RESEARCH
REPORT **2020**

2016/17 – 2019/20 LEVY CYCLE

SATI
SOUTH AFRICAN TABLE GRAPE INDUSTRY

CONTENTS

CHAIRMAN'S REPORT

Research is an invaluable tool for keeping an industry sound, productive and economically viable. Research, however, does not happen by itself. It must be done by well-trained, experienced and motivated people, and must be properly funded. One thing we, as an industry, have learned the hard way is that you cannot turn research on and off at will. Research capacity needs to be maintained so as to be available when you need it. Once lost, research capacity is almost impossible to recreate in the short term. It takes lots of money and time.

Therefore, when looking at funding research you must sometimes take the long-term view, and support certain people and infrastructure to ensure that they are available when you really need them. SATI thus tries to follow a balanced approach, and to not only spend money on the short-term needs or problems of the industry, but also to balance spending among the different programmes identified as key to the industry.

There is also the reality that demand for research exceeds the available money. In addition, the typical research project takes three to five years from conception and funding to when usable and reliable information becomes available. Mostly the industry can only take on new projects when the projects already in the funding cycle finish. Moreover, information is not knowledge. The information needs to be disseminated to industry where it must be adapted to specific conditions before it will become knowledge and common facts.

Our technology transfer program is therefore of utmost importance, and no project is approved for funding until we know how the information will be communicated to industry. Herein also lies a problem. The different avenues of technology transfer might not be the ones preferred by our target audience, namely the producers. We are continuously looking at this and trying to use the options best suited to the specific type of information that must be disseminated.

The biggest programme funded by industry was cultivar development. During the past funding cycle a new approach was implemented. The basic breeding and selection process stayed the same, but the evaluation phase of promising cultivars became more grower-orientated. Certain growers were tasked to evaluate the new cultivars on-farm. This not only saves money, but will hopefully also speed up the process as cultivars are evaluated under different conditions from the start.

A fairly big portion of the available funds was spent on market access – roughly 10% of the available funds of the past cycle, totalling just over R7.2 million. The increased emphasis on market access is also illustrated by the fact that only R3 million was spent on market access in the funding cycle before that. Much of the information used in market access projects is created in the other research programs of SATI, forming an invaluable chain from the field to the consumer.

We remain privileged to have experienced and dedicated researchers in our industry, and we also see new scientists coming through that will be taking over in future years. We must cherish this capacity, and do our utmost to maintain and build on this. We will need researchers in future years when new problems come along. Let us not be so comfortable in our current situation that we forget that things not only can change, but most probably will.

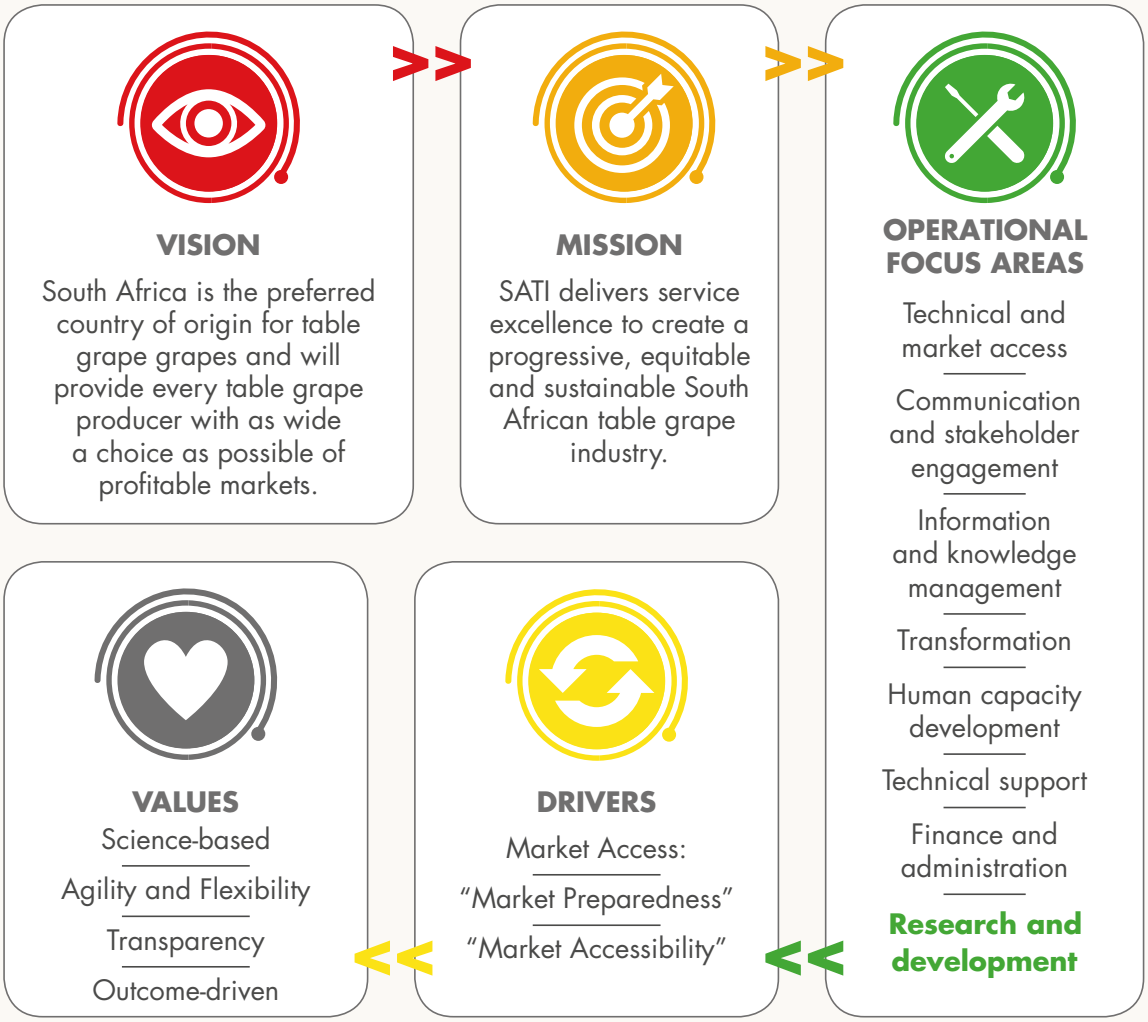
– KOBUS LOUW

"The common facts of today are the products of yesterday's research."

Duncan MacDonald

INTRODUCTION

One of SATI's primary objectives is market access, with the specific mandate to play a role in gaining access to new export markets and retaining and optimising access to existing markets. This is achieved through SATI's operational focus areas, of which Research and Technical Transfer is one.



The role of Research and Technical Transfer in market access is to fund projects which fall within two broad categories:

Market preparedness – projects which ensure that South Africa can continue to supply good quality product according to specifications required. Projects relating to production, quality, water and soil management, crop protection and cultivar development fall within this category; and

Market accessibility – projects which have a direct impact on gaining access to new markets or which have a direct impact on retention or optimisation of existing markets. Projects which can be directly used to motivate for specific export protocols or ensuring that access to a market is not prevented are examples of projects which fall within this theme.

Project Prioritisation and funding allocation

SATI identifies research and technical transfer projects in two different ways. The first is directly through market access requirements where scientific evidence is required to gain access to new markets or where it is required to retain or optimise access to existing markets ("Market Accessibility"). The second is in direct response to producers needs and directly relates to being prepared for the market ("Market Preparedness").

In response to needs identified from producers, the SATI Research and Technical Transfer Programme strives to develop scientific knowledge and technical tools that are relevant to the industry. Prior to 2020, producers were invited to share their research needs at annual research workshops, which were hosted in each table-grape region by SATI. Due to COVID-19, research needs are now identified by a survey of producers and industry service providers. Through this process, SATI can ensure that research is aligned with and relevant to industry, and can identify key topics for knowledge exchange and technical transfer.

At the start of the levy cycle, targets were set to spend three-quarters (75%) of the budget for research and technical transfer on research projects, and a quarter (25%) on technical transfer. Research funding is split across six research themes (Figure 1).

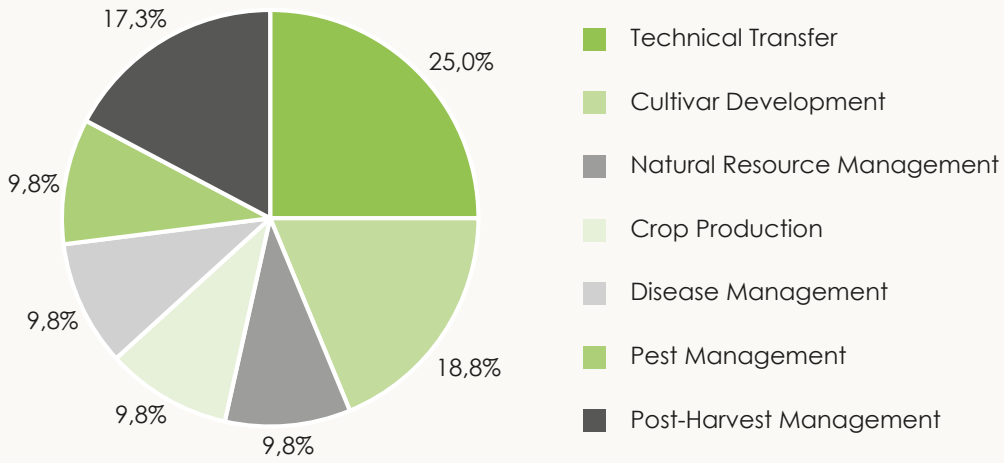


Figure 1: Relative % of total funding allocated to each research theme.

Description of research themes

1. **Cultivar development**

   The aims are to breed and to evaluate new table-grape cultivars that are specifically suited to South African conditions.

2. **Natural resource management**

   This research supports the sustainable management and efficient use of soil and water resources in table-grape production.

3. **Crop production**

   This research aims to address challenges and develop innovations in the cultivation of table grapes, and to assess the performance of rootstock cultivars.

4. **Disease management**

   This research aims to encourage optimal grapevine performance by minimising diseases, with a focus on the quality of grapevine material and on management practices that reduce the spread of grapevine diseases. Emphasis is also placed on disease management strategies that are safe for the environment and, as far as possible, reduce maximum residue limits.

5. **Pest management**

   Pest management research aims to safely minimise pests in table grapes, before and after harvest, with a special focus on management strategies that are safe for the environment, reduce maximum residue limits as far as possible, and optimise and maintain market access.

6. **Post-harvest management**

   This research focuses on optimising the handling and storage of table grapes across the cold chain, to ensure that table grapes are of good quality on arrival in the market, and to minimise quality claims. Included in this research theme were also projects which investigated post-harvest management protocols for market access purposes

In Figure 2, the actual expenditure can be compared to the planned expenditure in Figure 1.

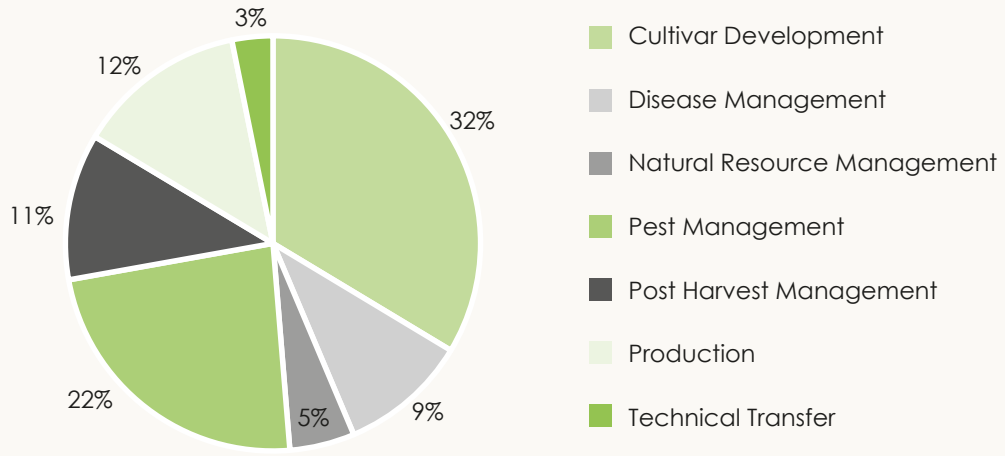


Figure 2: Relative % of total funding allocated to each research theme for 2016/17 - 2019/20 levy cycle.

Despite special emphasis being placed on technical transfer, it was difficult to spend the targeted 25% which means that in the new levy cycle (2020/21 to 2023/24) the target can be drastically reduced. Natural Resource Management also took up a very small portion of the budget. Pest Management and Cultivar Development on the other hand were allocated more than their target.

Research expenditure

Research funding for the 2016/2017–2019/2020 levy cycle averaged R7.2 million per year, and was spent on an average of 32 projects per year. Approximately R28.8 million was spent for the entire 2016/2017–2019/2020 levy cycle. The breakdown of expenditure per research theme is given in figure 3. Research spending increased by 112% compared to the previous levy cycle, thanks to increased export volumes.

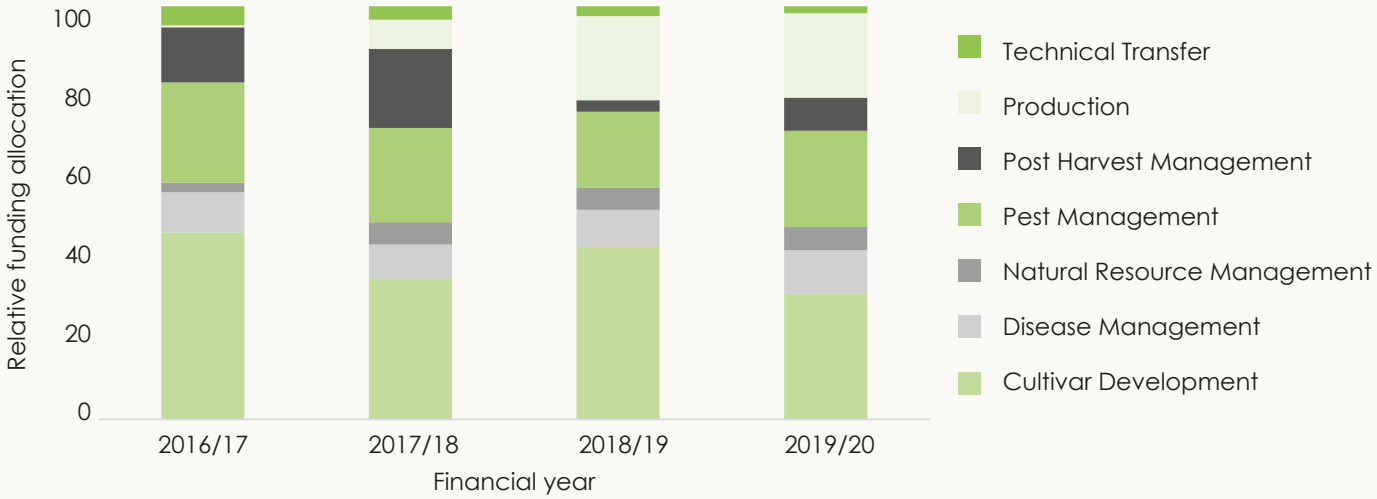


Figure 3: Relative % of total funding allocated to each research theme by fincial year.

Important to note is in the instance of Pest Management, the expenditure was higher than anticipated due to the sudden need to fund pest management projects in direct response to market access. In terms of Cultivar Development, expenditure was particularly high in this levy cycle due to the duplication of projects during the phasing out of ARC evaluation and the phasing in of Industry evaluation. The specific breakdown for Cultivar Development is given in Figure 4 where it shows how the ARC evaluation is phasing out (blue bar). In addition to the amounts reported in Figures 3 and 4, approximately R1.8 million was spent to establish the infrastructure on the seedling site at Lelienfontein. It is expected that the funds spent on Cultivar Development will stabilise and reduce over the next levy cycle.

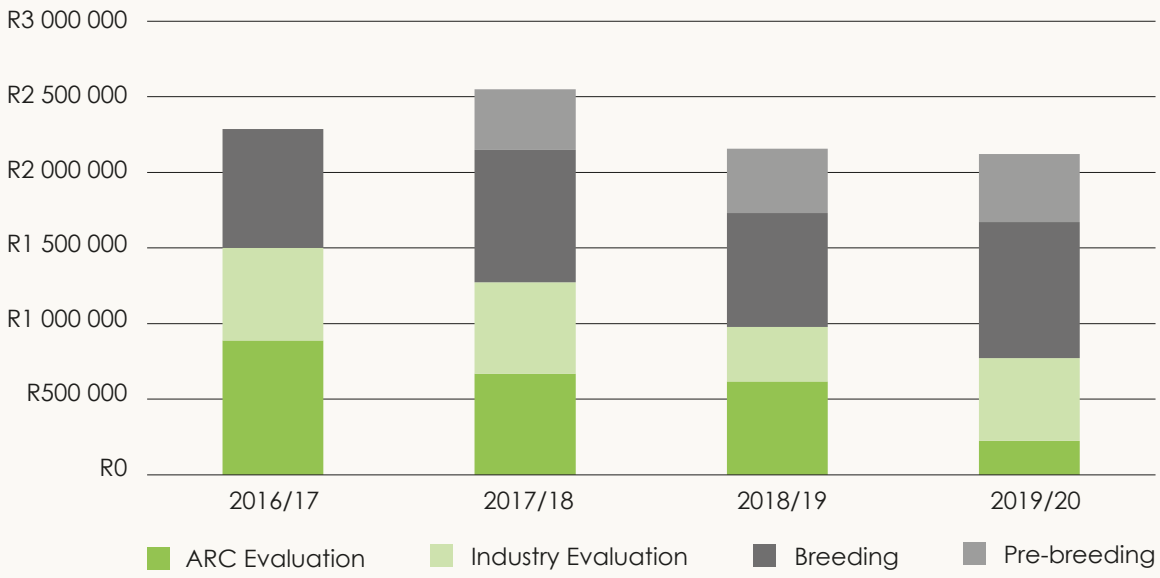


Figure 4: Breakdown of cultivar development expenditure.

Spending on market access was approximately R7.2 million, or a quarter of total research funding during the 2016/2017–2019/2020 levy cycle, compared to about R3.0 million for the previous cycle (Figure 5). This amount is expected to increase further over the next levy cycle.

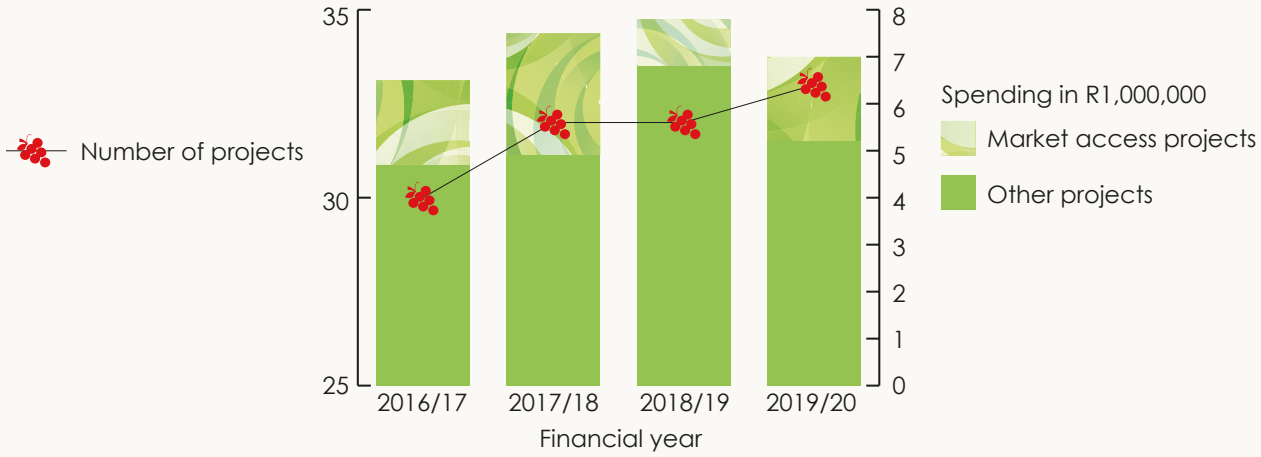


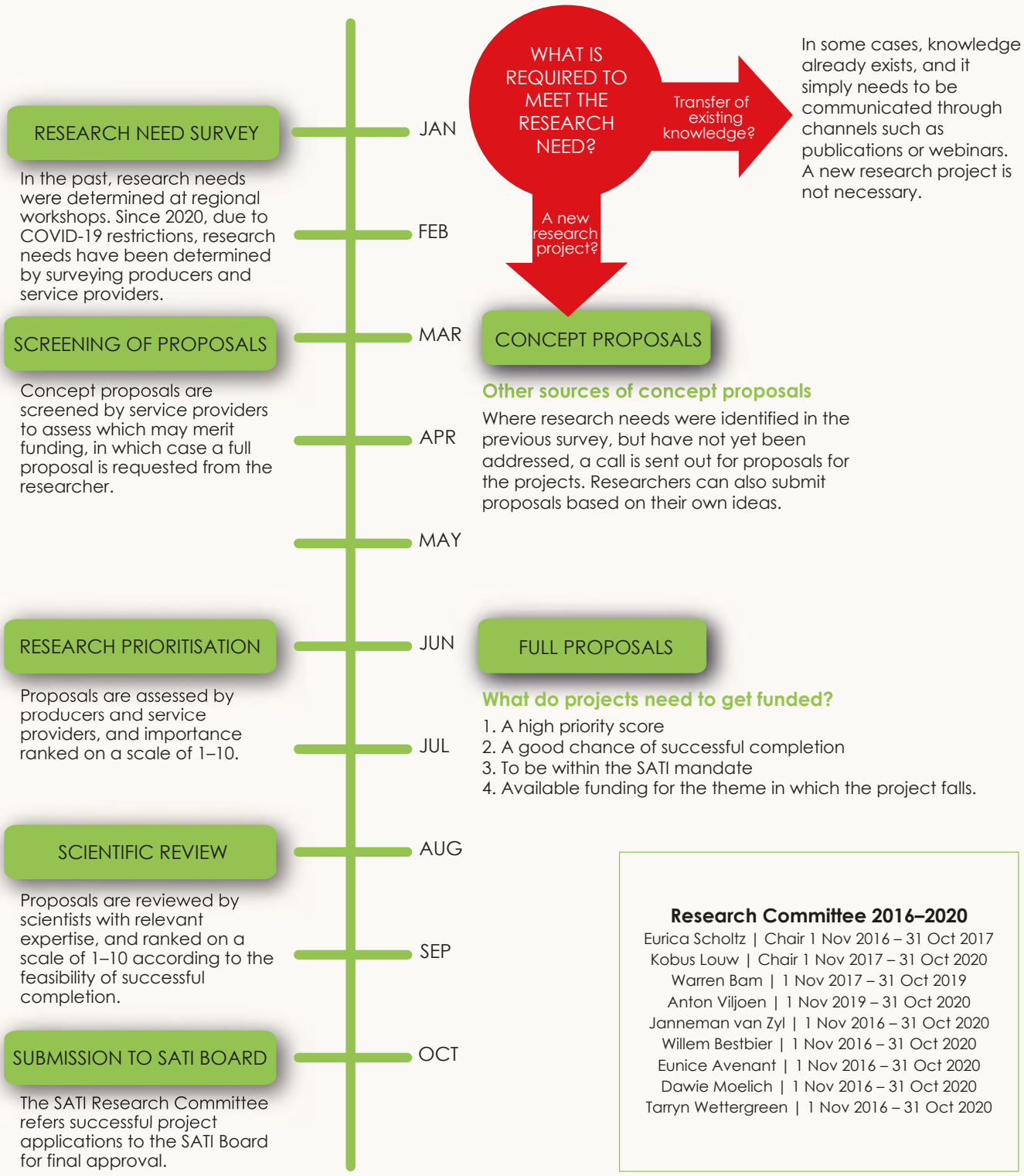
Figure 5: Number of projects and research spending per year for 2016/17–2019/20 levy cycle.

Structure and process

The SATI Research Committee is a committee of the SATI Board with the primary responsibility of ensuring that the SATI research portfolio is carried out within the framework of the SATI Strategic Plan. Additionally, it is the responsibility of the committee to ensure systems and processes implemented by the SATI Research and Technical Transfer Manager are fair, and research funds align with producer needs.

There are two types of committees that advised SATI. The Technical Committees assisted SATI to prioritise research needs, while the Scientific Review Committees assisted in assessing the science of project proposals. Due to COVID-19, these committees no longer meet in person, but same functions are still performed by their members.

Figure 1 illustrates the process by which SATI identifies which projects to fund.



Research Committee 2016–2020

Eurica Scholtz | Chair 1 Nov 2016 – 31 Oct 2017
Kobus Louw | Chair 1 Nov 2017 – 31 Oct 2020
Warren Bam | 1 Nov 2017 – 31 Oct 2019
Anton Viljoen | 1 Nov 2019 – 31 Oct 2020
Janneman van Zyl | 1 Nov 2016 – 31 Oct 2020
Willem Bestbier | 1 Nov 2016 – 31 Oct 2020
Eunice Avenant | 1 Nov 2016 – 31 Oct 2020
Dawie Moelich | 1 Nov 2016 – 31 Oct 2020
Tarryn Wettergreen | 1 Nov 2016 – 31 Oct 2020

NATURAL RESOURCE MANAGEMENT

DEVELOPING GUIDELINES FOR THE JUDICIOUS IRRIGATION OF TABLE GRAPES ACCORDING TO GRAPEVINE WATER-POTENTIAL MEASUREMENTS

Project leader C Howell | ARC Infruitec-Nietvoorbij
Project duration 2018-2021
Students qualified none

All table-grape production in South Africa relies on irrigation. South Africa has limited water resources, and table-grape growers are increasingly under pressure to improve their water-use efficiency. Climate change threatens to further reduce water availability. On the other hand, improved water-use efficiency promises the positives of reduced costs and, potentially, expanded area under production.

Optimising the irrigation schedule for table grapes presents challenges. How can growers best assess when water is needed? Irrigation scheduling often relies on soil-moisture measurements, but the instruments used may not be correctly calibrated. In addition, the refill point – the point at which irrigation is deemed necessary – may not reflect the true water requirements of the grapevines.

This project aims to determine refill points by measuring midday grapevine stem water potential, and relating this to soil moisture levels. Stem water potential is a direct measure of plant water status, and can be used to calibrate instruments that measure soil moisture. Once refill points have been determined and instruments calibrated, irrigation scheduling can continue based on the soil-moisture readings.

So far, the researchers have used grapevine stem water potentials to guide irrigation scheduling in experimental plots over two seasons, in ten different table-grape cultivars. Overall, irrigation based on stem water potential reduced water use by about a third, compared to conventional irrigation scheduling, while producing similar yields and grape quality.

Data collection continues, but the researchers have already begun to communicate their findings in presentations and at information days. The project outputs will include guidelines for the irrigation of table grapes based on stem water potential.

DETERMINING THE EFFECT OF NETTING ON WATER USE OF TABLE GRAPES IN THE LOWER ORANGE RIVER REGION

Project leader E Avenant | Stellenbosch University
Project duration 2015-2021
Students qualified M Mahlo | MSc; M Sadikge | MSc

There is growing interest in table-grape production under nets, as nets offer protection against damage from hail and sleet, sunburn, wind, and birds, and may also reduce the water needed for irrigation. This project aims to compare vines growing under nets to uncovered vines with respect to their water use, phenology, and vegetative and reproductive performance.

The research is underway in a commercial block of Sultanina in the lower Orange River region. One section of the experimental block is covered by white 20% shade-net while the other section is open. Data collected include rainfall, temperature, soil water content, irrigation volumes, total evapotranspiration, and sap flow. Phenology, vegetative growth, fertility, yield, grape quality, and various physiological measurements are recorded.

Data collection began during the 2018-19 season and will continue until the end of the 2020-21 season. Preliminary analysis has shown that air temperature is lower and relative humidity is higher under the nets. The vines under the nets have correspondingly lower transpiration rates. Total irrigation volumes were approximately 18% lower under the nets during the 2018-2019 season.

Water-use efficiency under the nets was 446 cubic litres per tonne production, compared to 623 for the uncovered vines. However, cooler conditions under the nets slowed phenological development by 2-3 days during the 2020-2021 season. Actual fertility and yields also appeared to be lower compared to the uncovered vines, which the researchers ascribe to the impact of shading on bud initiation.

The final results of this project will provide table-grape producers with better information for the management and irrigation of vines under nets.

CONFRONTING CLIMATE CHANGE

Project leader A Blignaut | Blue North Sustainability
Project duration 2008-2021
Students qualified none

The realities of climate change are increasingly recognised worldwide, and there is growing scrutiny of industries that are considered to be significant contributors to greenhouse-gas emissions. Agriculture produces greenhouse gases by land clearance, chemical and fertiliser application, and fossil-fuel consumption, as well as by energy-intensive storage, handling, and transport practices associated with exports.

South African fruit and wine industries recognise that responding to climate change is necessary if they are to maintain market share and global competitiveness. In 2008, several industry bodies, including SATI, took a proactive approach to develop a carbon-footprinting tool specifically for South African conditions. This resulted in the establishment of the Confronting Climate Change initiative, a partnership between South African fruit and wine industry bodies, the World Wide Fund for Nature, and the Western Cape Government.

The carbon footprint of something – whether a person, company, product, service, or any other entity – is a measure of the total amount of greenhouse gases it brings about. Measurement is the first step in management of any process, and knowing the carbon footprint of an entity is essential for the implementation of carbon reduction.

Table-grape growers, as well as other fruit-industry role-players, can now use the carbon emissions calculator on the Confronting Climate Change website to quantify and benchmark their carbon footprint. The results can be used to address consumer concerns and to meet audit requirements. Access to the carbon emissions calculator requires payment of an annual license fee. Other services that are available include multi-year reports for businesses, and support for developing carbon-reduction plans. The Confronting Climate Change initiative also offers regular training to users.

The project has identified that electricity used to pump water is the largest source of carbon emissions by South African fruit and wine farms. Synthetic nitrogen-based fertilisers are the second biggest source, and diesel consumption takes third place. Packaging material is the largest source of carbon emissions at packhouse level.

By measuring and benchmarking their carbon footprint, and reducing emissions through improved efficiency, businesses can protect and increase their market share, and growers can help mitigate climate change, thereby ensuring a sustainable future for their operations. Carbon reduction strategies also increase competitiveness by reducing inefficiencies, thereby potentially saving costs.

CROP PRODUCTION

EVALUATION OF ROOTSTOCKS FOR TABLE GRAPES

Project leader JH Avenant | ARC Infruitec-Nietvoorbij
Project duration 1997-2016
Students qualified none

The South African table- and dried-grape industries have long recognised the value of systematic assessment of rootstocks. Rootstocks trials were already underway in 1982, when table-grape research was taken over by the ARC-Nietvoorbij Institute for Viticulture and Oenology. The project was funded by industry, and led by Jan Avenant from 1995 to 2016.

In the Western Cape, rootstock trials were carried out at the Hex River experimental farm, De Doorns; Malanot, Paarl; and Nietvoorbij, Stellenbosch. In the lower Orange River region of the Northern Cape, trials were carried out at Fulham, Blouputs; and Kromhout and Rooiwal, both Kakamas. The first and the last vines that form part of this project were planted at the Hex River experimental farm in 1989 and 2015 respectively.

Scions that were included in this project were Autumn Royal, Barlinka, Bellevue, Bonheur, Crimson Seedless, Dauphine, Prime, Regal Seedless, Sundance, Sunred Seedless, and White Gem.

The following rootstocks were tested over the years:

Constantia Metallica – C. Metallica
Couderc 161-49 – 161-49C
Couderc 3309 – 3309 C
Dog Ridge
École de Montpellier 333 – 333 EM
Freedom
Harmony
Jacquez
Malègue 44-53 – 44-53M
Millardet et de Grasset 101-14 – 101-14 Mgt
Millardet et de Grasset 143B – 143B Mgt
Paulsen 1045 – 1045P
Paulsen 1103 – 1103P
Ramsey
Richter 99 – 99R
Richter 99 PS – PS R99
Richter 110 – 110R
Riparia Gloire – Riparia G.
RS-3 – Ramsey x Schwarzmann 3
RS-9 – Ramsey x Schwarzmann 9
Ruggeri 140 – 140Ru
Selection Oppenheim – SO4
USVIT 2-1, USVIT 8-7, USVIT 17, USVIT 28, and USVIT 41 – University of Stellenbosch.

The most relevant findings of these South African rootstock trials have been compiled in a book, *Tafeldruif-onderstokke in Suid-Afrika: 'n samevatting van 27 jaar se evaluering*, discussed elsewhere in this report. New rootstock trials are underway, as described in the next project summary.

THE EVALUATION OF TABLE-GRAPE ROOTSTOCKS FOR THE SOUTH AFRICAN TABLE GRAPE INDUSTRY

Project leader Graeme Matthews | Provar
Project duration 2017-2024
Students qualified none

Rootstock cultivars differ in how well they perform under different environmental conditions, in different soil types, and in response to challenges by various pests and diseases. Table-grape growers need to know the commercial potential and adaptability of available rootstocks so that they can make informed planting decisions.

This project aims to characterise the performance of new rootstocks at a range of trial sites. The sites represent different soil types and suboptimal growing conditions, such as replant soils or those with high pH and lime levels; salinization; sandy or heavy textures; waterlogging and *Phytophthora* infestation; or infestations of plant-pathogenic nematodes or *Phylloxera*.

Well-established rootstocks – Ramsey, Richter 110, and Paulsen 1103 – are added to the trial sites as controls. The scions are Crimson Seedless, Sugrathirtyfive (Autumn Crisp®), Sugrasixteen (Sable Seedless®), Sweet Celebration™, and Thompson Seedless.

Evaluation criteria include growth and vigour; fertility and yield; berry and bunch quality; general compatibility; ease of handling; phenological stages; and dates for applying treatments. Data are also collected on physical and chemical soil tests; nematode analysis; and air and soil temperatures.

The first vines, on three control and five new rootstocks – Harmony, SO4, RS-3, RS-9, and Ruggeri 140 – were planted at five trial sites in 2019. These are in De Doorns, the Northern Cape, Saron, and Vredendal. More vines on additional rootstocks will be planted in 2021, at three trial sites, in the Western and Northern Cape.

Data collection is already underway, but comprehensive evaluation of rootstock cultivars takes time, and this project is set to continue until 2024. The project is being carried out by independent evaluation company Provar.

THE EFFECT OF POST-HARVEST PRUNING ON RESERVE STATUS AND GROWTH-ARREST PHENOMENON

Project leader JH Avenant | ARC Infruitec-Nietvoorbij
Project duration 2018-2023
Students qualified K Toolo | MSc

Grapevines depend on stored carbohydrates for root growth leading up to bud break, for bud break, for initial shoot growth, and for the final stages of flower development. Insufficient stored carbohydrates lead to abnormal vine development in spring, usually seen as suspension of growth after budding starts. This is known as growth-arrest phenomenon. It is of economic importance in the lower Orange River region, and has also been observed in the Northern Province.

This project aims to establish the relationship between the carbohydrate and nutrient reserve status, and the phenology and performance of Sultanina H5 in the lower Orange River region and the Hex River valley. The researchers are also investigating the link between post-harvest pruning, reserve status, and growth-arrest phenomenon, in Sultanina H5 in the lower Orange River region.

Post-harvest pruning is a common practice which growers believe improve reserve accumulation in the current season, and bud-break and fertility in the next season. However, post-harvest pruning may have the opposite effect, reducing reserve accumulation and promoting growth-arrest phenomenon. The project compares four different post-harvest pruning protocols to a control which is pruned during winter.

So far, the researchers have collected phenological data and vine samples for two seasons. They found that vines from the Hex River valley had higher levels of stored carbohydrates in their roots, canes, and shoots, than vines from the lower Orange River region. Different pruning regimes did not appear to affect carbohydrate reserves, bud-break percentage, bud fertility, or grape yield and quality in the vines from the lower Orange River region.

The project is set to continue, and more data are needed before drawing conclusions.

GRAPE QUALITY FROM VINEYARD TO SHELF: RESPONSES OF CRIMSON SEEDLESS AND LUISA TO MESOCLIMATE, WATER REGIME, AND RIPENESS LEVEL

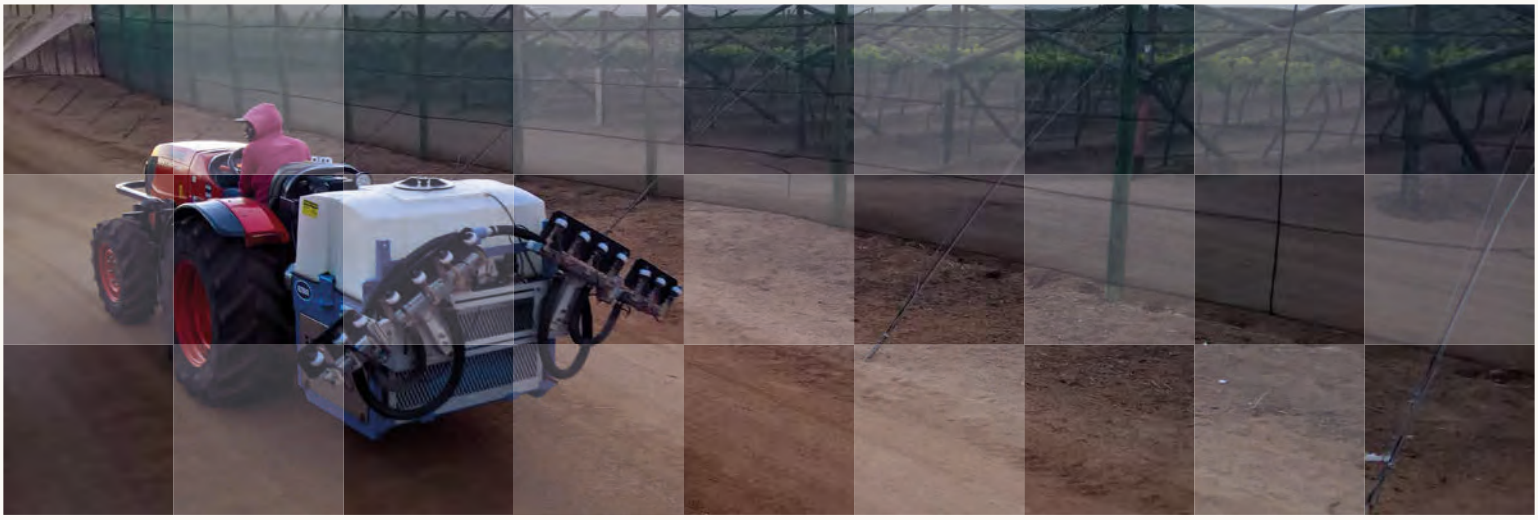
Project leader J Strydom + K Hunter | ARC Infruitec-Nietvoorbij
Project duration 2020-2023
Students qualified J Strydom | PhD

The profitable production of export-quality table grapes in South Africa relies on irrigation. The amount and timing of irrigation is critical to both yields and grape quality. Optimising irrigation schedules is therefore essential for maintaining the competitiveness and sustainability of the South African industry in a global marketplace. Yet water availability is a growing constraint to the South African table-grape industry.

This project aims to characterise the response of grapevines to four different irrigation treatments – 100%, 85%, 70%, and 55% of field water capacity – so as to better understand the impact of deficit irrigation. The researchers also compare grapevines grown under plastic to uncovered vines. Data collection includes growth and reproductive performance, physiological variables, berry quality, and post-harvest defects.

The trial commenced on Crimson Seedless during the 2019-2020 season. The site is a commercial farm in the Langeberg. A parallel trial on Luisa, an aromatic cultivar, will be run in Italy, and will focus on sensory quality.

The analyses of samples collected during the first season is ongoing. The project is set to continue until March 2023. The addition of plastic covering is planned for the 2021-2022 season.



CROP PROTECTION

PEST MANAGEMENT (INSECTS)

FOLIAR APPLICATION OF ENTOMOPATHOGENIC NEMATODES FOR THE CONTROL OF VINE MEALY BUG — *PLANOCOCCUS FICUS* — IN VINEYARDS

Project leader N Stokwe | Stellenbosch University
Project duration 2015-2021
Students qualified T Platt | MSc

Mealy bugs are pests of grapevines which also spread grapevine leafroll-associated viruses. Mealy bugs are difficult to control because of their spray-repelling waxy coating and their habit of hiding under bark and even on roots underground. Control is further complicated by increasing restrictions on pesticides imposed by importing countries.

Entomopathogenic nematodes are microscopic worm-like creatures that attack insects and offer a biological alternative to chemical control of mealy bugs. This project has explored practical questions around using *S. yirgalemense* for mealy-bug control. *Steinernema yirgalemense* was chosen because it both kills mealy bugs and grows readily in culture.

Results so far have shown that *S. yirgalemense* can penetrate mealy bugs within thirty minutes and that mealy-bug mortality peaks after three hours. Adding a spreader-sticker and an anti-dessicant to formulations containing nematodes significantly improves the deposition of nematodes on grapevine leaves.

S. yirgalemense was most effective against vine mealy bugs at 25°C and a relative humidity of 85%. Higher humidity appears more important than high temperatures, as nematode survival on leaves was better after a morning application than an afternoon application.

Field trials of *S. yirgalemense* have been conducted to assess the impact of nematodes applied to mealy-bug infested grapevines at different times during the season. The trials also looked at the efficacy of nematodes when applied to stems and branches. The final report of these trials is due in 2021.

INTEGRATED MANAGEMENT OF THE CONTROL OF FALSE CODLING MOTH, *THAUMATOTIBIA LEUCOTRETA*, ON STONE FRUIT AND TABLE GRAPES

Project leader P Addison | Stellenbosch University
Project duration 2016-2018
Students qualified V Steyn | PhD

False codling moth – *Thaumatotibia leucotreta* – is a pest on a variety of commercial crops, including stone fruit and table grapes. It is native to southern Africa, and considered a phytosanitary pest by several countries that import our fruit. While control options exist, the development of alternatives is important, as existing products may be lost due to the requirements of importing countries, or the evolution of resistant moths.

The aim of this project was to investigate biological control and mating disruption as alternative management methods for false codling moth in stone fruit and table grapes.

The researchers surveyed orchard soils for nematodes and fungi – known as entomopathogens – that attack and kill insects. They tested the effect of these entomopathogens on different life stages of false codling moth in the laboratory. Some of the entomopathogenic nematodes were able to kill 90%-100% of larvae. Eggs and pupae were less susceptible. Certain strains of entomopathogenic fungi killed up to 80% of larvae.

Semi-field trials with two species of entomopathogenic nematodes achieved infection rates of up to 85% of false codling moth larvae. The nematodes survived, and could still infect up to 60% of larvae seven days after application. The researchers point out that large-scale field trials are necessary to determine the impact of entomopathogens in commercial vineyards and orchards.

Field trials with mating disruption in vineyards proved that this method can almost completely eliminate false codling moth. The greatest reduction in moth numbers was found with 800 pheromone dispensers per hectare. The researchers were able to obtain the same reduction by placing as few as 36 dispensers per hectare, provided these dispensed the same total amount of pheromones as the 800 standard dispensers. This may offer an opportunity to economise on the labour of distributing the dispensers.

THE CONTROL OF MALE *MARGARODES PRIESKAENSIS* TO PREVENT REPRODUCTION

Project leader CA de Klerk | Private consultant
Project duration 2017-2018
Students qualified none

Margarodes prieskaensis is an insect pest that feeds on plant roots. It causes production losses and grapevine mortalities in Limpopo, Mpumalanga, and the Northern Cape. Female *Margarodes* remain underground, protected from chemicals, and come to the surface only to mate. However, male *Margarodes* are winged, and vulnerable to chemical control when flying in search of females.

This project aimed to test various chemicals against male *Margarodes prieskaensis*. This species of *Margarodes* depends on sexual reproduction, so the removal of males will prevent population increases. In addition, chemicals applied at the time of mating may eliminate females that have surfaced.

Laboratory trials showed that application of cypermethrin and dichlorvos killed 100% of both males and females. Acetamiprid, chlorpyrifos, and deltamethrin were less effective, but still provided good control. The majority of both males and females survived treatment with spinetoprim and indoxocarb.

The researcher points out that *Margarodes prieskaensis* mate during June and July, when grapevines are dormant, so there is no risk of residue problems associated with chemical applications. The results of the project were published in the February | March 2020 issue of the South African Fruit Journal.

THRIPS ON TABLE GRAPES IN THE NORTHERN CAPE AND MPUMALANGA: SPECIES IDENTITY, SEASONAL OCCURRENCE, AND ECONOMIC DAMAGE

Project leader E Allsopp | ARC Infruitec-Nietvoorbij
Project duration 2018-2021
Students qualified none

Thrips are tiny insects with piercing-sucking mouthparts. The majority of species feed on plants. Western flower thrips – *Frankliniella occidentalis* – and citrus thrips – *Scirtothrips aurantii* – are known to damage table grapes in Mpumalanga. There have also been reports of increasing thrips populations on table grapes in the Northern Cape in recent years.

This project aimed to identify the thrips species on table grapes in the Northern Cape, and to assess their economic impact. The project also aimed to study the seasonal occurrence and economic impact of Western flower and citrus thrips in Mpumalanga, and to assist growers to improve thrips management.

The researchers monitored thrips during two seasons in vineyards near Kakamas and Blouputs in the Northern Cape. Although several species of thrips were identified, and some were present in large numbers, no feeding damage was observed on either young shoots or young berries. Young shoots and berries are probably protected by early-season pesticide applications. Thrips numbers dropped during the course of the season and were low by the time of harvest.

Large numbers of *Haplothrips clarisetes* and *H. nigricornis* are sometimes present in flowering bunches of grapevines in the Northern Cape. The researchers conducted laboratory trials to investigate whether this should be concerning. They found no evidence that *Haplothrips* cause feeding damage to grapevine berries or shoots.

Two seasons of data collection in Limpopo and Mpumalanga indicated that early-season insecticide applications were effective in preventing damage to young shoots and berries. Western flower thrips were the most common species during flowering. Citrus thrips were the most common species later in the season, and damaged the young shoots and leaves produced during the secondary growth flush. The researchers highlighted a need for control measures for citrus thrips that will not leave residues on the grapes.

Some of the findings of this project were summarised in an article on thrips management in table grapes that appeared in the December 2019 | January 2020 issue of the South African Fruit Journal.

SEQUENCING THE GENOME AND TRANSCRIPTOME OF FALSE CODLING MOTH, *THAUMATOTIBIA LEUCOTRETA*, FOR PEST MANAGEMENT

Project leader J Terblanche | Stellenbosch University
Project duration 2018-2021
Students qualified Erika Huisaman | PhD

False codling moth – *Thaumatotibia leucotreta* – is a pest of table grapes and many other commercial crops. Control methods include chemical pesticides, mating disruption, and the sterile insect technique, but alternative management strategies are needed in case these options should no longer be effective or available.

The aim of this project is to support the development of additional management strategies for the control of false codling moth by sequencing its genome and transcriptome. The genome contains the information used to build and run a living organism. The transcriptome indicates which information is actively in use. For example, the transcriptome can provide insights on how a moth is able to resist a pesticide or to survive a stressor.

The researchers will extract genetic material from moths obtained from XSIT, and have this sequenced by Macrogen. Progress was delayed, due to technical issues, and COVID-19 restrictions, but work is currently underway, and the project has been extended.

To study the evolution of pesticide resistance, the researchers reared false codling moth larvae at different concentrations of spinetoram, and exposed them to different temperatures. They concluded that raising false codling moth at 4 mg per 100 ml of spinetoram for three generations would enable investigation of the genetic basis of resistance.

This research is ongoing. Genome-based control strategies are under investigation in many countries for a range of pests. Sequencing the genome and transcriptome will lay the foundation for similar research in false codling moth.

IN *VITRO* LIQUID CULTURE OF ENTOMOPATHOGENIC NEMATODES TO BE USED FOR FIELD TRIALS AGAINST FALSE CODLING MOTH

Project leader AP Malan | Stellenbosch University
Project duration 2017-2019
Students qualified MD Dunn | MSc

Entomopathogenic nematodes are tiny worm-like organisms that feed on insects, and occur naturally in the soil. Laboratory trials have shown that they can infect and kill up to 90%-100% of exposed false codling moth larvae, as well as lower percentages of eggs, pupae, and emerging adults. If entomopathogenic nematodes can be successfully utilised in vineyards, they offer the promise of environmentally friendly pest control with no risk of chemical residues.

Field trials of entomopathogenic nematodes have been constrained by a shortage of nematodes. The aim of this project was to determine the optimal conditions for the culture of two species of entomopathogenic nematodes – *Steinernema jeffreyense* and *S. yirgalemense* – that attack false codling moth.

Previous research has shown that entomopathogenic nematodes can be cultured in a liquid medium that is continuously agitated on a shaker. The nematodes feed on bacteria that grow in the liquid medium.

In this project, the researchers found that a smaller volume of liquid culture medium yielded a higher concentration of nematodes than a larger volume. They speculate that this is due to lower oxygen levels in the larger volume, highlighting the importance of maintaining sufficient oxygenation in mass culture systems.

Starting the cultures with a larger number of nematodes did not result in a larger final yield than starting with fewer nematodes. Maintaining the cultures at a uniform temperature in an incubator did not increase the final yield compared to keeping the cultures at room temperature.

The findings of this project will support the development of biocontrol options by enabling the production of sufficient numbers of nematodes for field trials.

EXPLORATION OF ORCHARD SANITATION AND THE POTENTIAL OF PARASITOID WASPS FOR THE BIOLOGICAL CONTROL OF FRUIT FLIES IN SOUTH AFRICA

Project leader P Addison | Stellenbosch University
Project duration 2018-2020
Students qualified B Stead | BSc Agric Hons

Fruit-fly control presents an ongoing challenge to commercial fruit growers. This project explored parasitoid wasps as potential biocontrol agents. Parasitoid wasps deposit their eggs inside the larvae of fruit flies. The developing wasps ultimately kill the fruit-fly larvae.

The researchers sampled fruit from orchards, gardens, and other habitats in the Western Cape, Mpumalanga, and Limpopo, and collected parasitoid wasps associated with fruit flies. Wasps were also obtained from other areas through partner institutions and collaborators. Identification was facilitated by a technique called DNA barcoding, which separates species based on genetic comparison.

Two species of wasp – *Fopius ceratitivorus* and *Psyttalia humilis* – that target fruit flies were found in Mpumalanga and Limpopo. Parasitoids of fruit flies were rare in the Western Cape. The researchers also identified seventy kinds of parasitoid wasp from the Afrotropical region. Some of these may be potential biocontrol agents.

Tests of augmentoria were carried out as part of this study. Augmentoria are mesh enclosures in which fruit-fly-infested fruit is placed. The mesh prevents emerging fruit flies from escaping but parasitoids can get out to hunt for more fruit flies.

The researchers found that augmentoria were unsuccessful in the Western Cape due to the scarcity of parasitoids. Augmentoria worked better in Mpumalangha and Limpopo. A 3 mm^2 mesh allowed the parasitoid wasps to escape while retaining all fruit flies.

Data collected on the numbers of parasitoids and fruit flies in different types of fruit showed that smaller fruit contain more parasitoids per unit mass than larger fruit. The researchers suggest planting indigenous or ornamental fruiting trees around vineyards to serve as a source of parasitoid-containing fruit. Growers can place this fruit in augmentoria to increase parasitoid numbers in their vineyards.

The project was a joint effort between several institutions, including the Iziko and Pretoria museums, and CIRAD, the French Agricultural Research Centre for International Development.

IMPLEMENTATION OF BIOLOGICAL CONTROL OPTIONS AGAINST FALSE CODLING MOTH IN FIELD TRIALS

Project leader P Addison | Stellenbosch University
Project duration 2019-2021
Students qualified F du Preez | PhD

False codling moth – *Thaumatotibia leucotreta* – is a pest of many commercial crops. The benefits of effective biological control of false codling moth include improved overall pest control and reduced reliance on chemical pesticides. The aim of this project was to investigate the use of different biological control agents in the field.

The researchers started by screening different entomopathogenic nematodes against soil stages of false codling moth. The experiments were done in soil in the laboratory to mimic natural conditions. They found that four different species of nematodes – *Heterorhabditis noenieputensis*, *H. zealandica*, *H. indica*, and *Steinernema yirgalemense* – each killed 89% or more of larval false codling moth when 50 nematodes per larvae were applied. Entomopathogenic nematodes were less effective against pupae.

Tests of entomopathogenic fungi showed that one fungal strain – *Metarhizium pingshaense* – was able to kill 90% of false codling moth larvae, and three other strains – *M. anisopliae*, *M. robertsii* and *M. brunneum* – were able to kill 58% or more.

The project will also include investigation of parasitoid wasps that develop in the eggs of false codling moth. Under natural conditions, one such wasp – *Trichogrammatoidea cryptophlebiae* – can infect and kill up to 80% of eggs. The researchers plan to survey the occurrence of parasitoid wasps of false codling moth in the Western Cape, and to assess the sensitivity of these wasps to commonly used pesticides.

SURVEY TO DETERMINE THE DISTRIBUTION OF PHYLLOXERA AND THEIR POTENTIAL EFFECT ON TABLE AND DRIED GRAPES

Project leader E Allsopp | ARC Infruitec-Nietvoorbij
Project duration 2019-2022
Students qualified none

Phylloxera – *Daktulosphaira vitifoliae* – is an insect related to aphids. It originates from North America and is a significant pest of grapevines worldwide. Phylloxera impacts grapevine performance by feeding on the root system. Grape producers have come to depend on resistant rootstocks to manage the effects of phylloxera.

The ability of rootstocks to resist phylloxera is influenced by growth vigour. Vines that are less vigorous due to suboptimal soil conditions, heat and drought stress, and infestations of pests such as ring nematodes, will be more susceptible to phylloxera. Young vines may also be less able to resist infestation.

South African vineyards were last surveyed for phylloxera in the 1970s. This project aims to conduct a new survey to establish how widespread phylloxera is in the major table- and dried-grape growing areas. The project will investigate whether phylloxera is harming vine performance, taking into account other factors that affect vine vigour.

The researchers identified poorly performing table-grape vineyards in the Berg and Hex River Valleys, and collected soil and root samples, as well as data that include rootstock and scion cultivar, age, performance, other pests and diseases, and stressors. They found phylloxera in 22 out of 26 vineyards surveyed. Phylloxera was present on rootstocks that are considered resistant – Richter 110 and Richter 99 – and moderately resistant – Ramsey and Paulsen 1103.

The researchers note that phylloxera, like many other soil-dwelling pests, is unevenly distributed in vineyards, complicating both sample collection and damage assessment. A small area of phylloxera in a vineyard is a potential focus from where infection could spread should the vineyard come under stress.

The survey and data collection are ongoing, with the project set to continue until 2022. Data analyses will include an assessment of the impact of phylloxera on grapevine performance.

DEVELOPING AN INTEGRATED PEST-MANAGEMENT STRATEGY FOR *MARGARODES PRIESKAENSIS* IN TABLE GRAPES

Project leader E Allsopp | ARC Infruitec-Nietvoorbij
Project duration 2019-2023
Students qualified T Erasmus | MSc

Margarodes prieskaensis is an indigenous insect that usually feeds on the roots of camel-thorn trees. *Margarodes* also attacks grapevines and reduces their productive lifespan. It causes problems in Limpopo, Mpumalanga, and the Northern Cape. This project aims to develop an integrated pest-management strategy to control *Margarodes*.

Control measures that are being evaluated include contact and systemic insecticides, and entomopathogenic fungi and nematodes.

Field trials with contact insecticides applied as soil drenches were conducted in the Northern Cape and Limpopo in June-August 2019 and 2020. Field trials with systemic insecticides applied as post-harvest sprays were conducted in the Northern Cape and Limpopo in 2020.

The data from these trials are still being analysed. Contact insecticides appear to show promise based on preliminary results. Further trials are being conducted.

Margarodes have been collected for laboratory-based evaluation of their susceptibility to entomopathogenic fungi and nematodes.

This project is set to continue until 2023.

TAXONOMY AND FIELD MANAGEMENT OF BANDED FRUIT WEEVIL — *PHLYCTINUS CALLOSUS*

Project leader P Addison | Stellenbosch University
Project duration 2019-2021
Students qualified none

Banded fruit weevils – *Phlyctinus callosus* – are indigenous to South Africa, and are considered a phytosanitary pest. Recent research suggests that banded fruit weevils constitute a species complex, which means that the *Phlyctinus callosus*-bucket contains more than one species of weevil. The different weevil species may differ in their feeding habits, their life-cycles, and their responses to chemical and biological control.

This study seeks to clarify the identity of banded fruit weevils collected from agricultural and natural habitats in the Western Cape. The researchers have

sampled weevils from apple orchards and vineyards in Ceres, Elgin, Greyton, the Langkloof, Rawsonville, Robertson, Stellenbosch, and Villiersdorp. Weevils were identified based on physical characteristics, and genetic material extracted for further analysis.

Preliminary results show that *Phlyctinus callosus* occurs in orchards and vineyards in Ceres, Elgin, Greyton, the Langkloof, Stellenbosch, and Villiersdorp. A second species of weevil, *Phlyctinus xerophilus*, occurs in vineyards in the Hex River Valley, Rawsonville, and Robertson; in apple orchards in parts of Ceres; and in wild vegetation in Stellenbosch.

The other aim of this project is to test the response of different weevil species to biocontrol agents. The weevils will be exposed to the nematodes *Steinernema yirgalemense* and *Heterorhabditis indica*, and the fungus *Beauveria bassiana* under laboratory conditions. Trials will assess the use of cardboard and straw traps to deliver disease-causing fungi to weevils. If the biocontrol agents are effective in the laboratory, field trials will also be conducted.

This project is ongoing, and is set to run until 2021.

MASS CULTURE AND FORMULATION OF ENTOMOPATHOGENIC NEMATODES FOR IMPROVED FIELD APPLICATION AGAINST KEY INSECT PESTS IN VINEYARDS

Project leader AP Malan | Stellenbosch University
Project duration 2020-2023
Students qualified M Dunn | PhD

Entomopathogenic nematodes occur naturally in soil where they reproduce inside the soil-dwelling stages of insects. Research has demonstrated that entomopathogenic nematodes are able to kill certain life stages of pests such as banded fruit weevils and false codling moths. These nematodes are potential biocontrol options for several pests of table grapes.

Testing the efficacy of entomopathogenic nematodes in the field requires large numbers of nematodes. Methods for culturing these nematodes in the laboratory in 250-millilitre flasks have already been developed. This project aimed to scale the production of three indigenous nematode species – *Heterorhabditis indica*, *Steinernema yirgalemense* and *S. jeffreyense* – to larger volumes.

The researchers tested different protein sources in the culture medium. They found that dried egg yolk powder was more cost-effective and yielded more nematodes than soy protein when used to culture *S. yirgalemense*. This discovery has enabled the consistent production of *S. yirgalemense* in 10-litre bioreactors, with average yields of 300 000 infective juvenile nematodes per millilitre.

S. jeffreyense also responded well to dried egg yolk powder, but the yields of infective juvenile nematodes were lower than for *S. yirgalemense*. Culture of *H. indica* is underway.

The researchers plan to investigate other aspects of culture optimisation, such as reducing the cost and time of production. They also hope to scale production further, to 100-litre and 1 000-litre industrial fermenters. Access to large numbers of nematodes will enable them to experiment with different formulations for application of nematodes to crops.

The project is set to run until 2023.

MASS CULTURE OF VINE MEALY BUGS

Project leader K Achiano | ARC Infruitec-Nietvoorbij
Project duration 2004-present
Students qualified none

Vine mealy bugs – *Planococcus ficus* – are sap-feeding insects. They damage vines directly, and secrete honeydew which attracts ants and encourages mildew. Mealy bugs also spread grapevine leafroll-associated viruses. In addition, mealy bugs are phytosanitary pests, and their presence will lead to rejection of consignments by certain markets.

The mass culture of vine mealy bugs is an ongoing project that aims to supply mealy bugs for experiments. It provides researchers with mealy bugs that are not resistant to chemical or biological agents. For example, in cases where mealy-bug control is unsuccessful, the chemical or biological agent can be tested in the non-resistant mealy bugs to determine whether resistance of the wild population is the reason for failure.

Mealy bugs are kept on butternuts, under regulated environmental conditions.

Most recently, mealy bugs have been supplied to Stellenbosch University, and the Cape Peninsula University of Technology.

BIOCONTROL OF TWO SPORADIC PESTS — BANDED FRUIT WEEVIL AND KATYDIDS — IN VINEYARDS AND ORCHARDS

Project leader P Addison | Stellenbosch University
Project duration 2016-2019
Students qualified F du Preez | MSc; B Dlamini | PhD

Banded fruit weevils – *Phlyctinus callosus* – and katydids – *Plangia graminea* – are sporadic pests of vineyards in the Western Cape. Katydids are also known as long-horned grasshoppers. They primarily feed on foliage, and outbreaks can reduce vigour and stunt development of vines.

One aim of this project was to investigate the biology, ecology, and impact of katydids. The other aim was to test the efficacy of biocontrol agents against banded fruit weevils and katydids in the laboratory.

A survey of grape producers found that katydids were mostly observed in wine grapes in the Cape Winelands region, and sporadically in the Breede River Valley. Katydids appear to be uncommon in table grapes. Growers reported that chemicals used to control other insects also suppress katydids, which the researchers speculate may be the reason why katydids are not often seen in table-grape vineyards.

Laboratory trials tested the response of katydids and weevils to twelve different species of entomopathogenic nematodes – these are nematodes that develop inside insects. Field trials were conducted with the nematode *Steinernema yirgalemense*, and the fungus *Beauvaria bassiana*, both in combination and alone.

The laboratory trials showed that several species of entomopathogenic nematodes can kill katydids and weevils. The nematode *Heterorhabditis zealandica* caused 100% mortality in katydids, and *H. indica*, *Steinernema yirgalemense*, and *S. jeffreyense* all caused more than 90% mortality. Nematodes were less effective against weevils, and different species of nematodes differed in their impact on larval, pupal, and adult weevils.

In the field trials, *Steinernema yirgalemense* applied to soil at 20-40 infective juveniles per square centimetre killed 69%-78% of larval weevils. Application of the fungus *Beauvaria bassiana*, followed two weeks later by application of *S. yirgalemense*, resulted in 100% mortality of adult and larval banded fruit weevils.

Katydids do not have soil life-stages, but the researchers believe that entomopathogenic nematodes applied to foliage could still offer a control option.

THE BIOLOGY, BEHAVIOUR, AND CONTROL OF TRIMEN'S FALSE TIGER MOTH ON SOUTH AFRICAN GRAPEVINES

Project leader S Johnson | Stellenbosch University
Project duration 2016-2020
Students qualified C Morris | MSc

Trimen's false tiger moth – *Agoma tremenii* – is native to Africa, and has become a sporadic pest of vineyards in the Northern Cape and Limpopo. The larvae feed on new growth, and can cause severe defoliation. This project examined the biology of Trimen's false tiger moth, so as to inform monitoring and control measures.

Moths were studied on two commercial table-grape farms in the Northern Cape. The first adults emerged from pupae in the soil in the middle of October. Eggs were laid near the top of the vine canopy. Larvae were not found on host plants other than grapevines. Newly hatched larvae favoured new growth, but older larvae were able to feed on older and larger leaves. Larvae of approximately 3 centimetres in length seemed to cause the most damage.

Adult numbers decreased in the middle of May. The moths survived the winter as pupae in the soil. The researchers deduced that up to four generations of Trimen's false tiger moth can occur in a year.

Moths can be trapped using an ultraviolet blue light trap. Traps containing pheromones based on those of the grapevine moth – *Phalaenoides glycinae* – failed to catch Trimen's false tiger moths, as did traps containing unmated female moths.

Larvae and pupae of Trimen's false tiger moth were exposed to entomopathogenic – insect-killing – nematodes and fungi in the laboratory. The nematodes *Steinernema yirgalemense* and *Heterorhabditis noenieputensis*, and the fungi *Beauveria bassiana* and *Metarhizium anisopliae*, all caused 100% mortality in larval moths, but had no effect on pupae.

Larvae were also treated with Delegate (active ingredient spinetoram), Steward (active ingredient indoxocarb), and Dipel (active ingredient *Bacillus thuringiensis*). Both Delegate and Steward are effective, with Delegate acting faster and Steward persisting longer. Dipel achieved total mortality within five days of application, but the researchers stress the importance of maximum spray coverage for effective control.

FALSE CODLING MOTH POPULATION GENETICS: GENE FLOW IN AGRICULTURAL ENVIRONMENTS

Project leader J Terblanche | Stellenbosch University
Project duration 2017-2021
Students qualified none

The false codling moth – *Thaumatotibia leucotreta* – is a pest of many crops, and has phytosanitary status. Previous research has suggested the existence of different strains of false codling moth with different feeding preferences. This implies that some populations may only utilise one host plant, which has consequences for control.

This project examines the population genetics of false codling moths from major crops and other host plants sampled in orchards, natural and semi-natural habitats, and home gardens, across South Africa. The aims are to identify whether host-specific strains exist; how moths move between locations; how moths move between crops and other hosts; whether some hosts act as reservoirs; and how moths disperse.

So far, larvae have been obtained from four types of fruit, originating from the Western Cape, the Eastern Cape, and Limpopo. Collecting larvae from fruit is necessary to ensure that the samples can be linked to a specific host plant. Adult moths are also being collected, using traps.

Once a complete sample set has been gathered, the researchers will extract and analyse genetic material from the larvae and moths. This will enable them to estimate the genetic diversity of different false codling moth populations across South Africa, to determine whether certain populations favour certain host plants, and to identify potential reservoirs from which moths can infest crops.

The project is set to run until the end of 2021.

PEST MANAGEMENT (NEMATODES)

THE EFFECT OF HOT-WATER TREATMENT FOR THE ERADICATION OF ROOT-KNOT NEMATODES — *MELOIDOGYNE* SPECIES — IN ROOTED GRAPEVINE NURSERY STOCK

Project leader R Knoetze | ARC Infruitec-Nietvoorbij
Project duration 2017-2019
Students qualified none

Root-knot nematodes – *Meloidogyne* species – penetrate and damage the roots of susceptible scion and rootstock cultivars. Affected vines are less able to absorb water and nutrients, and are therefore less vigorous and productive. Root-knot nematodes are widespread and also infect many other plants.

Infected nursery stock is a source of nematodes in new vineyards. The aim of this project was to test the efficacy of hot-water treatment for eliminating root-knot nematodes from rooted vines. At present, the South African Plant Certification Scheme for *Vitis* requires hot-water treatment at 50 °C for 45 minutes to eliminate crown gall and asters yellows phytoplasma. Hot-water treatment at 55 °C for 5 minutes is used to remove other superficial pathogens and pests.

The researchers infected the vines with root-knot nematodes – *Meloidogyne javanica* – under controlled conditions. They treated one group of vines with hot water at 50 °C for 50 minutes and one group at 55 °C for 20 minutes. The treated vines were compared to untreated, infected vines, and untreated, uninfected vines.

Trials were conducted on five rootstocks with different susceptibilities to root-knot nematodes. US 8-7 proved the most susceptible, followed by Richter 110, Paulsen 1103, and 143-B. Ramsey was the least susceptible.

Some root-knot nematodes survived after hot-water treatment in all the vines except those grafted on Ramsey. Treatment at 55 °C for 20 minutes reduced nematode numbers more than did treatment at 50 °C for 45 minutes. However plants treated at 55 °C subsequently grew less than plants treated at 50 °C.

The researchers conclude that hot-water treatment cannot be used as a stand-alone method to eliminate root-knot nematodes from plant material.

IDENTIFICATION AND CHARACTERISATION OF NATURALLY SUPPRESSIVE SOILS SPECIFIC TO RING NEMATODES

Project leader R Knoetze | ARC Infruitec-Nietvoorbij
Project duration 2020-2022
Students qualified none

Ring nematodes – *Criconemoides xenoplax* – are present in the majority of Western Cape vineyards. These worm-like pests are considered responsible for most of the nematode damage to vineyards in South Africa. Ring nematodes are difficult to control because they occur deep in the soil where nematicides cannot penetrate.

Scientists believe that certain soils naturally suppress ring nematodes. Such soils prevent nematodes from establishing and from causing disease, and reduce the severity of disease over the lifetime of a host plant. Indigenous microorganisms in naturally suppressive soils contribute to keeping nematode numbers low, and offer the promise of biological nematode control.

This project aims to identify and characterise soils that naturally suppress ring nematodes. The researchers will collect soil samples as well as data on the agricultural practices at field sites with unusually low ring nematode numbers. Soil samples will be tested in the laboratory to assess nematode suppression. Greenhouse trials comparing suppressive and non-suppressive soils will be conducted with potted grapevines and stone fruit.

Soils found to be suppressive will be analysed to determine physical and chemical characteristics, and to determine various aspects of soil health. The results will be related to the data on agricultural practices at the field sites. The researchers hope to identify which agricultural practices promote soil conditions that suppress ring nematodes.

The project only commenced in April 2020 and there are no results so far.

DISEASE MANAGEMENT (FUNGI)

INVESTIGATION INTO THE EFFICACY OF *TRICHODERMA* COLONISATION OF GRAPEVINE NURSERY PLANTS

Project leader L Mostert | Stellenbosch University
Project duration 2016-2019
Students qualified W van Jaarsveld | MSc

Young vines in nurseries and vineyards are vulnerable to infection by soil-borne organisms. Resulting conditions such as black-foot disease can cause decline and death of the vines. The aim of this project was to test whether a fungus called *Trichoderma* can prevent black-foot disease when applied to rootstocks.

Trichoderma products are available commercially for the treatment of pruning wounds. *Trichoderma* applied to wounds limits infection by harmful organisms. The researchers hoped that it could offer similar protection to rootstocks. They tested ten different types of *Trichoderma* in the laboratory against organisms that cause black-foot disease. *Trichoderma* inhibited the growth of black-foot agents in most cases.

Different application methods and different types of *Trichoderma* were investigated during two seasons at a commercial nursery. The experiments were done on Ramsey rootstocks grafted with sauvignon blanc. *Trichoderma* colonised rootstocks best when the base of graftling vines were first dipped in a dry *Trichoderma* product, and then also received a monthly *Trichoderma* soil drench after planting. This provided a measure of protection against black-foot disease to the base of the young vine, but not to the roots.

Soaking of bases of graftling vines in a *Trichoderma* suspension, and soil drenches as a stand-alone treatment, were not effective. Of the commercial products tested, those containing *Trichoderma atroviride* originating from grapevines gave superior results.

The researchers conclude that *Trichoderma* alone is not sufficient for the prevention of black-foot disease of nursery vines. Hot-water treatment of nursery vines remains the recommended control method.

MONITORING BUNCH ROT IN TABLE-GRAPE VINEYARDS USING VARIOUS TECHNIQUES

Project leader P Louw | Experico
Project duration 2017-2020
Students qualified none

Preharvest decay – known as bunch rot – of table grapes can reduce yields and promote post-harvest decay. Bunch rot is caused by a range of microbes. Infection during flowering and ripening can result in significant economic losses, and the risk of infection increases during ripening, as sugar levels rise.

This project aims to better understand the development of bunch rot in South African table-grape production, so that the industry can reduce pre- and post-harvest decay.

The researchers evaluated a total of nine vineyards from three production areas for the development of bunch rot during the 2019-2020 season. The investigation focussed on Prime Seedless in Limpopo, Thompson Seedless in the Northern Cape, and Crimson Seedless in the Western Cape. Vineyard assessments were done at bunch set, véraison, and harvest. Different methods were used to test leaves and berries for *Botrytis cinerea*.

Preliminary results suggest that decay is increased by open wounds, denser canopies, denser cover crops, and large amounts of debris on the vineyard floor. Poor vineyard sanitation combined with wet weather during ripening heightened the risk of decay. Sunburn did not increase decay. Chemical control had little impact once decay had established.

Several potential bunch-rot agents, including *Botrytis*, *Alternaria* and *Penicillium*, were cultured from berries using conventional techniques. The sensitivity of culture was improved when samples were frozen overnight and incubated for 9-10 days. More sensitive tests could allow earlier identification of *Botrytis* in vineyards. Testing based on PCR – polymerase chain reaction – is still ongoing.

The final results of this study will be used to improve decay-management tools by helping producers better assess the potential for bunch rot in their vineyards.

THE EFFECT OF HOT-WATER TREATMENT ON FUNGAL PATHOGENS IN PROPAGATION MATERIAL AND NURSERY VINES

Project leader F Halleen | ARC Infruitec-Nietvoorbij
Project duration 2017-2020
Students qualified M Webber | MSc

Hot-water treatment is used to control several disease-causing fungi and oomycetes in grapevine propagation material and nursery vines. The standard treatment of 50°C for 30 minutes is known to reduce the levels of *Pythium*, *Phytophthora*, and most trunk pathogens, but does not eradicate all infections. The aim of this project was to test the efficacy of hot-water treatment of 50°C for 45 minutes against disease-causing fungi in propagation materials and nursery vines.

The researchers exposed spores and cultures of twelve different disease-causing fungi to hot-water treatment to assess their susceptibility. They then tested propagation material that had been inoculated with the most heat-tolerant of the disease-causing fungi, and had received hot-water treatment. Lastly, they tested dormant grafted vines, obtained from commercial nurseries, before and after hot-water treatment. In all cases, hot-water treatment was at 50°C for 45 minutes.

Fungi that cause black-foot disease, *Botryosphaeria* canker and dieback, and *Phomopsis* dieback, were shown to be sensitive to hot-water treatment of 50°C for 45 minutes. However, agents of Petri disease were less sensitive, with *Pleurostomophora richardsiae* proving to be the most heat-resistant. *P. richardsiae* is associated with graft-union failures.

The researchers recommend that propagation material and nursery vines are treated with hot water at 50°C for 45 minutes. Hot-water treatment should be used together with other management practices, such as protection of pruning wounds, and sanitation of equipment and facilities.

Combining hot-water treatment with fungicides has the potential to improve the efficacy of hot-water treatment, especially to control *P. richardsiae*. This option is the subject of a follow-on project, funded by SATI.

DISEASE MANAGEMENT (VIRUSES)

DETECTION AND IDENTIFICATION OF VIRUSES IN SOUTH AFRICAN TABLE GRAPES

Project leader G Pietersen | Stellenbosch University
Project duration 2016-2020
Students qualified none

Viral diseases threaten the profitability of table-grape production by reducing yields and impacting quality. Infected vines may also show uneven or late ripening of grapes. Prevention is usually not only the best, but also the sole control option – new vineyards must be established with virus-free plant material.

Plant material is tested and certified as free of certain viral infections under the South African Plant Certification Scheme for *Vitis* – but all viruses are not covered by the Scheme. This is partly because it is not known which viruses occur in South African table grapes. Growers are thus vulnerable to the inadvertent introduction of infected vines.

This project was a survey of table-grape vines for viruses. Samples were collected from the main table-grape production areas, including the Paarl-Wellington area, Hex River Valley, the Northern Cape, and the Vredendal area. Over the course of two seasons, the researchers obtained a total of 160 samples representing 41 cultivars from 38 farms in nine districts.

The samples were tested using PCR – short for polymerase chain reaction. Positive samples were subjected to further testing to confirm the identity of the viruses. Eighteen viruses were found to occur in South African table grapes. The researchers called attention to the large number of samples with Grapevine leafroll-associated viruses – GLRaV2 and GLRaV3 – as well as Grapevine yellow speckle viroids – GYSVd-1 and GYSVd-2 – and Hop stunt viroid – HpSVd.

Grapevine rupestris vein feathering virus – GRVFV – was newly discovered in South Africa and requires further research.

The information gained from this survey can be used to better manage viral infections in South African table grapes. Informed decisions can be made about which viruses should be prioritised for mitigation or control strategies, and whether viruses should be considered for inclusion in the South African Plant Certification Scheme for *Vitis*.

The survey also contributed to developing testing capacity for viruses in South African table grapes, which is necessary for certification and control programmes.

IS THE PROBLEM WITH BERRY COLOUR IN CRIMSON SEEDLESS CAUSED BY VIRUSES?

Project leader G Pietersen | Stellenbosch University
Project duration 2019-2021
Students qualified none

The profitability of Crimson Seedless is closely tied to uniform development of red colour. A tendency to uneven coloration of berries within bunches, as well as of bunches within the same or different vines, impacts the economic performance of this cultivar. There are several potential causes of poor colour development and delayed ripening in grapes. This project investigates the possible contribution of viral infections.

So far, the researchers have monitored six Crimson Seedless vineyards in the Hex River Valley for two seasons. Colour development during early, middle, and late harvest was assessed. The aim is to identify and sample vines that consistently show poor colour development in all bunches.

Preliminary findings in one vineyard included the presence of leafroll symptoms very late in the 2020 season. The spatial distribution of vines with leafroll symptoms seems related to those with poor colour development. Further analysis of the data is necessary to determine whether leafroll symptoms are associated with poor colour development.

Two other vineyards in the trial were planted using vines that had been passed through virus-elimination procedures. The researchers note that bunches in both these vineyards coloured more quickly and deeply than bunches in vineyards where planting material had not been subject to virus elimination.

Testing of samples from four vines that showed severe colour deficiency in both 2019 and 2020 is being performed. The tests will identify any viruses that are present in the vines. This results of this project are expected toward the end of 2021.

COMPARATIVE EVALUATION OF COMMERCIALLY AVAILABLE GRAPEVINE FLECK VIRUS ELISA KITS

Project leader G Pietersen | Stellenbosch University
Project duration 2019-2019
Students qualified Katy Usher | MSc

Grapevine fleck virus – GFkV – is commonly detected in *Vitis* in South Africa, and is known to cause fleck disease in *Vitis rupestris*, a parent of many rootstock cultivars. Grapevine fleck virus can occur in combination with other viruses, and has been linked to reduced growth of vines, thereby limiting the quality and quantity of propagation material.

The South African Plant Certification Scheme for *Vitis* requires testing for Grapevine fleck virus using only methods approved by the Department of Agriculture, Land Reform and Rural Development. The Department approves tests based on the results of their evaluation. The aim of this project was to evaluate several commercially available test kits with the hope of gaining approval for their use.

ELISA – enzyme-linked immunosorbent assay – is the method of choice for virus testing within the South African Plant Certification Scheme for *Vitis*. The researchers obtained ELISA kits from from three European companies and a single US-based company. They evaluated the kits using samples that were known to be positive or negative for Grapevine fleck virus.

The performance of the three of the four ELISA kits proved similar. Detection of the virus was possible during all months, but there was more virus present in samples collected during the growing season.

The researchers have produced a protocol with details on which ELISA kits to use; what tissues to sample; what time of year to sample; how to pool samples; and how to process samples. This protocol is available for use in the South African Plant Certification Scheme for *Vitis*.

DETECTION AND IDENTIFICATION OF VIRUSES IN NUCLEAR PLANTS

Project leader G Pietersen | Stellenbosch University
Project duration 2020-2022
Students qualified none

There are several vitiviruses that infect grapevines. These include Grapevine viruses A to M. Grapevine viruses are associated with economically significant conditions such as the rugose wood disease complex of grapevines. Co-infection of Grapevine virus A with Grapevine leafroll-associated virus 3 can hasten the decline and death of table-grape vines.

A recent survey funded by SATI found vitiviruses and the closely related foveaviruses in more than 80% of the samples tested – this makes them the most common viruses present in South African table-grape vines. The financial impact on the South African table-grape industry has not been quantified.

Vines held in nucleus units are currently only tested for two vitiviruses – Grapevine viruses A and B – under the South African Plant Certification Scheme for *Vitis*. It is not known whether other vitiviruses occur in plants held in nucleus or foundation blocks. This project aims to survey nucleus and foundation blocks for vitiviruses using PCR – polymerase chain reaction – testing followed by next-generation sequencing. Next-generation sequencing will allow the researchers to tease apart the identity of viruses occurring in mixed infections.

The researchers point out that the identification of vines infected by a single type of vitivirus could pave the way for future trials to develop routine detection methods; to assess the economic impact of the viruses; and to determine routes of transmission – Grapevine viruses A and B are known to be transmitted by mealy bugs.

This project is new and there are no results as yet. It is scheduled for completion at the end of 2022.

POST-HARVEST MANAGEMENT

NON-DESTRUCTIVE QUANTIFICATION AND PREDICTION OF TABLE-GRAPE EXTERNAL AND INTERNAL QUALITY

Project leader UL Opara | Stellenbosch University
Project duration 2016-2019
Students qualified Andries Daniels | PhD

Table grapes need to be harvested at optimal maturity and their quality maintained throughout the post-harvest period to ensure that consumer expectations are met. Quality encompasses both internal, chemical characteristics – total soluble solids, titratable acidity, and pH – and external, visual appearance.

At present, internal quality is measured destructively in the vineyard and laboratory to assess whether fruit are ready to harvest. Visual inspection is done from vineyard through to packhouse, in an attempt to identify bunches at risk of developing post-harvest defects during storage and export.

This project investigated the use of Fourier transform near-infrared spectroscopy to measure both internal and external quality of table grapes. Infrared spectroscopy is non-destructive and rapid, and can be performed using a handheld device, or by automated systems.

The study looked at three white seedless cultivars, in the vineyard before harvesting, and in the packhouse. The researchers were able to use infrared spectroscopy to discriminate between high and low values of total soluble solids, titratable acidity, and the ratio between these. They were also able to identify browning and fruit with the potential to develop browning, and to estimate shelf-life.

One aspect of this project was the evaluation of four different models of handheld spectrometers. The researchers provide recommendations on the suitability of the different models for different applications.

The researchers concluded that handheld spectrometers create the opportunity to scan large numbers of berries in the vineyard, providing more information on average maturity, to inform decisions about harvest readiness. Spectrometers mounted in pack houses can scan large numbers of berries for internal quality, and identify those bunches likely to develop browning or other post-harvest defects.

ETHYL FORMATE FUMIGATION TO CONTROL GRAIN CHINCH-BUGS AND BANDED FRUIT WEEVILS IN EXPORT GRAPES

Project leader S Johnson | Stellenbosch University
Project duration 2017-2019
Students qualified none

Grain chinch-bugs – *Macchiademus diplopterus* – and banded fruit weevils – *Phlyctinus callosus* – are both phytosanitary pests. Their presence in exported fruit will lead to rejection of the consignment. Post-harvest fumigation of fruit with methyl bromide is an effective method of control, but methyl bromide is ozone-depleting, and alternatives must be found.

This project examined the use of ethyl formate as an alternative to methyl bromide for post-harvest fumigation. The researchers tested whether different concentrations of ethyl formate killed fruit weevils without damaging grapes. Previous work has shown that ethyl formate is effective against grain chinch-bugs.

Berries of Thompson Seedless, Regal Seedless, Crimson Seedless, and Sugranineteen (Scarlotta Seedless®) were exposed to ethyl-formate concentrations of approximately 30-150 grams per cubic metre, for up to six hours, at different temperatures. Quality was assessed after treatment, after cold storage of four weeks, and after cold storage plus shelf-life.

Banded fruit weevils were exposed to ethyl-formate concentrations of 15-50 grams per cubic metre. The researchers also tested ethyl-formate concentrations of 50-100 grams per cubic metre on chinch-bugs and weevils inside packaging.

The researchers concluded that both banded fruit weevils and grain chinch-bugs can be controlled by ethyl-formate fumigation at concentrations that did not damage the table-grape cultivars which were tested.

Fumigation trials in this study were carried out in the laboratory. The researchers stress that more work is needed to scale ethyl-formate fumigation for large volumes of fruit. They have developed technology to safely dispense ethyl formate into shipping containers. The next steps are to test the efficacy of ethyl formate against phytosanitary pests in containers, and to develop technology for fumigation of cold rooms.

ASSESSING WHETHER FREEZING OR CHILLING DAMAGE CAUSES POST-HARVEST DEFECTS IN TABLE GRAPES SUBJECTED TO PHYTOSANITARY COLD-TREATMENT REGIMES

Project leader DH Moelich | SATI
Project duration 2015-2017
Students qualified none

Cold treatment for phytosanitary purposes – so-called cold steri – is a requirement when table grapes are exported to certain markets. Cold steri has been associated with post-harvest defects such as stem browning, and freezing or chilling injuries. This project aimed to identify whether incorrect cooling contributes to poor grape quality, and subsequent price discounting and economic losses.

The researchers placed data loggers in 12-18 monitoring positions in table-grape pallets that were exported. They collected data either in cooling tunnels or inside reefer containers, during 15 commercial table-grape consignments over two seasons. Data included air and pulp temperatures.

Temperature data was classed as falling in either a red or a yellow zone. The red zone represents freezing temperatures, whereas the yellow zone represents temperatures where storage defects may occur, but the likelihood is uncertain.

Results showed that temperatures occasionally fall into the red zone during preparatory cooling in land-based storage, but that potentially damaging temperatures are more common at sea. Damaging temperatures at sea occur when shipping lines use stepwise adjustment of set points. The researchers stress that potentially damaging temperatures were limited to localised positions in the shipping containers, but that the majority of cartons were not affected.

This study suggests that large-scale freezing is not the primary cause of quality problems with South African table grapes in certain markets. However, changes to the cold-treatment protocol should allow shipping lines to avoid potentially damaging temperatures, thereby removing a possible cause of post-harvest defects.

The researchers also point out that the cold-treatment protocol includes a mandatory 72-hour pre-cooling period, which increases the time between harvest and marketing by 7-10 days. This could contribute to reduced quality of South African table grapes that are exported to certain markets.

EVALUATING THE RELATIONSHIP BETWEEN *BOTRYTIS CINEREA* LEVELS AT HARVEST, AND *BOTRYTIS* ROT OCCURRENCE AT THE END OF STORAGE

Project leader S Ferreira + S van Zyl | Westcape Biotech + ExperiCo
Project duration 2017-2019
Students qualified none

Botrytis cinerea is a fungus that causes economic losses in several crops. Table grapes are infected by *Botrytis* spores as early as flowering, but berries usually only develop symptoms of decay during storage and transport. *Botrytis cinerea* is able to survive cold-storage temperatures, and will take advantage of any breaks in the cold chain to grow and to sporulate.

The aim of this project was to assess whether decay levels after storage are related to the quantity of *Botrytis* present at harvest. *Botrytis* was quantified using qPCR – short for quantitative polymerase chain reaction.

Grapes were harvested and packed, and the cartons divided into five groups. Four of the groups were treated with different numbers of *Botrytis* spores, and the fifth group was an untreated control. One third of the cartons received SO_2 sheets, and the remainder did not. Cartons were stored under standard conditions, and monitored for the quantity of *Botrytis* present as well as the development of decay.

The researchers were able to quantify the amount of *Botrytis* accurately using qPCR. They also found that the development of decay was strongly correlated with the number of *Botrytis* spores inoculated into the cartons. This indicates that qPCR can be used to assess the *Botrytis*-infection status of table grapes before storage, and to then predict the probability of decay.

Decay in berries kept in cold storage for 24 hours followed by three days at room temperature was compared to decay in berries kept in cold storage for four weeks followed by three days at room temperature. There was a strong correlation between decay levels in the two groups. The researchers suggest that the development of decay in a sample of berries stored at room temperature could provide information on the decay potential after cold storage.

POST-HARVEST MANAGEMENT PROJECTS TO SUPPORT MARKET ACCESS

Balancing the benefits and risks of trade

The global movement of fresh produce benefits both growers and consumers, but it also carries the danger of spreading pests and diseases – this is called phytosanitary risk.

Governments of importing countries manage phytosanitary risk by processes which our fruit-industry stakeholders collectively refer to as market access. This includes controlling which countries can export specific products to them, and stipulating risk-mitigation measures which must be applied to these products. Market access is negotiated between the governments of importing and exporting countries – not by industry bodies or individuals.

Market access is an ongoing process involving the national plant-protection organisations of both countries, and is informed by scientific research and expert knowledge. The role of SATI in market access is to support the South African government by providing relevant research findings and technical expertise. This is why SATI funds research into the management and mitigation of phytosanitary risks.

Market access research projects

Table grapes are exported at low temperatures to maintain fruit quality during the sea voyage. Low temperatures also have the potential to kill certain pests that pose phytosanitary risks, notably fruit flies and false codling moths. Importing countries that are concerned about these pests stipulate low-temperature or cold-treatment regimes – often called cold sterilisation – as a condition for market access.

Although table grapes are not susceptible to chilling injury from low temperatures, they are, like several other temperate fruits, vulnerable to damage from freezing. The lower the temperatures required for market access, the greater the risk of freezing damage during pre-cooling or transport. For this reason, SATI has been funding research into effective but less restrictive temperatures for cold sterilisation – cold enough to kill pests but not too close to freezing temperatures.

During the 2016-2020 research cycle, SATI funded experiments looking at cold treatments for false codling moths and Natal fruit flies. The aim is to provide the South African government with scientific grounds on which to negotiate for less restrictive requirements from certain importing countries with regards to low-temperature treatments.

CULTIVAR DEVELOPMENT

THE DEVELOPMENT OF NEW TABLE-GRAPE CULTIVARS

Continuous improvement of domesticated plants and animals is indispensable to commercial agriculture – including South African table-grape production. Growers need cultivars that delight buyers through consistent fruit quality and reliable storability. They also need vines that are adapted to local conditions and cost-effective to manage. Developing better cultivars for South African table-grape growers has been the focus of several research projects spanning many decades.

The five phases of cultivar development

1. Phase 1a: breeding

The first step in developing a new cultivar is crossing parents that are likely to impart desirable characteristics to their progeny. Seeds harvested from the female parents are used to produce large numbers of seedling plants. This process is technically demanding due to the requirement for new table-grape cultivars to be seedless.

Embryo rescue	Seedless grapes contain a rudimentary soft seed that is not naturally viable. The embryos in seedless grapes must be removed and raised using tissue culture techniques under laboratory conditions – a process known as embryo rescue. The establishment of embryo-rescue capacity was an important achievement of the table-grape breeding programme at the ARC Infruitec-Nietvoorbij.

2. Phase 1b: seedling screening

Seedlings are grown on their own roots for so-called Phase 1 screening. They are allowed to produce a single bunch per shoot. No growth regulators are applied. The seedlings are screened based on seedlessness, crunchy berry texture, large berry size, and loose bunch structure. Those seedlings that show potential are further evaluated in Phase 2 trials.

3. Phase 2a: evaluation of selections

Budwood from chosen seedlings are grafted onto rootstocks for Phase 2a trials – these grafted vines are called selections. They are planted at an evaluation site and exposed to standard vineyard treatments for thinning and enlargement. Grape quality is evaluated before and after cold storage to judge storability and market potential.

4. Phase 2b: evaluation of promising selections

Selections that perform well in Phase 2a trials are called promising selections. They qualify for Phase 2b trials. In the past these trials were conducted at experimental farms which were mostly based in the Western Cape. More recently the trials are being done by commercial table-grape producers in the various growing regions. The promising selections are evaluated for yield, crack resistance, pre- and post-harvest quality, storability, and response to viticultural practices.

5. Commercialisation

The final phase of new cultivar development is commercialisation. This includes the rapid multiplication of plant material, so that growers can gain access to new cultivars as quickly as possible. Commercialisation of these ARC-bred cultivars is managed by Culdevco.

INDUSTRY-DRIVEN EVALUATION OF ARC-BRED CULTIVARS

The process described above was previously conducted entirely by the ARC. In 2014, SATI initiated discussions with the ARC so as to increase industry involvement in the evaluation of new selections. SATI believed that selections needed to be evaluated in each table-grape growing region, and that their members would benefit from direct exposure to the process.

In 2016, SATI and the ARC came to an agreement whereby table-grape breeding would continue at Nietvoorbij, and evaluation would be performed by industry. They signed a material transfer agreement that provided industry with access to ARC-bred plant material.

A numbers game	The table-grape breeding project has existed since 1977, while the embryo-rescue project has been running since 1988, under the leadership of Phyllis Burger. A recent project report provides insight into the effort required to breed a new cultivar. The researchers collected approximately 26 700 rudimentary seeds from 36 crosses in 2018, and transferred the embryos to tissue culture. They raised roughly 3 200 plants, of which 18 were selected the following year for Phase 2 trials.

Seedlings bred by the ARC used to be raised at Nietvoorbij. Since 2017, the seedlings are raised in Wellington at the Lelienfontein nursery of Bosman Adama. In 2017, approximately 10 500 seedlings were transplanted to Lelienfontein, and the first of

these fruited in 2018, allowing for screening and selection.

Phase 2a screening was carried out by the ARC at their Bien Donné and Hex River Valley evaluation sites until 2019. Subsequently, new selections are moved to Buffelskraal in the Hex River Valley, to be assessed under the leadership of Anthony Hill. Those selections that are considered promising are then passed on to the test growers in the different regions, listed in table 1.

Table 1: Test growers that will evaluate promising selections

Region	Owner	Site
Berg River	Johan Vlok Jr	Morester
	Warren Bam	Wesland Boerdery
Hex River	Jaco du Toit	Meerlust
	Reyneke Viljoen	De Vlei
Northern Provinces	Andre Lombard	Anlo Farming
	Petra Pieterse	HN Pieterse Boerdery
Olifants River	Andree Engelbrecht	Dessie Farm
Orange River	Piet Karsten	Yarona
	Reyneke Viljoen	Verste Stuiwer

Three promising selections have so far been planted on at least one site in each of the three regions.

Maintaining the health of plant material is critical to the success of cultivar development. SATI has partnered with SAPO to provide testing for viruses as part of the industry-driven evaluation process. Promising seedlings are tested regularly to ensure that they are free from harmful viruses before they are multiplied for commercial purposes.

NEW TECHNOLOGIES TO SUPPORT CULTIVAR DEVELOPMENT

Plant breeders have historically faced two challenges – what crossings will produce the best results? And how can they identify and eliminate unsatisfactory offspring as quickly as possible?

The problem is that individuals can have genes for desirable – or undesirable – characteristics without displaying those characteristics. For example, some seeded grapes have genes for seedlessness, and can potentially produce seedless offspring. When a breeder uses such a seeded grape as a parent, it becomes necessary to wait until the progeny themselves bear grapes to know whether or not they are seedless.

Molecular markers offer breeders a potential solution. Molecular markers are sections of the genome that are associated with certain characteristics. They allow screening of organisms to identify whether they possess the genes for certain characteristics. This lets breeders choose parents that have good genes, and rapidly find the keepers among their progeny.

In table-grapes, molecular markers already exist for seedlessness, for resistance to downy and powdery mildew, and for increased potential for muscat aroma. A new project under the leadership of Justin Lashbrooke of the South African Grape and Wine Research Institute at Stellenbosch University aims to identify additional markers.

A wish list of markers was drawn up in consultation with industry, and includes crunchiness, sweet-neutral eating quality, green stems, and storability. Producers would also like to see markers for elongated berry shape, and the natural occurrence of large berry size, loose bunches, uniform berry and bunch size, and good colour. Characteristics to avoid are tough skin, astringent taste, cracking, and blush.

The project started in 2018 and is set to continue until 2022. So far, the researchers have focussed on optimising the techniques needed to extract and analyse genetic material, as well as finding the best way to link genetic information to plant characteristics. The goal is to provide a set of tools that will support the ARC breeding program.

KNOWLEDGE TRANSFER

TAFELDRUIF-ONDERSTOKKE IN SUID-AFRIKA: 'N SAMEVATTING VAN 27 JAAR SE EVALUERING

Project leader JH Avenant | ARC Infuitec-Nietvoorbij
Project duration 2017-2017
Students qualified none

Ramsey is the most popular rootstock in the South African table-grape industry, accounting for 82% of all rootstocks, according to a census conducted by SATI in 2017. But other rootstocks are available, and Ramsey may not be the best choice for every situation. The aim of the table-grape rootstock booklet was to make information about available rootstocks accessible to industry.

The rootstock booklet is in Afrikaans and includes the results of several local rootstock trials conducted over the past twenty years. The chapters cover the following aspects:

- current figures for and trends in use of rootstocks for table-grapes in South Africa
- compatibility and affinity of different rootstocks and scions
- viticultural characteristics of the ten most common rootstocks available in South Africa.
  - Ramsey
  - Richter 110
  - Paulsen 1103
  - Richter 99
  - US 8-7
  - Ruggeri 140
  - SO4
  - Dog Ridge
  - Freedom
  - Harmony
- adaptability of rootstocks to physical, chemical, and biological soil conditions as observed in rootstock trials
- tables summarising the main findings of relevant rootstock trials.

Viticultural characteristics of each rootstock are presented on a single page for easy reference, and include

- tolerance to phylloxera, pathogenic nematodes, phytophthora, crown gall, wet conditions, dry conditions, salinization, and lime
- compatibility and affinity
- ease of rooting
- growth habit, both grafted and ungrafted
- leaf-petiole nutrient status tendencies
- general comments on use.

The booklet makes extensive use of charts and tables that present information concisely, and make it easy to consult. It is available from SATI as *Tafeldruif-onderstokke in Suid-Afrika: 'n samevatting van 27 jaar se evaluering*.

SOIL PREPARATION FOR SUSTAINABLE WINE AND TABLE GRAPE VINEYARDS

Project leader JL van Zyl | Stellenbosch University
Project duration 2016-2017
Students qualified none

A good root system is foundational to the performance of any grapevine. Soil conditions – not genetics – drive root development in South African vines. The shallow soils typical of South African vineyards tend to restrict root penetration and to constrain plant productivity. Compaction, acidity, salinization, and abrupt textural transitions are all factors that impact the profitability of vineyards.

Correct soil preparation is critical for the success of a vineyard. Soil preparation can contribute to more uniform vineyards, earlier bearing, higher yields, and increased profits. There is a large body of South African research on soil preparation before vineyard establishment, but the information has not been readily accessible to growers. This project aimed to combine all the existing knowledge in a practical, user-friendly publication.

The book, *Soil Preparation for Sustainable Wine and Table Grape Vineyards*, was co-authored by Johan van Zyl and Eduard Hoffman, and published in 2019. Production was sponsored by Villa Crop. Chapters include:

- soil impediments to root penetration
- detection of root impediments
- root responses to soil conditions
- special soil preparation structures
- soil drainage
- choice of implement for soil preparation
- application of ameliorants during soil preparation
- re-compaction
- aboveground grapevine response.

The book recently won an award from the OIV – International Organisation of Vine and Wine. The OIV is an intergovernmental scientific and technical organisation working on all aspects of grapevine culture and grape-related products.

Soil Preparation for Sustainable Wine and Table Grape Vineyards is available through SATI, Winetech, and Villa Crop, as well as in a Kindle Edition, from Amazon.

FERTILISATION GUIDELINES FOR THE TABLE GRAPE INDUSTRY

Project leader PJE Louw | SAPEX
Project duration 2016-2020
Students qualified none

Correct fertilisation is essential for the profitable production of premium quality grapes. Existing South African guidelines for vineyard fertilisation were either outdated or focussed on wine grapes. The aim of this project was to publish fertilisation guidelines for vineyards that built on previous guidelines developed by Winetech; that incorporated the latest research; that were scientific yet practical; and that were specifically applicable to table-grape production.

The project was coordinated by Kobus Louw, and the resulting book, *Fertilisation guidelines for the table grape industry*, was co-authored by Kobus Conradie, Pieter Raath, Dawid Saayman, and Bennie Diedericks. The book was published in 2020. Chapters include:

- collection of soil and leaf samples
- interpretation of soil analysis reports for vineyards
- chemical correction of soils during soil preparation
- maintenance fertilisation
- practical guidelines for implementation of a fertilisation programme
- the relationship between fertilisation, the nutritional status of a vineyard, and grape quality
- fertilisation of rootstock mother blocks and nurseries.

Fertilisation guidelines for the table grape industry is available in both Afrikaans and English through SATI. Production was sponsored by Villa Crop.

OTHER KNOWLEDGE TRANSFER ACTIVITIES

In addition to the books published, SATI has continued to work hard at making information accessible to industry through other knowledge transfer activities:

- The SATI website was recently upgraded, and it now includes a *Knowledge Hub*, where summaries of what is planned in current research projects can be found, *Information Sheets* can be downloaded, the SATI training videos can be watched, the discontinued *SATI Technical Bulletin* and the regularly published *SATI Research Reports* are archived, online copies of books published can be accessed, basic weather information can be downloaded, and useful resources are made available.
- SATI continues to support and partner with SASEV on their annual information days, which was first the first time hosted online last year due to Covid-19.
- SATI regularly published articles relating to ongoing and closed out projects, as well as content which directly responds to industry knowledge gaps as identified through SATI's annual research needs analysis.

It is envisaged that these industry resources will continue to grow over time.

Content developed by:
Anna Mouton

Enquiries:
Tarryn Wettergreen
Research and Technical Transfer Manager
tarryn@satgi.co.za
021 863 0366

SATI
South African Table Grape Industry