sugraone. In view of this, a separate table for Prime Seedless is not presented. The application of GA to Regal Seedless is strictly forbidden in view of the adverse effects that GA application has on the taste of Regal Seedless. Furthermore, Regal Seedless has inherently large berries and GA application is not needed to acquire the expected berry size.

Table 4.9 The man-hours and cost of GA application according to recommended practices by Sun World for Sugraone cultivated in the Lower Orange River area.

	Berry enlargement	
	1st Application	**2nd Application**
Timing of action	Applied when most berries have reached 6-8 mm diameter	Within a week of the first application
Trade name of GA	ProGibb® 4%	ProGibb® 4%
Volume GA/100L of water	32 ml	32 ml
Parts GA per million	10	10
Average dipping volume/ha	500 L	500 L
Volume GA applied/ha	0.160 L	0.160 L
Cost of GA per litre	R250.00	R250.00
Cost of GA per application/ha	R40.00	R40.00
Trade name of wetting agent	Bladbuff	Bladbuff
Volume wetting agent applied/ha	0.5 L	0.5 L
Cost of wetting agent per litre	R21.00	R21.00
Cost of wetting agent per application/ha	R10.50	R10.50
Man-hours for action/ha	45	45
Labour cost (hourly wage: R2.68)	R120.60	R120.60
Total cost per application/ha	R171.10	R171.10
Final total cost/ha of GA application	R342.20	

4.3.6 OTHER CULTURAL PRACTICES

Cultural practices such as insect and disease management, fertilisation and vineyard floor management (weed control) did not form part of this study. Variation in man-hours and cost within these practices is implicit and it would be impossible and aimless to try and extract significant differences for these practices between the four cultivars. Girdling and protection of grape bunches were the only other cultural production practices that were considered in the study.
Girdling is a quick action and the labour input is relatively low and it was assumed that different cultivars with the same age and growth would need similar man-hours to girdle. From the experimental plots in this study that used girdling, it was determined that the average man-hours needed for this action was 20 man-hours per hectare. Prime Seedless is very prone to bird damage and the bunches have to be covered with bags to prevent bird damage when the berries reach 20 mm in diameter. From the experimental plots, the average man-hours for this action were calculated as 175-200 man-hours per hectare for the covering of 14-16 bunches per vine. The covering of bunches of the other three cultivars is not a standard practice in the Lower Orange River area and it is presumed for the purposes of this study that no covering of bunches did take place for Sultana Seedless, Sugraone and Regal Seedless.

4.4 DISCUSSION

4.4.1 PRUNING (AND TYING OF CANES WHERE APPLICABLE)

The test for differences between the man-hour means for the pruning (and tying of the canes where applicable) action of the cultivars was not significant (P=0.863) and Bartlett's test indicated that heterogeneity of variance occurred (P=0.0131). The average man-hours for pruning and tying of the canes of Sultana Seedless and Sugraone were calculated as 385±25.2 and 450±57.7 man-hours per hectare corresponding to a calculated cost of R1032.14±R67.54 and R1204.66±R154.64, respectively.

The variation within the results from the various experimental plots for Sugraone was bigger than that of Sultana Seedless. Production unit number two and four's man-hours spent on pruning and tying of canes for Sultana Seedless and Sugraone were considerably lower than the average presented for the two cultivars (with consideration of the standard deviation in Fig. 4.1). The lower man-hours spent by production unit number two for both the Sultana Seedless and Sugraone experimental plots can be attributed to the fact that the same team of season workers are used each year which is well trained prior to pruning. The Sultana Seedless and Sugraone vines on production unit number four were only planted in 1999 and six to eight bearer shoots per vine were pruned while training was still taking place. This unit's man-hours was thus lower than the other units, but it is expected that the man-hours spent on pruning and tying of the canes for both cultivars will increase as the vines mature and grow larger until the optimum number of bearer shoots (probably twelve) is obtained. The man-hours spent on pruning and tying of the Sugraone vines on production unit number seven is much higher than any of the other units. This can be attributed to the fact that the Sugraone vines on this unit were planted only in 1999. The pruning and training of the selected cordons and spurs to the short bearers system required a lot of labour-hours during the year of study to ensure a good vine framework. The pruning man-hours (and cost) will increase and the man-hours for training will decrease as the vines mature and grow older. Training usually only continues up to the third year after planting. When training is finished, the man-hours needed for pruning (no tying of canes will occur since the short bearer pruning system is used) may be in line with the average man-hours as presented for this action, or even lower since less man-hours is usually needed for pruning vines trained to the short bearer pruning system. The vigorous growth (lots of shoots) of the Sugraone vines (grafted on R110 and flood irrigated) on production unit number three may explain the high man-hours needed for pruning and tying of the canes on this experimental plot.

The average man-hours for pruning (and tying of the canes where applicable) of Regal- and Prime Seedless were calculated as 370±198 and 361±198 man-hours per hectare with a total calculated cost of R992.49±R530.64 and R967.48±R530.64, respectively. The variation within the results from the various experimental plots for Regal- and Prime Seedless were very high as expected. The man-hours spent by production unit number six on Regal Seedless was in line with what is expected for the long bearers pruning system, the number of bearer shoots that was left per vine and the fact that the vines on this unit was fully trained. The reason for the high man-hours needed by production unit number seven for Regal- and Prime Seedless is the same as for Sugraone on the corresponding production unit.

The man-hours spent by production unit number nine on this action for Prime-and Regal Seedless was very low. These vines were also only planted in 1999, so the young age and growth of the vines allowed the manager on this unit only to prune and train four cordons (short bearer pruning system) per vine up to this point. Training and further development of the vine framework will proceed during the next pruning period and it is expected that the man-hours spent on this action will increase as the vines grow older and bigger.

The average man-hours for pruning and tying of the canes presented for Sultana Seedless and Sugraone will give producers a good indication of what may be expected from these two cultivars in terms of labour input and labour cost along the Lower Orange River area for fully trained vines. Although the average presented for Sugraone for this action was slightly higher than that of Sultana Seedless, there is little to choose between these two cultivars on these grounds. Both are pruned to the long bearer pruning system, with 10-12 bearer shoots per vine and 14-20 buds per bearer shoot as a norm in the Lower Orange River area. The average man-hours and labour cost of pruning and tying of the canes for both Regal- and Prime Seedless as presented, was high considering the young state of the vines on the various experimental plots. This can be attributed to the fact that all the Regal- and Prime Seedless vines on the various experimental plots were very young and training to the short bearer pruning system was still taking place. The pruning and training of the selected cordons and spurs to the short bearers system required a lot of labour-hours to ensure a good vine framework. It is expected that the pruning man-hours and labour cost will increase while the man-hours spent on training will decrease until maturity of the vines. When training is finished, the man-hours needed for pruning of Regal- and Prime Seedless may be in line with the average man-hours as presented for this action or even lower. It is a recommended practice to prune and train Regal- and Prime Seedless vines to the short bearer system in view of the high fertility of the cultivars. Pruning short bearers is usually a quicker action than cane pruning. Accordingly, it is expected that the pruning of mature and fully trained Regal- and Prime Seedless vines will consume less man-hours than mature Sultana Seedless and Sugraone.

4.4.2 CANOPY MANAGEMENT

The test for differences between the man-hour means for canopy management of the cultivars was significant (P=0.0628). However, according to Bartlett's test, no heterogeneity of variance occurred (P=0.521). The average man-hours for canopy management of Sultana Seedless and Sugraone were calculated as 910±65.9 and 1006±85.5 man-hours per hectare with a total extrapolated cost of R2439.81±R179.29 and R2696.42±R229.14, respectively. The average man-hours for canopy management as presented for Sultana Seedless is lower than that of Sugraone. The data as presented is a good reflection of what may be expected from mature Sultana Seedless and Sugraone cultivated along the Lower Orange River area in terms of labour input and labour cost for canopy management.

The average man-hours for canopy management of Regal- and Prime Seedless were calculated as 578±169 and 846±55.5 man-hours per hectare with a total extrapolated cost of R1549.04±R452.92 and R2268.17±R148.74, respectively. The variation within the results from the various experimental plots for Prime Seedless is small considering the large number of factors that contributed to variation. Data from the various experimental plots for Regal Seedless varied considerably. The man-hours and cost for canopy management of production unit number six were low in comparison to production unit numbers seven and nine. This experimental plot experienced poor and uneven budburst in the year of study. It resulted in poor canopy and bunch development as well as vines within the same block being at different phenological stages. Management of this unit decided to rather allocate labour to the better table grape blocks on the farm in view of the poor state of this Regal Seedless block. Accordingly, more than one canopy management action was conducted at the same time and less man-hours were spent on canopy management of this experimental plot in the year of the study than would be the case in a year of good and even budburst. Including this production unit to calculate the average man-hours for canopy management actually provides a distorted indication of what can be expected in terms of labour- and cost input for canopy management of Regal Seedless. The man-hours and labour cost for canopy management of all the Prime Seedless production units were higher than that of corresponding experimental production units of Regal Seedless. The corresponding information regarding canopy management of the young Sugraone vines on production unit four and seven is useful to compare to the young Regal- and Prime Seedless vines. No significant differences in terms of the average man-hours spent on the canopy-management action of Sugraone, Sultana and Prime Seedless existed. The average man-hours for canopy management of Regal Seedless was, however significantly lower than the other three cultivars, mainly because of the inclusion of experimental plot six in the calculation of the man-hour average. Excluding production unit six and using only the data of production units seven and nine to calculate the average man-hours for this action, will provide a better indication of labour- and cost input for canopy management of young Regal Seedless vines. In this scenario, the man-hours for canopy management of Regal Seedless will be considerably higher, leading to no significant differences for this action between the four cultivars.

Since the man-hours needed for canopy management of the young Regal-and Prime Seedless vines are expected to increase up to maturity, it may be speculated that the average man-hours and labour cost for this action for mature Sultana Seedless and Regal Seedless vines will be closely correlated, whereas Sugraone and Prime Seedless will compare well.

4.4.3 BUNCH MANIPULATIONS

The test for differences between the man-hour means for the bunch manipulation action of the cultivars was significant (P=0.08). However, according to Bartlett's test, no heterogeneity of variance occurred (P=0.2749). The average man-hours for bunch manipulations of Sultana Seedless and Sugraone were calculated as 351±71.6 and 800±125 man-hours per hectare with a total cost or R939.34±R191.89 and R2143.33±R335.00, respectively. The considerable variation within the results from the various experimental plots for Sultana Seedless can mainly be attributed to the management and success of the gibberellic acid (GA) application for flower cluster thinning and enlargement of berries on the various experimental plots of Sultana Seedless.

The data as presented for the bunch manipulation action of Sultana Seedless and Sugraone will provide the reader with a good indication of what may be expected from these two cultivars in terms of labour input and labour cost for this action along the Lower Orange River area. In the case of Sultana Seedless, the correct timing and concentrations of GA applied for flower cluster thinning and sizing of berries, is the ultimate factor determining the extent of bunch thinning needed and the number of uneven and small berries to be removed from the bunch. Production units that achieved optimal timing and concentration of GA application for thinning and sizing of their Sultana Seedless, saved significantly on subsequent bunch manipulations. The production managers of production units five and seven confirmed that the correct timing and concentration of the GA applications within the specific season was responsible for the low labour inputs needed for the bunch manipulations of Sultana Seedless. As can be seen from Figure 4.3, the average man-hours needed for bunch manipulation of Sultana Seedless are significantly lower than Sugraone and Prime Seedless. The climate (season) also plays an important role in the ultimate effect of GA application, highlighting the importance of knowledge and experience to perform this action successfully.

GA is not applied to Sugraone, leading to less control over berry set from a production point of view. Sugraone is known for the set of uneven and small berries that could lead to high labour inputs on bunch manipulation. It appeared as if the problem with small and uneven berries was larger, or at least for the season of the study, in the warmer areas of the Lower Orange River (data from production units eight and nine). The man-hours needed for the manipulation of almost all the production units of Sugraone were nearly twice as much as that of corresponding experimental production units of Sultana Seedless. Accordingly, the man-hours needed for bunch manipulation of Sugraone was significantly higher than that of Sultana Seedless, but was not significantly higher than Prime Seedless.

The average man-hours for bunch manipulations of Regal- and Prime Seedless were calculated as 370±270 and 676±310 man-hours per hectare with a total extrapolated cost of R990.71±R723.60 and R1810.79±R830.80, respectively. The variation within the results from the various experimental plots for Regal Seedless was extremely big. As already explained in section 4.4.2, production unit number six-experienced poor and uneven budburst in the year of study, leading to a reduction in man-hours spent on the various manipulations. In addition, a divergent number of bunches per vine was left based on the condition of the vine. In the year of study, the canopy management and bunch manipulation of this specific experimental plot of Regal Seedless was neglected/reduced because of the poor growth pattern experienced. Including this production unit to calculate the average man-hours for bunch manipulation actually provides a distorted indication of what can be expected in terms of labour- and cost input for bunch manipulation of Regal Seedless. From Figure 4.3 it seems as if the average man-hours needed for bunch manipulation of Regal Seedless is significantly lower than Sugraone and Prime Seedless. Exclusion of experimental plot six (due to the cultivation problems as explained) may lead to a higher man-hour average for this action of Regal Seedless and accordingly leading to no significant differences between Sugraone, Regal- and Prime Seedless in terms of man-hours for this action. In the case of production unit number seven of Regal Seedless, only 10 bunches per vine was left in view of the young age of these vines and accordingly the man-hours for this action was also very low. This unit also experienced little problems with uneven and small berries. Production unit number nine left only 14 bunches per vine. This unit, however, spent an enormous amount of man-hours (909 man-hours) on the bunch manipulation of Regal Seedless due to large amounts of small and uneven berries that was present.

In view of the young age of the vines, varied numbers of bunches were also left in the case of the Prime Seedless experimental plots. Accordingly, variation in the results was considerable. The man-hours of production unit number seven was considerably lower than that of the other experimental plots of Prime Seedless, also considering the fact that only ten bunches per vine was left. The manager experienced problems with small and uneven berries with the Prime Seedless resulting in the higher man-hours compared to the corresponding Sugraone and Regal Seedless experimental plots on production unit seven. Production unit nine left only 14 bunches per vine. As was the case for Regal Seedless, this unit spent a higher amount of man-hours (1246 man-hours) to remove uneven and small berries from the bunches. In general, the man-hours spent on bunch manipulation of Prime Seedless was high for all experimental plots when considering the number bunches left per vine. The average man-hours for this action of Prime Seedless were significantly higher than Sultana Seedless, but not significantly lower than Sugraone.

Production unit seven left 10 bunches per vine and needed 130, 80 and 181 man-hours for bunch manipulation of Sugraone, Regal- and Prime Seedless of the same age (all planted in 1999), respectively. The initial indication from this single production unit is that young Prime Seedless requires the highest labour input for bunch manipulation, followed by Sugraone and then Regal Seedless. Production unit nine supports the trend that young Prime Seedless requires more bunch manipulation than young Regal Seedless. Fourteen bunches per vine was left for Regal- and Prime Seedless planted in 1999 and 2000, respectively. The Prime Seedless required considerable higher man-hours for bunch manipulation than the Prime Seedless. Production unit number four left 16 bunches per vine for Prime Seedless, as was the case for the Sugraone experimental block on the same production unit. Their man-hours spent on bunch manipulation was nearly the same, suggesting that Prime Seedless and Sugraone are similar in terms of labour input/cost regarding bunch manipulation of young vines.

The man-hours spent on this action will increase for both the Regal- and Prime Seedless production units as more bunches per vine is left as the vines mature and enter full production. The average man-hours for bunch manipulation of young Prime Seedless, with 10-14 bunches left per vine, did not differ significantly from mature Sugraone, with on average 20-24 bunches left per vine. In view of this, it can be speculated that mature Prime Seedless may have the highest labour input for bunch manipulation of all the cultivars, followed closely by Sugraone. Mature Regal Seedless may need higher labour input for bunch manipulation than Sultana Seedless, depending on the success of the GA treatments of the Sultana Seedless. Further investigation is, however, needed to confirm this speculation. Statistical analysis of the current data however indicated that the average man-hours spent on bunch manipulation of Sultana Seedless are significantly lower than Sugraone and Prime Seedless (and possibly Regal Seedless as explained).

The amount of man-hours needed for bunch manipulation will vary from one year to another for all the cultivars. The labour input for bunch manipulation is comprehensively affected by seasonal variables, ultimately determining the labour- and cost input for bunch manipulation, especially for Sugraone and Regal- and Prime Seedless where no GA application for flower thinning is recommended. There are also indications that the set of uneven and small berries of Regal- and Prime Seedless decreases as the vines mature. This fact still has to be confirmed in the Lower Orange River area.

4.4.4 GIBBERELLIC ACID (GA) APPLICATION

From the data presented it is clear that Regal Seedless has a definite advantage above the other cultivars, since no GA applications are necessary. Sultana Seedless is by far the most "expensive" for this action (R1439.50/ha). The labour input is however low if tractor spraying is used for GA application. The cost and labour input for Sugraone and Prime Seedless is for all practical reasons the same when the same number of bunches is left per vine (R342.20). The dipping technique for GA application is recommended for both Sugraone and Prime Seedless, which can save large quantities of GA, but in turn adding to the labour inputs.

4.4.5 OTHER CULTURAL PRACTICES

In view of the young state of the Regal- and Prime Seedless vines no girdling was performed on them. Girdling is not recommended for Regal Seedless as it may have an effect on the taste and the inherent berry size of this cultivar makes this action redundant.

The covering of Prime Seedless bunches to protect them from bird damage is a standard practice in the Lower Orange River area. The incidence of birds is very high in the Lower Orange River area, making this a very important action for Prime Seedless. The labour input and cost of this action in relatively high in the light of the fact that the other cultivars do not need this action. This factor is a definite disadvantage for Prime Seedless from a labour and cost of production perspective.

4.5 CONCLUDING REMARKS

The very young age of the vines and the limited number of experimental plots available for Regal- and Prime seedless was responsible for large variation within the same manipulation on different experimental plots per cultivar. The fact that producers are still in a learning phase to acquire the “best possible practices” for these two cultivars in the Lower Orange River area, also contributed to the large variation. The data presented provide valuable information regarding labour input and cost of production for young Regal- and Prime Seedless vines and mature Sultana Seedless and Sugraone per cultural action. Although considerable variation was observed in the extracted data, the extensive base-descriptions of the cultivars and the experimental plots aided to understand the sources of variation. The qualified data sets therefore are suitable to indicate trends for the various actions in terms of the labour inputs/cost between the cultivars studied. This analysis paves the way for further investigation regarding labour inputs for pruning, canopy management and bunch manipulation in the Lower Orange River area. Optimally, this should include older, fully matured vines and more experimental plots for Regal-and Prime Seedless to increase the accuracy of measurement. The analysis method (calculating the input costs per cultivation action rather that using mean combined values from all inputs) proved to deliver valuable information that could ultimately lead to a much clearer picture of input costs and enhancing the producer's ability to determine his cost-effective cultivation practices. This analysis method is of general importance for the table grape industry and not only linked to the Orange River production area.

4.6 LITERATURE CITED

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ADDENDUM B

Table B.1 An example of the document provided to producers/managers to extract the information required for the pruning action.

ACTIVITY REGISTER Action: Clean pruning Prepared by Henning Burger			
Cultivar		Sultana Seed.	Sugraone
Block number		1	2
Rootstock		R99	143B
Planting date		1996	1995
Size of block (ha)		2.0	1.0
Vines/ha		1683	1683
Total number of workers in block		40	38
Start of action	**Date**	4 July 2001	1 July 2001
	Time	08:00	08:00
End of action	**Date**	7 July 2001	2 July 2001
	Time	17:00	15:30
Working hours per day		8	8
Specify working hours		08:00-13;00 13:00-17:00	08:00-13;00 13:00-17:00
Hours needed to complete action		24	14.5
Average hourly wage		R2.68	R2.68
Man-hours/block for action		960	551
Man-hours/ha for action		480	551
Labor cost/ha for action		R1286.40	R1476.68
Specify any other inputs for this action in the space below None			

Table B.2 An example of the document provided to producers/managers to extract the information required for the application of rest breaking agents.

ACTIVITY REGISTER **Action: Application of rest breaking agent** **Prepared by Henning Burger**			
Cultivar		Sultana Seed.	Sugraone
Block number		1	2
Rootstock		R99	143B
Planting date		1996	1995
Size of block (ha)		2.0	1.0
Vines/ha		1683	1683
Method of applying rest breaking agent		Spraying	Spraying
Trade name of rest breaking agent		Dormex®	Dormex®
Concentration used		5%	4%
Total volume applied/ha		750 L	750 L
Volume rest breaking agent applied/ha		37.5	30
Cost of rest breaking agent/litre		R60.00	R60.00
Total cost of rest breaking agent/ha		R2250.00	R1800.00
Trade name of adjuvant applied		LI700	LI700
Concentration of adjuvant		100 ml/100 L	100 ml/100 L
Volume adjuvant applied/ha		0.75 L	0.75 L
Cost of adjuvant/litre		R55.00	R55.00
Cost of adjuvant/ha		R41.25	R41.25
Total number of workers in block		1	1
Start of action	**Date**	15 July 2001	10 July 2001
	Time	08:00	09:00
End of action	**Date**	15 July 2001	10 July 2001
	Time	10:00	10:00
Working hours per day		8	8
Specify working hours		08:00-13;00 13:00-17:00	08:00-13;00 13:00-17:00
Hours needed to complete action		2	1
Average hourly wage		R4.00	R4.00
Man-hours/block for action		2	1
Man-hours/ha for action		1	1
Labour cost/ha for action		R2295.25	R1845.25
Specify any other inputs for this action in the space below None			

Table B.3 An example of the document used to summarize the information gathered from the "Activity register" documents (Table B.1-B.2) the producer/manager used to extract the information needed per manipulation for this study.

SULTANA SEEDLESS: Summary of actions

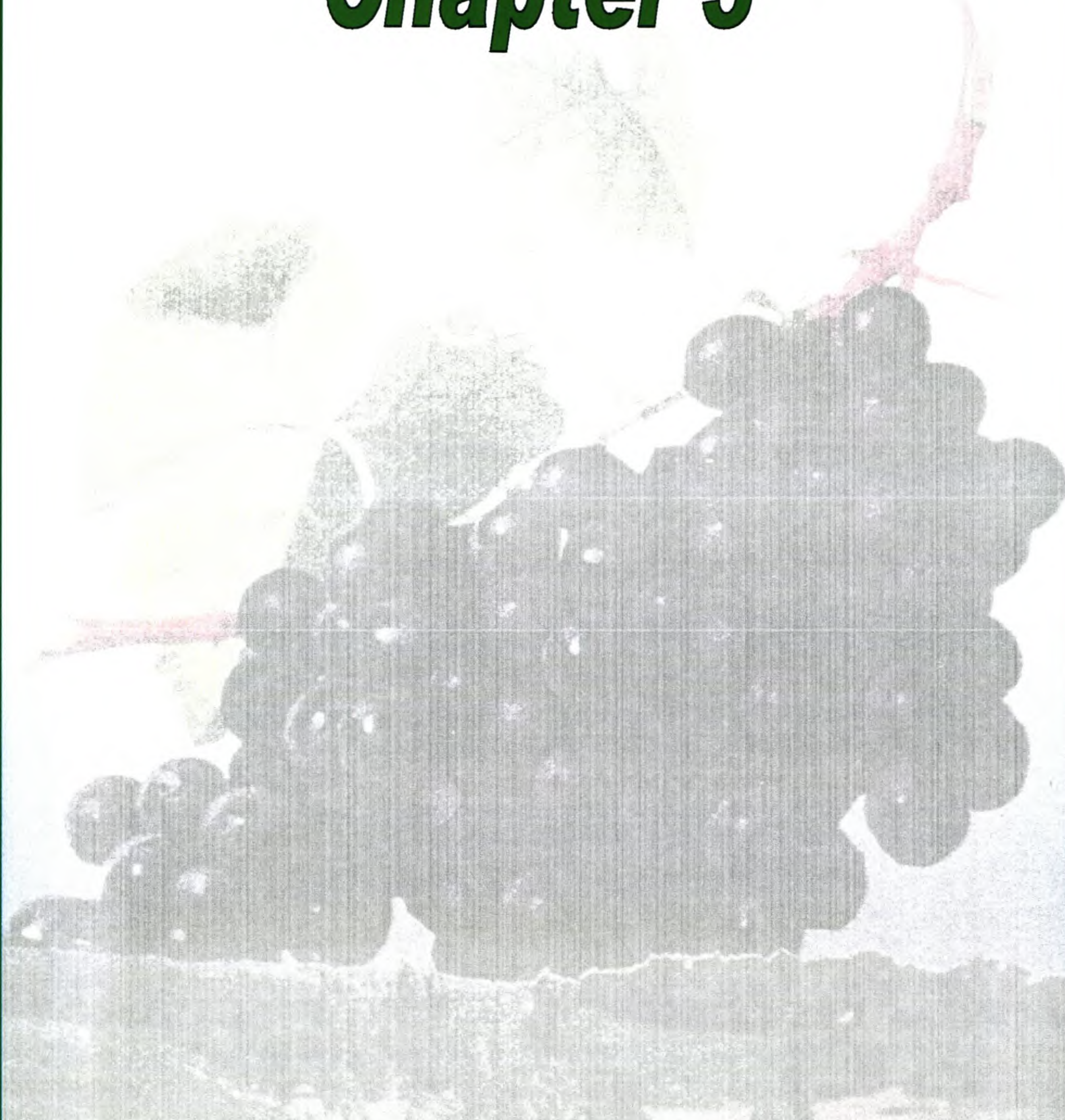
Farm name:	XXX-farming	**Rootstock**	R99	**Irrigation**	Micro	**Cartons/ha**	4200
Cultivar:	Sultana	**Planting date**	1996	**Pruning sys.**	Long	**Class 1**	2500
Block name/number	1	**Plant distance**	3.0 x 2.0 m	**Bearers/vine**	12	**Class 1.5**	1500
Size of block:	2.0	**Trellising**	Gable	**Buds/bearer**	18	**Local**	200

	Action/Activity per hectare	**Commencement date of action**	**Direct man-hours needed for action (h)**	**Average wage per hour**	**Agents used for action**	**Application method**	**Total cost of agents per hectare**	**Total cost per hectare**	**Export cartons**
1	Summer pruning	15 Feb	80	R3.10				R248.00	
2	Evaporative cooling	None	-	-				-	
3	Agents applied for leaf abscission	None	-	-	-	-	-	-	
4	Pre pruning activities	8 Jun	15	R3.10				R46.50	
5	Pruning	4 Jul	480	R3.10				R1488.00	
6	Rest breaking agent application	15 Jul	1	R4.00	Dormex+LI700	Spraying	R2291.25	R2295.25	
7	Gathering of pruned shoots for tillage	31 Jul	70	R2.80				R196.00	
8	Bark removal for girdling and mealy bug control	5 Aug	180	R2.80				R504.00	
9	Suckering of shoots	10 Sept	191	R3.10				R592.10	
10	Tying of shoots	20 Sept	180	R3.10				R558.00	
11	Suckering of sprouts and anchors	24 Sept	80	R3.10				R241.00	
12	Leaf removal	30 Sept	120	R3.10				R372.00	
13	Gibberellin treatments	15 Oct	1	R5.00	Progibb+bladb	Spraying	R1434.90	R1439.90	
14	Crop thinning	22 Oct	106	R3.10				R328.60	

Table B.3 Continued

	Action/Activity per hectare	Commencement Date of action	Direct man-hours needed for action (h)	Average wage per hour	Agents used for action	Application method	Total cost of agents per hectare	Total cost per hectare	Export cartons
15	Girdling	25 Oct	80	3.10				R248.00	
16	Shortening of bunches and removal of uneven berries	26 Oct	90	3.10				R279.00	
17	Hanging of cover-bags	None	-	-				-	
18	Bunch thinning	20 Nov	120	R3.10				R372.00	
19	Tip an top actions	25 Nov	80	R3.10				R248.00	
20	Pre -packing preparations	Nov/Dec	N/A	-				-	
21	Physical cutting of grapes for packing	27 Dec	120	R3.25				R390.00	
22	Packing of grapes	27 Dec	N/A	-				-	
23	Total cartons (4.5 kg) produced/ha								4000
24	Packing material							R560.00	
25	Weed control program							R440.00	
26	Pest control program							R3900.00	
27	Fertilizer program							R2150.00	
28	Irrigation program							R2740.00	
29	Tillage program							R980.00	

Chapter 5



RESEARCH RESULTS

Comparative analysis of four white seedless table grape cultivars taking into account productivity (yield), value (price achieved) and extraordinary costs (vine and fruit production royalties)

RESEARCH RESULTS

5.1 INTRODUCTION

The yield, price achieved and extraordinary costs of cultivation for a certain cultivar, in conjunction with production and establishment costs, are major determinants of the profitability of table grape cultivars. Knowing the establishment and production costs is not enough to make an educated decision to undertake table grape production. The potential profitability and extraordinary costs such as vine and fruit production royalties must also be considered. Cultivar profitability is directly related to the yield and the price achieved by the cultivar. The former is a function of site, soil, cultivar, vineyard management, weather, season as well as various other unpredictable factors. Table grape price is not only a function of the current market supply and demand, but also reflects on the producer and the ability of the exporter to market the grapes. Different cultivars are subject to different pricing structures. Proper site selection and vineyard management can improve fruit quality and subsequently enhance the value of the grapes (Bordelon, 2002).

Rate of return on investment is an important consideration. It can take anything from five to twenty years to recover the costs of establishment and begin making a profit on a table grape vineyard. Cash returns during production are based on grape yield, price received, production costs and extraordinary costs of production. A well-managed vineyard will come into production in year three, and will reach full production in year four. Newer planting techniques and plant material have been showing small crops in the second year. When yields and prices are high with low production and extraordinary costs, establishment cost recovery is relatively quick. However, when yields and/or prices are low with high production and extraordinary costs, cost recovery can be beyond reasonable expectations (Bordelon, 2002).

The effects of increasing yield or price of table grapes can be calculated using different price and yield scenarios. As an example, it will take 20 years to recover the costs of establishment from a table grape vineyard that yields 3000 cartons/ha and achieves a price of R25.00/carton. In this scenario grape production is not economically viable. However, if prices are R40.00/carton, costs of establishment may be recovered in ten years or at R45.00/carton costs may be recovered in seven years. Likewise, as yield increases, time of cost recovery decreases.

Regal- and Prime Seedless are new additions to the cultivar profile of the Lower Orange River area and virtually no information is available on yields and prices achieved in the context of the Lower Orange River area and in comparison with the other popular cultivars like Sultana Seedless and Sugraone. Within the framework of this study it was aimed to compare the cultivars Sultana Seedless, Sugraone, Regal- and Prime seedless with regards to productivity (yield), value (price achieved) and extraordinary costs (vine and fruit production royalties). The information will be used to extract statistical significant differences between the cultivars where possible or at least provide trends within these study topics.

5.2 MATERIALS AND METHODS

Determining the yield of Sultana Seedless, Sugraone, Regal- and Prime Seedless was performed by obtaining the relevant information from the producers. Each producer received a folder containing all the information relevant to his production unit, together with forms to extract the yield information (see Table B1-B3 in the Addendum B of Chapter 4) per experimental plot. The producers had the choice to fill in these forms or to provide us with their yield information, as it exists in their system. A complete yield data set was compiled and checked for each experimental plot, after which analysis commenced. The total number of 4.5 kg export cartons produced per hectare was determined for each of the experimental plots. The export table grapes included class 1 and class 1.5 table grapes and excluded class 2, local marketed table grapes and processed table grapes. Information from all the experimental plots was used to obtain an average total number of 4.5 kg export cartons produced per cultivar. The assumption was made that each experimental plot was managed to its optimal potential by the various producers to ensure the highest yield and quality possible. All data presented are on an annual, per hectare basis.

The value (price achieved) of the various cultivars for the 2001/2002 table grape season was put into perspective by using data from a survey which included information regarding payments for the various cultivars during the 2001/2002 table grape season in the Lower Orange River area (Ferrandi and Van der Merwe, 2002). The survey was conducted on prominent table grape farming units in the Lower Orange River area, including most of the farming units that was part of this particular comparative study of the white seedless cultivars. The Ferrandi survey included 6.612 million 4.5 kg export cartons. According to export figures provided by ORPA in 2002, 14.46 million 4.5 kg cartons were exported from the Lower Orange River area during the 2001/2002 table grape season. This survey of Mr. Ferrandi consequently included 46% of total export from this area. Table grapes from the following export companies operating in the area were included in this survey: Afrifresh, Agrimax, Capespan, Colors, EXSA, Fine Brothers, Fruits Unlimited, FTK, Grape Company, Grapes Direct, Green Marketing, Lona Fruit, SAFE, Sunpride and Ukulima. In view of the range of payment methods used by the different export companies, the payments were compared based on Delivered in Port (DIP) payment norms. The following items were included in the calculation of a DIP payment for class 1 and class 1.5 table grapes:

- Shipment, harbor costs and exporter 's commission were subtracted
- Sugraone royalties were subtracted

- Any VAT on local S.A costs were counted back
- Transport costs to the harbour, Perishable Products Export Control Board (PPECB) inspection, Deciduous Fruit Producers' Trust (DFTP) and ORPA levies were not subtracted
- Distinctions were made between intake week, cultivar, class 1 and class 1.5 table grapes
- The calculated DIP payment per week was weighted according to the volumes exported each week

Vine and fruit production royalties were categorised under extraordinary costs for table grape production. Where applicable, information regarding the vine and fruit production royalties was gathered from the holders of the plant breeders' rights of the cultivars. The data on total number of export cartons were investigated for significant differences ($P \leq 0.10$) between the four cultivars. Analysis of variance were performed with the SAS system

5.3 RESULTS

5.3.1 PRODUCTIVITY (YIELD)

Harvesting of the early cultivars commences from weeks 45-46 in the Lower Orange River area (Figs. 2.5-2.7 in Chapter 2). Prime- and Flame Seedless are the first cultivars to reach maturity and are usually the first cultivars to be harvested followed by Sugraone, Regal- and Sultana Seedless according to maturation date. Table 5.1 depicts the yield results gathered from the individual experimental plots for the 2001/2002 packing season for Sultana Seedless, Sugraone, Regal- and Prime Seedless while Table 5.2 shows the statistical analysis of the information gathered for each of the four cultivars from the various experimental plots. The test for differences between the productivity (yield) of the various cultivars for the 2001/2002 season was significant ($P=0.0608$). According to Bartlett's test, no heterogeneity of variance occurred ($P=0.3847$). Figure 5.1 depicts the average number of 4.5 kg export cartons produced per hectare for the various cultivars and the variation within the results from the different experimental plots.

Table 5.1 The harvest results gathered from the various experimental plots for the 2001/2002 packing season for Sultana Seedless, Sugraone, Regal- and Prime Seedless.

SULTANA SEEDLESS								
Production unit number*	Area	Bunches per vine left	Start of harvesting (Week)	Class 1 cartons/ha (4.5 kg)	% of total	Class 1.5 cartons/ha (4.5 kg)	% of total	Total export cartons/ha (4.5 kg)
1 ('93)	Grob.	24-28	Week 1	1872	53.0	1660	47.0	3532
2 ('96)	Kanon.	24	Week 1	4320	90.0	480	10.0	4800
3 ('96)	Kanon.	24	Week 52	2591	60.0	1729	40.0	4320
4 ('99)	Kakam.	14	Week 1	1024	64.0	576	36.0	1600
5 ('97)	Kakam.	22	Week 1	2640	67.3	1280	32.7	3920
7 ('94)	Augra.	26	Week 52	6200	100.0	0	0.0	6200
8 ('96)	Augra.	28-32	Week 52	4130	62.4	2487	37.6	6617
9 ('92)	Blou.	24	Week 52	3222	93.7	216	6.3	3438
Average				**3250**	**73.8**	**1054**	**26.2**	**4303**
SUGRAONE								
Production unit number*	Area	Bunches per vine left	Start of harvesting (Week)	Class 1 cartons/ha (4.5 kg)	% of total	Class 1.5 cartons/ha (4.5 kg)	% of total	Total export cartons/ha (4.5 kg)
1 ('94)	Grob.	24-28	Week 52	3443	85.0	608	15.0	4051
2 ('96)	Kanon.	28	Week 51	5220	90.0	580	10.0	5800
3 ('97)	Kanon.	20-24	Week 51	1721	70.0	738	30.0	2459
4 ('99)	Kakam.	16	Week 51	765	45.0	935	55.0	1700
5 ('98)	Kakam.	22	Week 50	2700	60.0	1800	40.0	4500
7 ('99)	Augra.	10	Week 51	3000	100.0	0	0.0	3000
8 ('93)	Augra.	28-32	Week 50	3732	62.1	2281	37.9	6013
9 ('92)	Blou.	24	Week 50	3124	92.2	264	7.8	3388
Average				**2963**	**75.5**	**901**	**24.5**	**3864**
REGAL SEEDLESS								
Production unit number*	Area	Bunches per vine left	Start of harvesting (Week)	Class 1 cartons/ha (4.5 kg)	% of total	Class 1.5 cartons/ha (4.5 kg)	% of total	Total export cartons/ha (4.5 kg)
6 ('98)	Kakam.	N/A	Week 50	850	50.0	850	50.0	1700
7 ('99)	Augra.	10	Week 51	2800	100.0	0	0.0	2800
9 ('99)	Blou.	14	Week 49	1708	80.0	427	20.0	2135
Average				**1786**	**76.7**	**426**	**23.3**	**2212**
PRIME SEEDLESS								
Production unit number*	Area	Bunches per vine left	Start of harvesting (Week)	Class 1 cartons/ha (4.5 kg)	% of total	Class 1.5 cartons/ha (4.5 kg)	% of total	Total export cartons/ha (4.5 kg)
4 ('99)	Kaka.	16	Week 49	1876	67.0	924	33.0	2800
7 ('99)	Kaka.	10	Week 47	870	67.5	418	32.5	1288
9 ('00)	Blou.	14	Week 47	1665	85.0	293	15.0	1958
Average				**1470**	**73.2**	**545**	**26.8**	**2015**

*Planting year indicated in brackets

Table 5.2 Statistical analysis of the data received regarding the yield (4.5 kg cartons) per hectare from the various experimental plots for the four cultivars.

Source of variation	DF	Mean square	P-value
Cultivar	3	5922482	0.0608
Error	18	2010758	
Total	21		

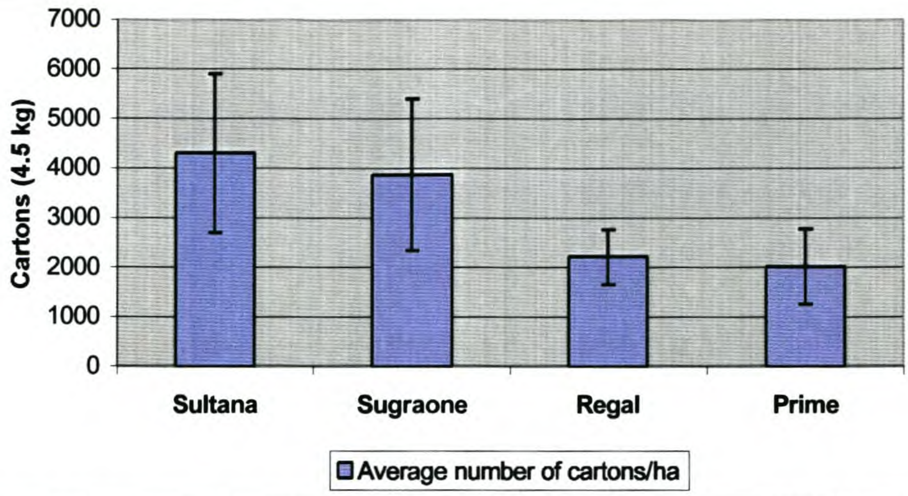
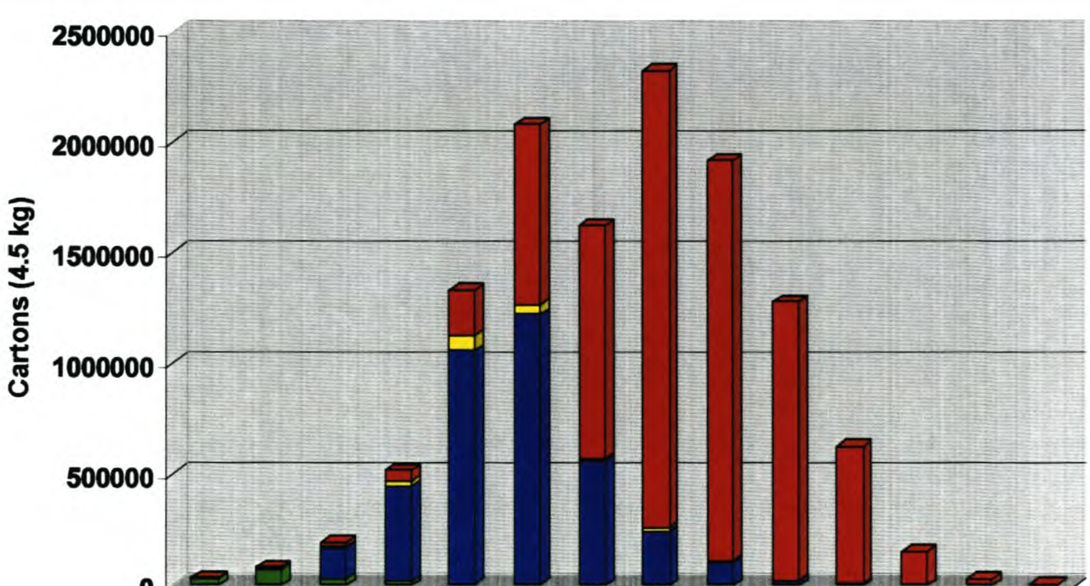


Fig 5.1 The average number of export cartons (4.5 kg) yielded per hectare by the four cultivars based on data extracted from different experimental plots along the Lower Orange River during the 2001/2002 season. The statistical analysis was generated with the SAS system (Error bars indicate the standard deviation).

5.3.2 VALUE (PRICE ACHIEVED AT THE MARKETPLACE)

Harvesting commenced a week later in the 20001/2002 season than the previous season and peaked from week 51 up to week 2. Harvesting is usually finished by week 7 in the Lower Orange River. Prime Seedless (see Fig. 5.2) was the first white seedless cultivar to be harvested during the 2001/2002 season in the Lower Orange River area (weeks 46-49) followed by Sugraone (weeks 47-3), Regal Seedless (weeks 48-2) and Sultana Seedless (weeks 48-7).



	46	47	48	49	50	51	52	1	2	3	4	5	6	7
Sultana	0	1280	21440	47239	202234	817590	1058030	2064870	1810430	1260880	618117	150128	25776	3377
Regal	0	0	3424	23548	71366	42384	6344	15025	4668	0	0	0	0	0
Sugraone	2720	11800	138964	430596	1055430	1222160	560160	242494	102356	17634	8373	0	0	0
Prime	30257	67196	30145	14951	2707	309	0	0	0	0	0	0	0	0

Fig. 5.2 Total number of 4.5 kg cartons white seedless (class 1 and class 1.5) packed per week in the Lower Orange River area for the 2001/2002 season (ORPA, 2002).

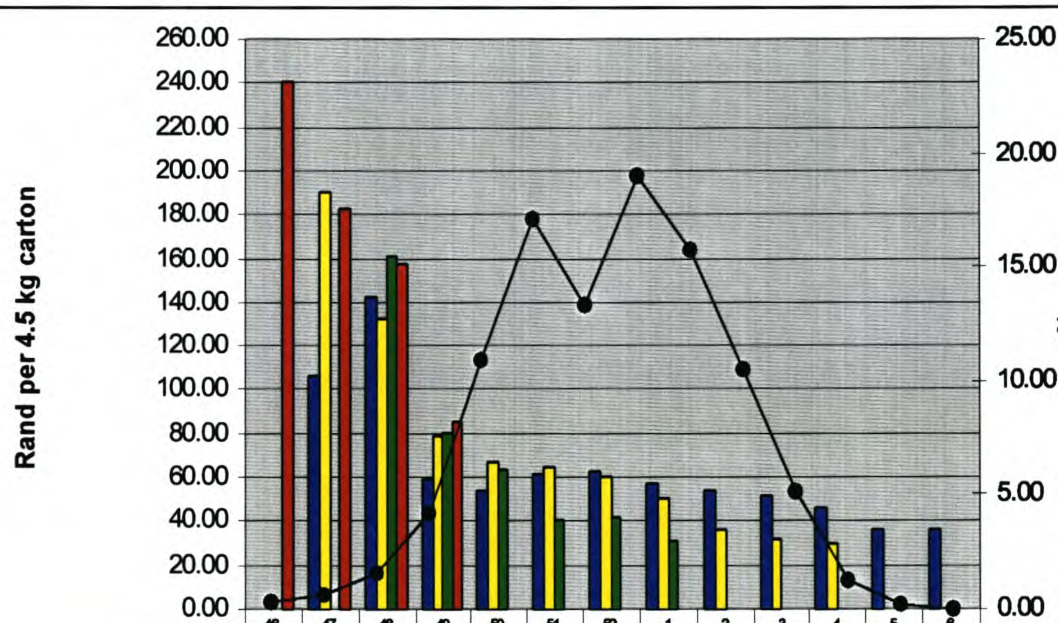
Figures 5.3-5.4 show the average weighted DIP payment for class 1 and class 1.5 white seedless, respectively for the four cultivars and the percentage supply of white seedless (including class 1 and class 1.5) per week from the Lower Orange River area. Figure 5.5 shows the average DIP payment for class 1 and class 1.5 for Sultana Seedless, Sugraone, Regal- and Prime Seedless for the full 2001/2002 season.

5.3.3 EXTRAORDINARY COSTS (VINE AND FRUIT PRODUCTION ROYALTIES)

The purpose of the section was to compare the cultivars regarding any extraordinary cultivation costs. Only vine and fruit production royalties (where applicable) were identified as possible extraordinary costs to be taken into account in this analysis.

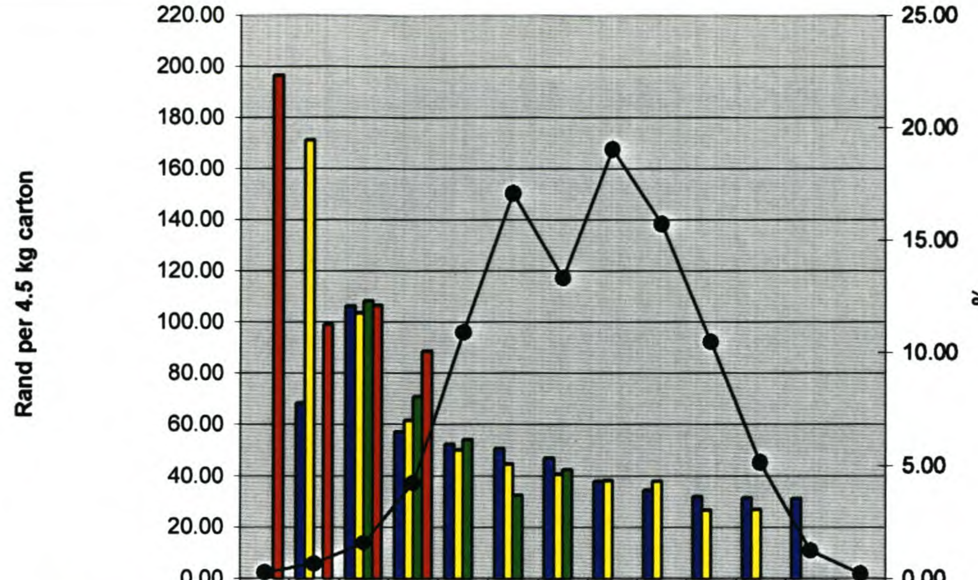
5.3.3.1 Sultana Seedless

Sultana (Sultanina or Sulltana Seedless) has been known in South Africa before 1926 and originated from Anatolia. Sultana is seen as "community property" and accordingly no vine and fruit production royalties are applicable to Sultana Seedless.



	46	47	48	49	50	51	52	1	2	3	4	5	6
Sultana Seedless	0.00	105.60	141.74	59.43	53.59	60.67	62.58	56.76	53.69	51.21	45.72	35.87	36.54
Sugraone	0.00	190.46	132.31	78.79	67.04	64.74	59.81	50.57	36.11	31.97	29.53	0.00	0.00
Regal Seedless	0.00	0.00	160.44	80.08	63.32	40.01	41.61	30.89	0.00	0.00	0.00	0.00	0.00
Prime Seedless	240.60	182.37	157.14	85.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%Suppy (Class 1+1.5)	0.27	0.66	1.59	4.24	10.93	17.09	13.33	19.06	15.73	10.49	5.14	1.23	0.21

Fig 5.3 Orange River 2001/2002: Average weighed DIP payment (R/4.5 kg) (Ferrandi and Van der Merwe, 2002) for class 1 Sultana Seedless, Sugraone, Regal- and Prime Seedless and the percentage supply of white seedless (class 1 and class 1.5) per week from the Lower Orange River area (ORPA, 2002). No production of a cultivar in a specific week is indicated with no price (R0.00).



Week	46	47	48	49	50	51	52	1	2	3	4	5	6
Sultana Seedless	0.00	68.38	106.41	57.17	52.28	50.71	46.97	38.03	34.45	31.98	31.47	31.18	0.00
Sugraone	0.00	171.30	103.65	61.60	50.13	44.67	40.65	38.14	37.89	26.50	26.89	0.00	0.00
Regal Seedless	0.00	0.00	108.32	70.93	54.15	32.49	42.33	0.00	0.00	0.00	0.00	0.00	0.00
Prime Seedless	196.60	99.12	106.60	88.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Supply (Class 1+1.5)	0.27	0.66	1.59	4.24	10.93	17.09	13.33	19.06	15.73	10.49	5.14	1.23	0.21

Fig 5.4 Orange River 2001/2002: Average weighed DIP payment (R/4.5 kg) (Ferrandi and Van der Merwe, 2002) for class 1.5 Sultana Seedless, Sugraone, Regal- and Prime Seedless and the percentage supply of white seedless (class 1 and class 1.5) per week from the Lower Orange River area (Orpa 2002). No production of a cultivar in a specific week is indicated with no price (R0.00).

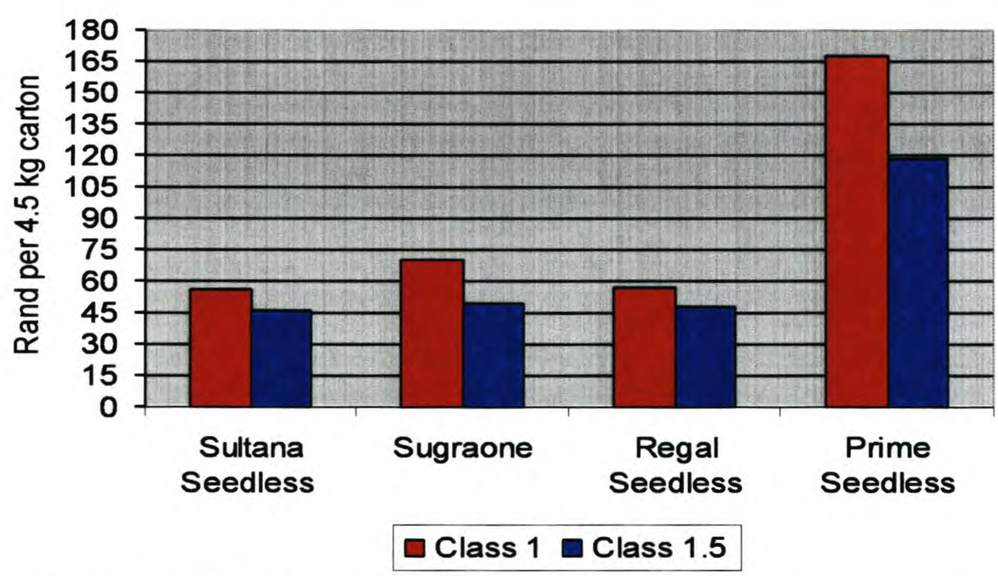


Fig 5.5 Orange River 2001/2002: Average DIP payment (R/4.5 kg) for class 1 and class 1.5 Sultana Seedless, Sugraone, Regal- and Prime Seedless for the full production season (Ferrandi and Van der Merwe, 2002).

5.3.3.2 Sugraone

Information regarding the vine and fruit production royalties payable on Sugraone is presented in Tables 5.3-5.4. The information regarding the royalty's payable for

Sugraone was provided by Mr. Johan Jooste, Sun World representative in South Africa.

Table 5.3 Vine and fruit production royalties payable on Sugraone.

Vines planted	
On vines planted up to 1998	US$ 0.30 per vine
On vines planted from 1999 onwards	US$ 0.12 per vine
Cartons exported: 1998/99 to 2011/12	
Cartons exported up to week 50	US$ 0.45 per 4.5 kg carton
Cartons exported from week 51 onwards	US$ 0.30 per 4.5 kg carton
Cartons exported: 2012/13 until agreement expires	
Cartons exported up to week 50	US$ 0.23 per 4.5 kg carton
Cartons exported from week 51 onwards	US$ 0.15 per 4.5 kg carton

Table 5.4 The vine and fruit production royalties paid to Sun World from 1998 to 2002. The Rand/US$ exchange rate for the 1st of June for each year has been used to convert to a comparable Rand per vine (or 4.5 kg carton) amount.

VINE ROYALTIES: SUGRAONE					
Year	**US$/Vine**	**Exchange rate (1st of June)**		**Rand/Vine**	
Vines planted up to 1998	0.30	1998	R5.19	1998	R1.56
Vines planted from 1999 onwards	0.12	1999	R6.22	1999	R0.75
		2000	R6.97	2000	R0.84
		2001	R8.01	2001	R0.96
		2002	R9.81	2002	R1.18
FRUIT PRODUCTION ROYALTIES: SUGRAONE					
Period (1998/99 to 2011/12)	**US$/4.5 kg carton**	**Exchange rate (1st of June)**		**Rand/4.5 kg carton**	
Cartons exported up to week 50	0.45	1999	R6.22	'98/'99	R2.80
		2000	R6.97	'99/'00	R3.14
		2001	R8.01	'00/'01	R3.60
		2002	R9.81	'01/'02	R4.41
Cartons exported from week 51 onwards	0.30	1999	R6.22	'98/'99	R1.87
		2000	R6.97	'99/'00	R2.09
		2001	R8.01	'00/'01	R2.40
		2002	R9.81	'01/'02	R2.94

5.3.3.3 Regal Seedless

Information regarding royalties payable on Regal Seedless was provided by Dr. Jan Loubser, head of the table and raisin grape division of the ARC-Fruit, Vine and Wine Research Institute. Regal Seedless only has royalties payable on the vines sold and no fees are collected on the cartons exported. Royalties on Regal Seedless are payable per vine purchased and are managed by SAPO, the license holder in South Africa. The table and raisin grape division of the ARC-Fruit, Vine and Wine Research Institute in conjunction with SAPO, determines the vine royalties payable on Regal Seedless for each year. The royalties are payable to the ARC-Fruit, Vine and Wine Research Institute and are charged in SA Rand. Table 5.5 indicates the amount per vine that was paid for the past five planting seasons.

Table 5.5 Vine royalties payable to the ARC-Fruit, Vine and Wine Research Institute for Regal Seedless for the past five planting seasons. The Rand/US$ exchange rate for the 1st of June for each year has been used to convert to a comparable US$ per vine amount.

Vines Royalties: Regal Seedless			
Year	**Rand/vine**	**Exchange Rate**	**US$/vine**
1997	0.56	R4.47	0.13
1998	0.70	R5.19	0.13
1999	0.80	R6.22	0.13
2000	1.60	R6.97	0.23
2001	1.70	R8.01	0.21

5.3.3.4 Prime Seedless

Vine royalties as well as fruit production royalties are applicable on this cultivar. Hoekstra Fruit Farms (Pty) Ltd is the registered sole distributor of Prime Seedless in South Africa, Namibia and Zimbabwe and is also responsible for the collection of royalties. Information regarding the vine and fruit production royalties payable on Prime Seedless was provided by Hoekstra Fruit Farms (Pty) Ltd and is presented in Tables 5.6-5.7.

Table 5.6 Vine and fruit production royalties payable on Prime Seedless.

Vines planted	
For any new plantings of Prime Seedless	US$ 0.10 per vine
Cartons exported	
Irrespective of time period	US$ 0.20 per 4.5 kg carton

Table 5.7 The vine and fruit production royalties paid to Hoekstra Fruit Farms (Pty) Ltd. from 1997 to 2002. The Rand/US$ exchange rate for the 1st of June for each year has been used to convert to a comparable Rand per vine (4.5 kg per carton) amount.

VINE ROYALTIES: PRIME SEEDLESS					
Period	**US$/Vine**	**Exchange rate (1st of June)**		**Rand/Vine**	
From the date that Prime Seedless was released for commercial table grape farming in S.A. onwards	0.10	1997	R4.47	1997	R0.45
		1998	R5.19	1998	R0.52
		1999	R6.22	1999	R0.62
		2000	R6.97	2000	R0.70
		2001	R8.01	2001	R0.80
		2002	R9.81	2002	R0.98
FRUIT PRODUCTION ROYALTIES: PRIME SEEDLESS					
Period	**US$/4.5 kg carton**	**Exchange rate (1st of June)**		**Rand/4.5 kg carton**	
Irrespective of time period	0.20	1997	R4.47	'96/'97	R0.89
		1998	R5.19	'97/'98	R1.04
		1999	R6.22	'98/'99	R1.24
		2000	R6.97	'99/'00	R1.39
		2001	R8.01	'00/'01	R1.60
		2002	R9.81	'01/'02	R1.96

5.3.3.5 Summary of the vine royalties that were payable for the various cultivars in 2001

A summary of the vine and fruit production royalties that was payable for the various cultivars during the 2001/2002 table grape season are presented in Tables 5.8-5.9.

Table 5.8 Summary of the vine royalties that were payable for the various cultivars in 2001. The Rand/US$ exchange rate for the 1st of June 2001 has been used to convert to a comparable Rand/US$ per vine amount.

VINE ROYALTIES for 2001			
Cultivar	**US$/vine**	**Rand/vine**	**Example of vine royalties payable (Rand) at 3.0 x 1.8 m vine spacing (1852 vines/ha)**
Sultana Seedless	0	0	R0.00
Sugraone	0.12	0.96	R1777.92
Regal Seedless	0.21	1.70	R3148.40
Prime Seedless	0.10	0.80	R1481.60

Table 5.9 Summary of the fruit production royalties that were payable for the various cultivars during the 2001/2002 table grape season. The Rand/US$ exchange rate for the 1st of June 2002 has been used to convert to a comparable Rand/US$ per 4.5 kg carton amount.

FRUIT PRODUCTION ROYALTIES for the 2001/2002 season			
Cultivar	**US$/4.5 kg carton**	**Rand/4.5 kg carton**	**Example of fruit production royalties payable (Rand) for 3000 cartons (4.5 kg) produced per ha**
Sultana Seedless	0	0	R0.00
Sugraone (Cartons exported up to week 50)	0.45	4.41	R13230.00
Sugraone (Cartons exported from week 51)	0.30	2.94	R8820.00
Regal Seedless	0	0	R0.00
Prime Seedless	0.20	1.96	R5880.00

5.4 DISCUSSION

5.4.1 PRODUCTIVITY (YIELD)

The test for differences between the productivity (yield) of the various cultivars for the 2001/2002 season was significant (P=0.0608) and according to Bartlett's test, no heterogeneity of variance occurred (P=0.3847). The average total export cartons per hectare for Sultana Seedless and Sugraone was calculated as 4303±567 and 3864±542 (4.5 kg) cartons, respectively for the 2001/2002 packing season. The yield for Sultana Seedless of production unit four of was conspicuously lower than the average and the yields of the other production units. The vines on this unit were only planted in 1999 and were not yet in full bearing during the 2001/2002 packing season. Only 14 bunches per vine were left during yield regulation in view of the young state of the vines. If this unit were omitted from the calculation, the average total export cartons per hectare for Sultana Seedless would have been higher (4690 export cartons per hectare). The young vines were, however, included in the calculation to act as comparison to the young vines on the Regal- and Prime production units and to give a realistic indication of what may be expected from these cultivars in terms of productivity in the Lower Orange River area. It is also important to note that the 2001/2002 packing season was an above average season in terms of yield for the Lower Orange River area.

The average yield calculation for Sugraone included two production units (units four and seven) with young vines, which were not in full bearing during the 2001/2002 packing season. Accordingly, their yields were lower than the average and the yield of the other production units. Production unit four and seven left only 16 and 10 bunches per vine, respectively. As was the case for Sultana Seedless, if the young vines were left out of the calculation, the average total export cartons per hectare for Sugraone also increases to 4369 export cartons per hectare.

The average total export cartons per hectare for Regal- and Prime Seedless were calculated as 2212±320 and 2015±437 (4.5 kg) cartons, respectively for the 2001/2002 packing season. All the production units of Regal- and Prime Seedless consisted of young vines and yields as indicated depict this fact.

No statistical significant differences existed between the average yields of Sultana Seedless and Sugraone. Many of the Sugraone production units had a higher yield than corresponding Sultana Seedless production units during the 2001/2002 packing season. However, from the data presented, the average yield of Sultana Seedless was higher (by ±350 cartons) than Sugraone during the 2001/2002 table grape season in the Lower Orange River area. This trend is in line with past experience in terms of yield for these two cultivars in the Lower Orange River area.

No statistical significant differences existed between the average yields of Regal- and Prime Seedless. The average yields of Regal- and Prime Seedles was however significantly lower than Sultana Seedless and Sugraone. This can be attributed to the young age and accordingly the limited number bunches left per vine on the various Regal- and Prime Seedless experimental plots. The average yield of Regal Seedless as calculated from the experimental plots was higher (by ±200 cartons) than Prime Seedless during the 2001/2002 table grape season in the Lower Orange River area. Production unit number four experienced the highest yield for Prime Seedless (2800 cartons), followed by Sugraone (1700 cartons) and Sultana Seedless (1600 cartons) for the same age vines and bunches left per vine. Production unit number seven, however, experienced the highest yield from Sugraone (3000 cartons), followed by Regal Seedless (2800 cartons) and Prime Seedless (1288 cartons) for the same age vines and bunches left per vine. On production unit nine, Regal Seedless (2135 cartons) performed better than the same age and bunches left per vine Prime Seedless (1958 cartons).

From these contradicting results it is impossible to conclude whether young Regal, or Prime Seedless performs the best in terms of yield in the Lower Orange River area, nor is it possible to predict the possible yield of mature Regal and Prime Seedless for the future in this area.

5.4.2 VALUE (PRICE ACHIEVED AT THE MARKETPLACE)

With table grape farming along the Lower Orange River, the emphasis lies on the grapes ripening as early as possible in order to obtain the highest prices by supplying the overseas markets early in the season. The maturation date of a table grape cultivar in the Lower Orange River plays an important role in determining the price of the fruit on overseas markets. During intake weeks 46-48, the supply of table grapes was still low during the 2001/2002 season. The high demand for table grapes on the markets ensured very good prices for fruit in this period. There was a dramatic drop in price from weeks 48 to 49 onwards during the 2001/2002 table grape season due to an increased supply of grapes on the markets with a demand that stabilised.

Prime Seedless, which is an early maturing cultivar, obtained very high prices during week 46 (R240.60 for 4.5 kg class 1 grapes) since this was the only cultivar already being harvested in the Lower Orange River area (Figs. 5.3-5.4). Sultana Seedless and Sugraone were harvested from week 47 with Sugraone obtaining the highest price of the three cultivars for both class 1 and class 1.5 grapes. Regal Seedless was harvested from week 48 and obtained the highest price of the four white seedless cultivars for both class 1 and class 1.5. It is obvious that a new cultivar entering the market does very well in the first week of supply and outperforms existing cultivars in the market. After this, the price obtained by a cultivar is dependent on supply, demand and very importantly, customer preference. The early cultivars such as Prime Seedless and Sugraone performed well in terms of price early in the season (up to week 50), after which Sultana Seedless constantly performs best later in the season. This is a very important factor to consider when decisions concerning cultivar profile are made. The advantage of high prices early in the season is however not always applicable to the later maturing regions. The later maturing cultivars in the later harvesting regions can outperform cultivars such as Prime Seedless and Sugraone.

The average highest DIP payment for class 1 and class 1.5 for the full 2001/2002 table grape season in the Lower Orange River area was made for Prime Seedless in view of the fact that it was supplied for only a period of four to six weeks very early in the season when the demand for table grapes was very high (Fig. 5.5). This fact makes it hard for the other cultivars to compete with Prime Seedless in terms of profitability, although the production cost may be higher and productivity lower than the other cultivars. Sugraone obtained the second highest payment for class 1 and class 1.5 for the full 2001/2002 table grape season and Sultana- and Regal Seedless was in the same class in terms of DIP payment for class 1 and class 1.5 table grapes.

Generally, it can be said that the average seasonal prices achieved for white seedless table grape correlated significantly to the volumes supplied, and therefore the weekly supplies determine the price development. It is clear that the prices deteriorated considerably when the volumes that reached the markets increased (Figs. 5.3-5.4). The late start of the 2001/2002 season ensured a shorter supply period to the market early on, in turn leading to the prices remaining high for Prime Seedless and early Sugraone early on in the season.

5.4.3 EXTRAORDINARY COSTS (VINE AND FRUIT PRODUCTION ROYALTIES)

It is clear from Table 5.8 that Regal Seedless had the highest vine royalty in 2001, followed by Sugraone, Prime Seedless and Sultana Seedless, which had no vine royalty applicable. During the time of signing the agreement between the Deciduous Fruit Board and Sun World in 1998, Sugraone was the earliest white seedless cultivar produced in the Lower Orange River area followed by Sultana Seedless. Prior to and during the negotiation of the agreement, no meaningful other cultivars were tested or available to erode the status that Sugraone enjoyed in the Lower Orange River area. The subsequent release of Regal- and Prime Seedless, however, changed this picture over the past few seasons. Large scale planting of Regal Seedless and especially Prime Seedless took place from 1999. Prime Seedless is now the earliest white seedless cultivar cultivated in the Lower Orange River area and Regal Seedless is planted as supplementary cultivar to Sultana Seedless.

Table 5.9 indicates that the fruit production royalties payable on Sugraone are presently (2001/2002 table grape season) more that double that of Prime Seedless. This will remain so until 2012 when the fruit production royalties will decrease to a level similar to that of Prime Seedless. No fruit production royalties are applicable to Sultana- and Regal Seedless. In view of the fact that Prime Seedless is a very early maturing cultivar with lower fruit production royalties than Sugraone and with Regal Seedless having no fruit production royalties applicable, it is expected that Sugraone will experience major competition from these two cultivars in the Lower Orange River area. However, the adaptability, profitability, productivity and best possible practices to produce high quality table grapes, have already been established for Sugraone in the Lower Orange River area. These factors, however, still need to be established for Regal-and Prime Seedless on a long-term basis. The extraordinary cost of vine and fruit production royalties is an important factor to consider when new plantings are made. It is a major cost for the production of certain cultivars and can run into thousands of Rand per hectare each year and a decision must be made if this extra cost can be financially justified.

5.5 CONCLUDING REMARKS

Consistency of production is an extremely important aspect in cultivar choice. In the Lower Orange River area, with its extreme climate, occasional reduced yields may occur on even the hardiest cultivars even if special measures are taken to protect the vines from damage. Years of reduced crops should be figured into the cost of production of a certain cultivar so that the prices received accurately reflect the overall profitability on a sustainable basis. No information is available on the sustainability regarding output yields of Regal and Prime Seedless in comparison to Sultana Seedless and Sugraone. This factor still needs to be established for these cultivars and will also to a large extent determines the long-term viability of Regal- and Prime Seedless in the Lower Orange River area with it's unique environment conditions.

5.6 ACKNOWLEDGEMENTS

The author would like to thank Mr. Chris Ferrandi for providing information regarding the prices achieved by the various cultivars in the Lower Orange River area during the 2001/2002 table grape season.

5.7 LITERATURE CITED

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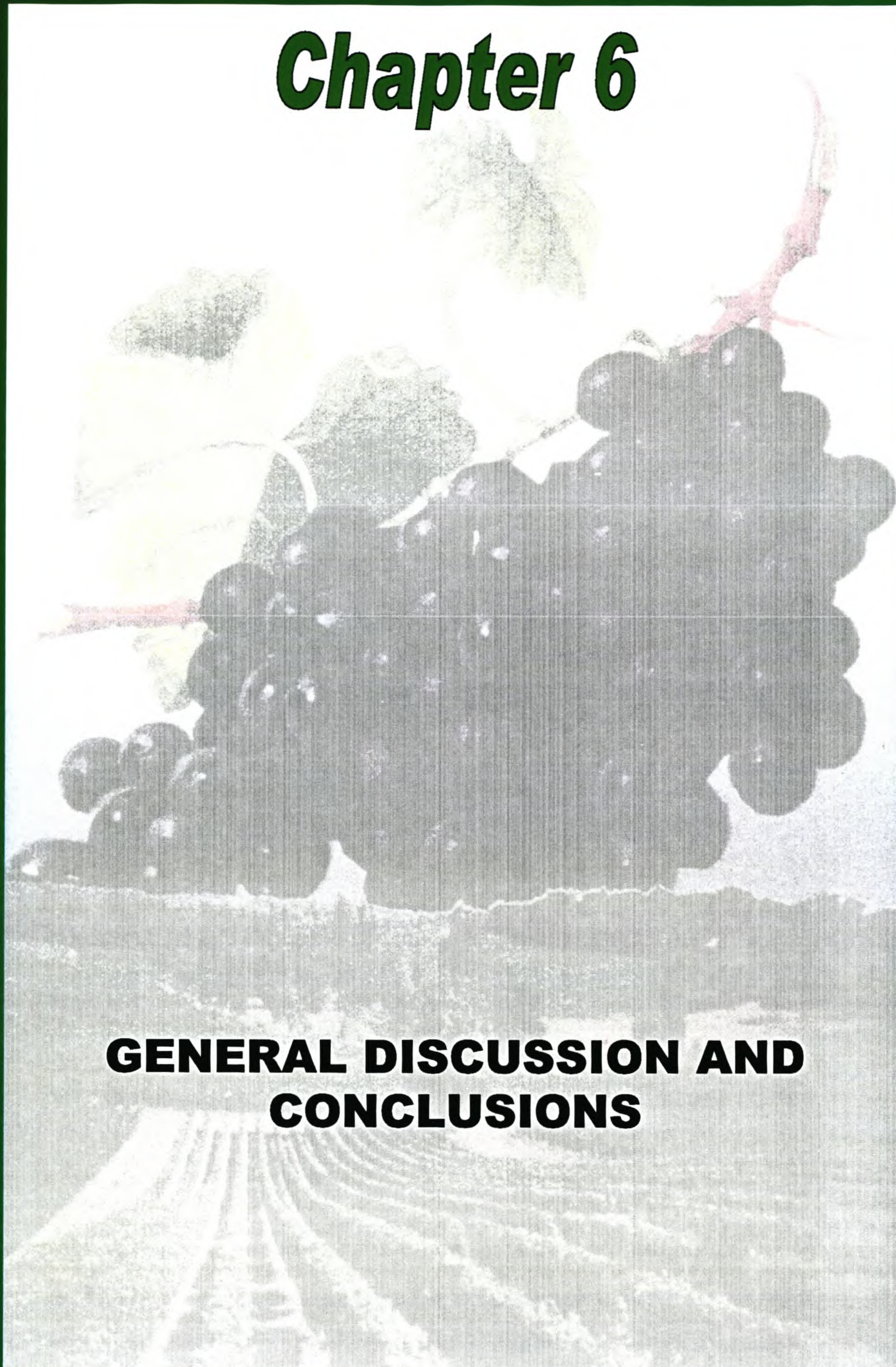
Chapter 6



GENERAL DISCUSSION AND CONCLUSIONS

GENERAL DISCUSSION AND CONCLUSION

Table grape production has created an oasis along a narrow ribbon of fertile land in the middle of a dry semi-desert area in the Northern Cape of South Africa. This spectacle can be seen on the banks of the Lower Orange River, stretching from Groblershoop in the east to Onseepkans in the west. Besides its unsurpassed rugged beauty, table grape production in the Lower Orange River area is also the economic mainstay for thousands of people in the region, benefiting either directly or indirectly from the area's rich soils, abundant water and unique climate for producing top quality table grapes. In view of the immense water- and soil resources of this area, gradual expansion of the table grape industry has taken place over the years. However, during the past five years, plantings have increased rapidly, elevating the Lower Orange River area to the fastest growing table grape region in South Africa. In conjunction with the overall growth in the area, new cultivar introductions are slowly altering the traditional cultivar profile, especially with regard to the white seedless cultivars.

The aim of this study was to compare four white seedless cultivars, Sultana Seedless, Sugraone, Regal- and Prime Seedless to obtain initial indications and trends regarding the relative cost-effectiveness (especially in terms of labour) and long term potential of these cultivars in the area. This study was undertaken with some inherent complexities as described in chapter one, mainly linked to the few and recent plantings of two of the studied cultivars. The cultivars were compared taking into account farming input cost (especially labour input), productivity (yield), value (price achieved at the market place) as well as extraordinary costs when applicable. Eight experimental plots each for Sultana Seedless and Sugraone were identified that covered most of the Lower Orange River area. It was only possible to identify three experimental plots for Regal- and Prime Seedless vines that already fruit bear fruit. In total, 22 experimental plots and nine different farms formed part of this study. A primary description per experimental plot regarding rootstock, irrigation system, training and trellising, etc. was done to obtain as much historical and new data on each unit and block studied as possible, specifically to qualify results obtained from it. The production managers of each of the experimental plots collaborated in providing information regarding the input costs, especially in terms of labour, linked to various cultural production manipulations for each cultivar. The required information were extracted from their record keeping systems or by means of documents provided to them to keep record of the necessary information. Information regarding yield of each experimental plot was extracted in the same way. The value (price achieved) of the various cultivars for the 2001/2002 table grape season were put into perspective by using data from a survey which included information regarding payments for the various cultivars during the 2001/2002 table grape season in the Lower Orange River area. Information regarding vine and fruit production royalties (where applicable) was provided by the various plant breeder rights' holders of the cultivars. The data for the various study topics were investigated (where possible) for statistical significant differences (P≤ 0.10) between the four cultivars by means of analysis of variance. The SAS system was used to do the all-necessary statistical analysis. The test for differences between the combined set of data (Table 6.1) regarding the average man-hours spent on all the cultural production manipulations per hectare of the cultivars was significant (P=0.021421). The test for differences between the combined set of data (Table 6.2) regarding the average cost of all the cultural production manipulations per hectare of the cultivars was also significant (P=0.028821).

Table 6.1 Statistical analysis the combined set of data regarding the average man-hours spent on all the cultural production manipulations per hectare of the cultivars.

Source of variation	DF	Mean square	P-value
Cultivar	3	929229.2	0.021421
Error	18	224539.5	
Total	21		

Table 6.2 Statistical analysis the combined set of data regarding the average cost of all the cultural production manipulations per hectare of the cultivars.

Source of variation	DF	Mean square	P-value
Cultivar	3	6106619	0.028821
Error	18	1612733	
Total	21		

It is evident from the summary presented in Fig. 6.1 that the overall labour requirements for the successful cultivation of Sultana Seedless was significantly lower than that of Sugraone. For pruning and tying of canes, canopy management and especially for bunch manipulation, Sultana Seedless needed less man-hours to complete these actions. The man-hours spent on pruning and canopy management of Sultana Seedless was not significantly (at P≤ 0.10) lower than Sugraone, but it was significantly lower in the case of bunch manipulation. The labour input for the application of GA to Sultana Seedless was also lower than was the case with Sugraone. This can be attributed to the fact that GA is normally applied to Sultana Seedless by tractor spraying, while the bunch dipping technique is applied with Sugraone, in view of the negative effects canopy wetting with GA has on the fertility of Sugraone.

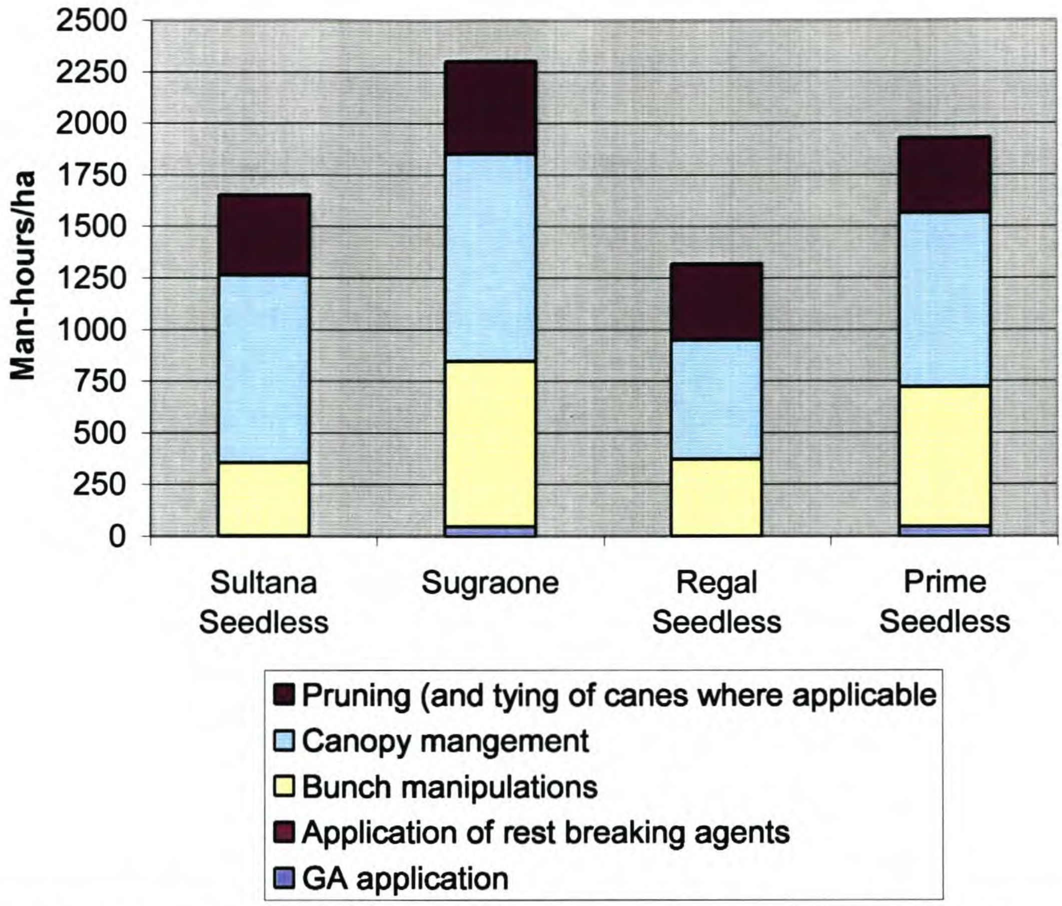


Fig. 6.1 Combined set of data regarding the man-hours spent per cultural production manipulation per hectare as determined for the four cultivars during the 2001/2002 table grape season along the Lower Orange River (compiled from research results presented in chapter 4 of this thesis).

From a cultural cost point of view (for the studied topics), the difference between Sultana Seedless and Sugraone was not significant (Fig. 6.2). Sultana Seedless requires extensive GA treatments for flower cluster thinning and berry sizing. GA treatments for Sugraone, however, are only recommended for berry sizing and the concentration of these applications is also lower than for Sultana Seedless. The cost for this action for Sugraone, was accordingly much lower than for Sultana Seedless. It is however important to mention that the correct timing and the concentration of GA applications to Sultana Seedless is critical to obtain optimal berry thinning and berry size within the variable seasonal and climatical conditions of the Lower Orange River area. This fact was highlighted by producers who had low labour input requirements for bunch manipulation, due to the correct timing and concentration of GA treatments. When timing and concentration of GA treatments are not optimal for Sultana Seedless, it can lead to extensive bunch manipulation, leading to higher labour inputs and even a higher cultural production cost than Sugraone. During the period of this study, the overall cultural production cost of Sultana Seedless was lower than that of Sugraone, mainly because of the lower labour input and cost for the bunch manipulation action.

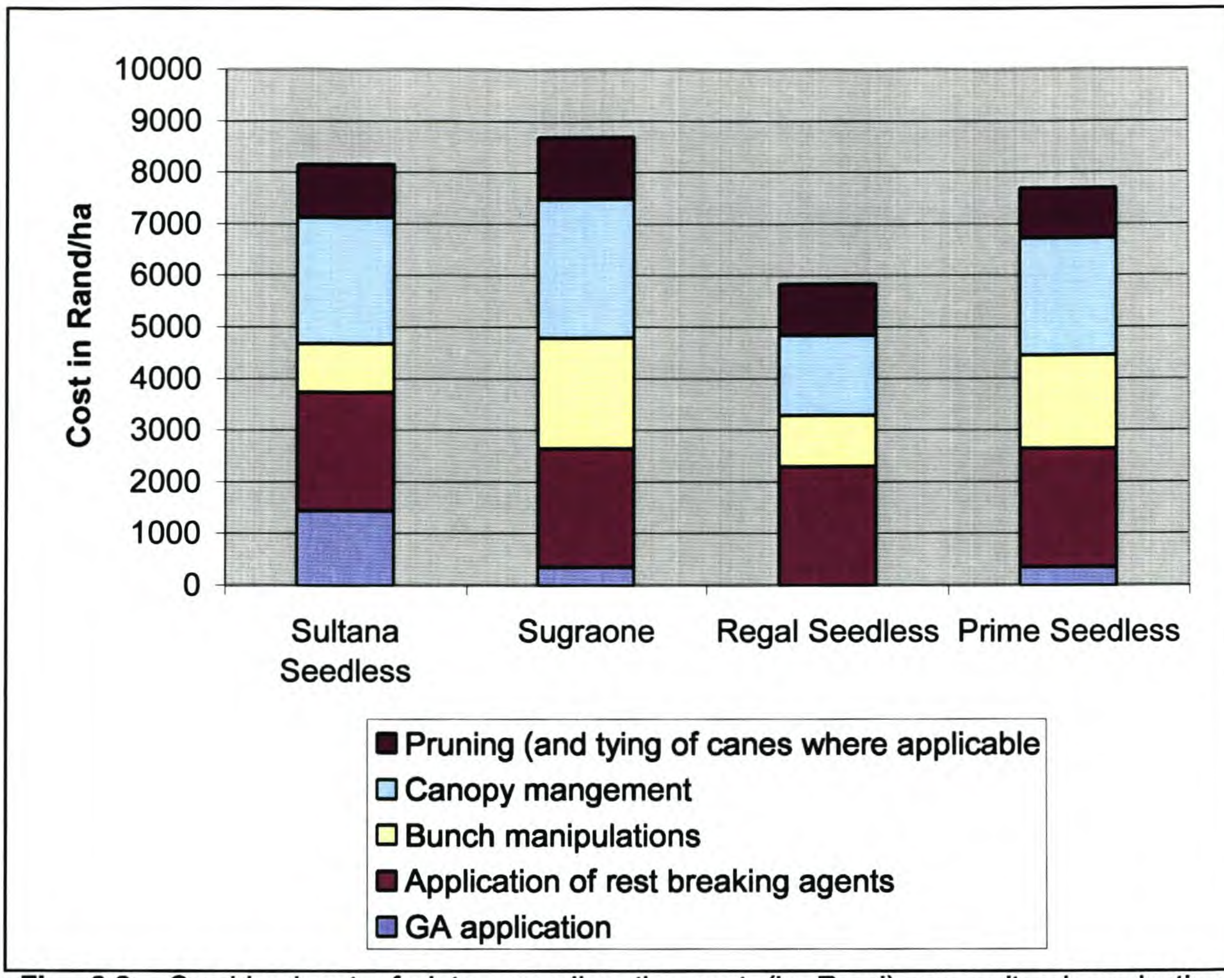


Fig. 6.2 Combined set of data regarding the cost (in Rand) per cultural production manipulation per hectare as determined for the four cultivars during the 2001/2002 table grape season along the Lower Orange River(compiled from research results presented in chapter 4 of this thesis).

The overall labour requirements and cultural production cost of young Regal Seedless was significantly lower than the same aged Prime Seedless as presented in Figs. 6.1-6.2. The labour input and cost of all the individual cultural production manipulations of Prime Seedless was significantly higher than that of Regal Seedless except for the pruning action. In view of the fact that all of the Regal- and Prime Seedless experimental plots consisted of young vines, it can be expected that labour input and cost of canopy management and bunch manipulation will increase as the vines mature, increase in the canopy size takes place and the full crop load is left. The man-hours and cost of pruning for both Regal-and Prime Seedless may decrease slightly when training to the short bearer pruning system is finished. During the year of the study, training were still taking place, which required high labour inputs, subsequently elevating the cost of this action. Statistical analysis of the data from the year study showed no significant differences between the four cultivars in terms of man-hours for the pruning action. It can be speculated that the pruning action for mature, fully trained Regal-and Prime Seedless vines will require lower labour input than Sultana Seedless and Sugraone, which both require cane pruning. Pruning of short bearers is usually a quicker action than for cane pruning where tying of the canes to the trellis wires is also involved.

Bunch manipulation for both Regal- and Prime Seedless will increase as the vines mature and the full number of bunches per vine is left. The labour input and cost of bunch manipulation for both Regal- and Prime Seedless was high during the year of study, especially for Prime Seedless, when considering the number of bunches left per vine (10-16 bunches per vines). Both cultivars experienced problems with the set of uneven and small berries in the year of study. The man-hours spent on bunch manipulation of young Prime Seedless was significantly higher than that of mature Sultana Seedless, but no significant differences existed with mature Sugraone for this action. The initial indication is that mature Prime Seedless will have the highest labour input requirements and cost for bunch manipulation of the four cultivars, followed closely by Sugraone and then Regal Seedless and Sultana Seedless. The labour input and cultural production cost of Prime Seedless is also significantly higher than that of Regal Seedless, since this cultivar requires no GA treatments for thinning and berry sizing. From these preliminary results, it is obvious that Regal Seedless has a tremendous advantage above the other three cultivars in the production cost category due to the fact that no GA application or girdling is necessary for flower cluster thinning, or to attain the required berry size. The labour input requirement and cost of GA application for Prime Seedless is the same as for Sugraone, since the recommended practice for this action is the same for the two cultivars.

The initial indications from this study were that the labour input and the cost for the production cultural practices studied for young Prime Seedless vines were very high in comparison to the mature Sultana Seedless and Sugraone vines, especially for the canopy management and bunch manipulations actions. It was experienced during the study year that Prime Seedless was prone to the set of small and uneven berries which lead to very high labour input requirements and cost for the bunch manipulation action. Prime Seedless is also very prone to bird damage. The bunches of Prime Seedless have to be covered with bags to prevent bird damage when the berries reach 20 mm in diameter. The incidence of birds is very high in the Lower Orange River area, making this a very important action for Prime Seedless. The labour input and cost of this action in relatively high in the light of the fact that the other cultivars do not need this action. This factor is a further disadvantage for Prime Seedless from a labour and cost of production perspective.

Accordingly, it is speculated that mature Prime Seedless will have the highest labour input and cultural production cost of the four cultivars, followed by Sugraone. Sugraone is also known for the set of small and uneven berries, especially in difficult climatic seasons, requiring high labour input for the bunch manipulation action in the Lower Orange River area. Ultimately the correct timing and concentration of the GA applications for thinning and berry sizing will largely determine the cultural production cost and labour input for Sultana Seedless. From the initial results of this study, it seems that mature Regal Seedless will have the lowest cultural production cost of the four cultivars, in view of the fact that no GA or girdling is required for the successful cultivation of this cultivar. Some producers experienced problems with the set of small and uneven berries with Regal Seedless during the year of the study. It is expected that in difficult climatic seasons the labour input for Regal Seedless, especially in terms of bunch manipulation, may be high. In view of this it may be speculated that mature Sultana- and Regal Seedless will be in the same class when considering overall labour input for the cultural production practices linked to the cultivation of these two cultivars in the Lower Orange River area. According to experience with older Regal- and Prime Seedless vines in the Western Cape, it is suggested that the problem with the set of uneven and small berries decreases with an increase in vine age. This, however, still needs to be confirmed in the Lower Orange River area.

In terms of productivity per hectare (yield), there was very little to choose between Sultana Seedless and Sugraone (no statistical significant difference). Both these cultivars produced high yields of good quality during the 2001/2002 table grape season. Yields from certain experimental plots of Sugraone were higher than corresponding experimental plots of Sultana Seedless on the same production unit and *visa versa*, highlighting the similarities in productivity when cultivation practices is managed optimally to produce high yielding, good quality Sultana Seedless and Sugraone. The effort of Sun World in providing producers with the "best possible practices" through regular free consultation with viticultural- and soil specialists in the area, is also paying dividends in increasing Sugraone yields in the Lower Orange River area. The large variation in the yield results of the Regal- and Prime Seedless experimental plots, due to the young state of the vines, limited number of experimental plots and the fact that producers in the area are still in a phase of acquiring the "best possible practices" for the two cultivars, made it impossible to provide trends or initial indications in terms of productivity for mature Regal- and Prime Seedless. From the initial data, however, young Regal Seedless vines produced higher yields that the same age Prime Seedless vines on corresponding production units, but this difference was not significant. Consistency of production for these two cultivars still need to be established in the Lower Orange River, where occasional reduced yields may occur due to the extremities of climate experienced in the area. When considering consistency of production, Sultana Seedless and Sugraone have proven themselves in the area.

The early maturing cultivars such as Prime Seedless and Sugraone always perform very well in terms of price when harvested up to week 50. Up to this point the supply to overseas markets is low with a high demand for white seedless grapes. Later during the season, after week 50 when the supply of table grapes has increased sharply to the overseas markets, Sultana Seedless is usually the best performer in terms of price of the four cultivars. This is a very important factor to consider when decisions regarding cultivar choice according to profitability are made in an area of the Lower Orange River. Early maturing regions of the Lower Orange River area can obtain very high prices for early cultivars like Prime Seedless and

Sugraone. This advantage of high prices early in the season is, however, not always applicable to early cultivars in the later maturing regions of the Lower Orange River area. At this point, the white seedless supply to the overseas market has increased while the demand that stayed relatively constant, leading to a drop in price is obtained. This explains why later maturing cultivars such as Sultana- and Regal Seedless with higher yields and lower production cost can outperform lower yielding early cultivars with high production costs in the late harvesting region of the Lower Orange River area. Cultivar choice according to profitability is a complex decision in the sense that it is region related. Profitability is not only determined by harvesting date/region (price achieved) but also by yield, production input costs, quality and customer demand and acceptance of the specific cultivar.

The once off vine royalty related to the production of Regal Seedless is the highest of the four cultivars, followed by Sugraone and then Prime Seedless. No vine or *fruit* production royalties is applicable to Sultana Seedless, nor is any *fruit* production royalties applicable to Regal Seedless. The annual fruit production royalties payable for Sugraone and Prime Seedless is the single highest contributing factor to total production cost for these two cultivars. Figure 6.3 shows the fruit production royalties payable for 3000 cartons (4.5 kg) produced per hectare prior to week 50 during the 2001/2002 season to illustrate this fact for the various cultivars.

Fruit production royalties of Prime Seedless and especially Sugraone are major costs of production that can run into tens of thousands of Rand per hectare each year and a decision must be made by the individual producer if this extra cost can be financially justified. Prime Seedless is the earliest white seedless cultivar in the Lower Orange River, a position Sugraone held until the introduction of Prime Seedless to the area. The high prices obtained for Prime Seedless financially justifies the extraordinary cost of the fruit production royalties applicable to the cultivar. The good yields and prices obtained for early Sugraone may also justify the high fruit production royalties payable on this cultivar, but the fact that the royalties payable on Sugraone are twice as high as Prime Seedless, may have a major impact on producers choice of cultivar when future plantings are planned. Regal Seedless with only its vine royalty applicable will ensure this cultivar to also be competitive in this regard.

The author of this study is satisfied and confident that the data presented for Sultana Seedless and Sugraone will provide readers with good information regarding labour input and cost of the various cultural production actions, yield and price achieved as experienced in the Lower Orange River area. The production units that were part of this study were chosen on the grounds of their good record keeping system and their willingness to contribute to this study. In that regard the author is satisfied that the data presented in this paper were the best that were available within the limitations of the study. The aim to provide trends within the study topics, especially for Regal- and Prime Seedless, while considering the complication factors, was also satisfied. In this regard, analysis of the four predominant white seedless cultivars with the novel method of analysing the costs per cultivation was a worthwhile effort. The results obtained will provide present and future producers of these cultivars with valuable information regarding the cost-effectiveness, viability and possible profitability within the Lower Orange River production area. It will also assist producers with much needed information when cultivar choice for new or replanting purposes must be made and other important decisions regarding labour scheduling and determining labour needs for the important spring- and summer treatments, necessary for the successful cultivation of table grapes, are made.

This study with its limitations must be seen as a starting point for further, in-depth investigation into the cost-effectiveness and long-term potential of these four cultivars, especially Regal-and Prime Seedless in the Lower Orange River area. Further investigation would be useful and need to include older, fully matured vines and more experimental plots for Regal-and Prime Seedless to confirm or disregard all speculation and trends resulting from this study.

The trends and indications obtained from this study make a valuable contribution to the general information available regarding the economical impact of table grape farming from a producer's point of view. The fact that the information was gathered, analysed and presented per cultivation action per cultivar provide specialised information regarding the costs of certain viticultural actions. This approach is quite novel and is in line with worldwide trends to ensure that farming activity is market-driven and maximally cost-effective. The approaches used to extract and analyse data in this comparative analysis has shown the value of having qualified and specified data sets and should raise awareness for the advantages of optimised and detailed record-keeping on production units.