Hortgro Science

2017/18 Annual Report

HORTGRO

Growing Fruit IQ

Contents page.

01.

The Chairman's Report.

The drought that started in 2016 impacted on the 2017 and 2018 season, the tail of this will still unfortunately play itself out in the upcoming 2019 season.

This extreme weather event highlighted the impact of climate change on all stakeholders in the Agricultural Industry. The theme of our annual Hortgro Science Technical Symposium "The Big Thirst" summed up the situation in which we found ourselves. The content of the Symposium highlighted the steps that the Industry had taken to mitigate the situation as well as plans to address a similar situation in the future.

What was encouraging was the way in which the various role-players were willing to share their experiences and work together to develop strategies to survive and, in some cases, thrive under these trying conditions.

With reference to the above, I urge you to try and read the following reports:

"The Future of the Western Cape Agricultural Sector in the context of the 4th Industrial Revolution"

Western Cape Department of Agriculture.

"Draft Climate Smart Agriculture Strategic Framework for Agriculture, Forestry and Fisheries' DAFF.

These reports highlight how the future might look and steps needed to be taken to mitigate the impacts of these two unfolding scenarios. The pro activeness of these two Departments needs to be applauded; the challenge we now face is the successful implementation of these strategies.

Four Hortgro Science Advisory Council meetings were held during this financial year:

22nd November 2017, 20th February 18, 22nd May and the 22nd August 2018.

The reason for referring to these meetings and dates is that an executive summary is produced, arising out of these meetings, as a way of informing our constituencies as to the content and focus of our Council activities.

01

On behalf of all our producers, a big thank you for your commitment and contribution.

How many of these have you read?

Try and get hold of these; a quick, easy read to keep informed and up to speed. Two (2) Council members retired during the year under review, a heartfelt thanks to Matthew English (Fruitways) and William Myburgh (DFDC) for serving the Industry in this capacity.

As has become customary in my report I would like to thank all members who serve on the various committees that assist and guide our research effort through Hortgro Science; your input is appreciated, and I hope you find some value in the network and exposure made possible through this involvement.

Lastly, to the Hortgro Science Management team, what a privilege it is to be part of such an innovative, creative and dynamic team; on behalf of all our Producers, a big thank you for your commitment and contribution.

Stephen Rabe

02.

General Manager's Report.

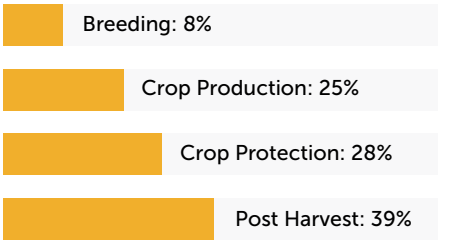
The primary objective of Hortgro Science remains to keep South African pome and stone fruit growers internationally competitive and economically sustainable.

Our focus is to generate new knowledge, technologies or practices that are required to mitigate, avoid or overcome threats and risks and to exploit opportunities. There are a number of shifts that have taken place in where research project funding has been allocated. Pome fruit, which have a larger budget to work with, funded 75 projects. The shift that has taken place over the past period has been away from breeding which now represent 8% of the project budget. Post Harvest is the largest spend at 39% with Crop Protection (including market access projects) at 28% and Crop Production at 25%.

For stone fruit, 57 projects were funded. Breeding remains important at 32% while Postharvest dominates the spending at 38%. Crop Protection (including market access) absorbed 17%. Crop Production remains low at 17% and focuses mostly on rootstock evaluation.

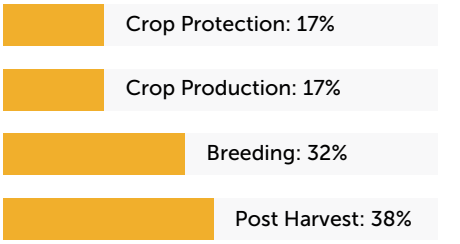
01.

Pome Fruit



02.

Stone Fruit



Industry has taken a more active role in human capacity development in order to ensure that we have a pipeline of graduates flowing into the industry and researchers in place to address our research requirements. 18% of the research budget is now directed at research posts in order to fill some of the strategic capacity gaps. It is critical to have the right people in place to train the next generation of researchers and technical experts entering the industry.

The establishment of the 'Chair in Applied Pre-harvest Deciduous Fruit Research' at Stellenbosch University with Prof Karen Theron in the position at the Department of Horticultural Sciences is an example of the industries commitment to this objective. In 2017/18 fifty nine post graduate students were funded to a value of R 3,4 million. We are encouraged that 36% of the students are busy with their PhDs and 46% of the students are black students.

3.4
million rand funded

46%
are busy with PHDs.

36%
are black students.

"Science, my lad, is made up of mistakes, but they are mistakes which it is useful to make, because they lead little by little to the truth."

Jules Verne (Author of 'Around the World in Eighty Days')

The funding of research remains the determinant of how much research can be conducted for an industry. Hortgro Science, through the levies, leveraged additional funding on a 1:1 basis. During the 2017/18 year less funding was leveraged from alternative sources. The Postharvest Innovation (PHI) fund which was funded through the Department of Science and Technology (DST) reached the end of its cycle. We are however pleased to hear that a new cycle will be initiated in 2019. The Human Resources for Industry Programme (THRIP) run by the Department of Trade and Industry (DTI) changed its rules with the result that Hortgro's funding reduced dramatically, but we have submitted new research proposals and hope to grow our participation in this programme. Collaborative funds have been raised through the Western Cape Department of Agriculture for the Confronting Climate Change project and a number of projects have been co-funded by other local industries. The South African government as well as industries level of funding research needs to grow substantially to be on par with some of our competing nations. This aspect has been recognised by both parties but needs to be acted on if we are to remain competitive internationally.

Hortgro Science is continually challenged on the question of "are you focusing on the right stuff?" We are guided by over 200 individuals, made up of technical advisors, growers, researchers, industry experts and retired academics who sit on one of our 30 focus workgroups, peer work groups and technical advisory committees. We are greatly indebted to our small pool of researchers and the larger pool of technical people who assist us in these endeavours.

We are excited about our new initiative – The *Fresh Quarterly*. I quote from the forward of the first copy of the *Fresh Quarterly* where I stated the following: "The *Fresh Quarterly* – born out of the need to find an appropriate vehicle to communicate to stone and pome fruit growers – aims to inform our readers and key customers about past and present industry research. Our content focuses on why the research was done, lessons learnt and its benefit to the industry. This publication targets and serves the bottom-line in terms of recommendations and implementation."

"Well done to our science communications specialist Esté Beerwinkel for your marvellous layout and 'feel' of the Fresh Quarterly. We trust that it will fulfil its role in 'getting the information out'.

A second 'new initiative' was the introduction of the "Hortgro Science Research Showcase". Here the objective was to give an overview of all the research that is currently being conducted in the form of five minute presentations. The showcase took place over 3 days – each day focusing on a research programme (Crop Production, Crop Protection, Post Harvest). We got excellent feedback and we will look to introduce this showcase every alternate year. In addition, our communications team in conjunction with our programme managers and the relevant researchers published 48 popular articles during the 2017/18 year. A total of 8 events were organised which were attended by cumulatively 2 123 people. Well done to Thea van Zyl for your excellent organisation of our events.

02”

I would like to end off by thanking the Hortgro Science team that coordinates and drives the research process.

I would like to end off by thanking the Hortgro Science team that coordinates and drives the research process. It is a great and happy team that, in turn, work with a large group of extremely committed and competent individuals that serve a great industry.

Hugh Campbell

Richard Hurndall

“A special note of thanks goes to Richard Hurndall who has served the industry for 35 years and retires at the end of 2018”.

It is difficult to measure a lifetime of facilitation, networking and implementation, often behind the scenes without much fuss – just getting on with it. It has been a delight to have worked with Richard for close on 20 years as a colleague and as a tremendous source of knowledge and wisdom.

Hugh Campbell

03.

The Hortgro Science team.

01. Hugh Campbell – General Manager
hugh@hortgro.co.za / 021 870 2945

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02. Richard Hurndall - Research and Technology Manager & Postharvest Programme Manager
richard@hortgro.co.za / 021 870 2947

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03. Prof Wiehann Steyn – Assistant General Manager & Crop Production Programme Manager (Extraordinary Associate Professor in the Department of Horticultural Science, Stellenbosch University)
wiehann@hortgro.co.za / 021 870 2948

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04. Matthew Addison – Crop Protection Programme Manager
mfa@sun.ac.za / 021 870 2953

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05. Elise-Marie Steenkamp – Group Communications Manager
elise-marie@hortgro.co.za / 021 870 2950

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06. Esté Beerwinkel – Science Communications Specialist
este@hortgro.co.za / 021 870 2949

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07. Theresa Sonnenberg – Research Administrator
theresa@hortgro.co.za / 021 870 2958

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08. Thea van Zyl – Events Coordinator
thea@hortgro.co.za / 021 870 2900

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09. Dr Daleen Stenekamp – Applied Researcher in Crop Protection positioned at Stellenbosch University
Daleen@hortgro.co.za / 021 882 9164

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10. Terence Asia –Crop Protection Technical Assistant
021 882 9164

The staff seconded to Stellenbosch University

Dr Xolani Siboza – Department of Horticultural Science
Dr Ken Pringle (5/8 appointment) – Department of Conservation Ecology and Entomology
Dr Shelley Johnson - Department of Conservation Ecology and Entomology

Chair in Applied Pre-harvest Deciduous Fruit Research at Stellenbosch University

Prof Karen Theron

Contract positions funded through research projects

Laura Allderman – Dormancy projects
Dr Marelize de Villiers – False Codling Moth projects

A special note of thanks goes to Richard Hurndall who has served the industry for 35 years and retires at the end of 2018.

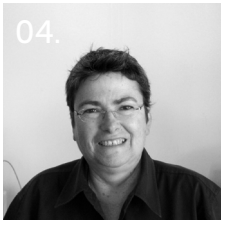
04.

The Breeding Programme.

04”

The breeding and evaluation programme at the ARC has been in a state of transition over the past 2 years.

Hortgro Pome and Hortgro Stone are finalising their strategy relating to the road ahead with the objective of having a more focused breeding programme within particular fruit types. The summary reports captured in this annual report document the projects that are currently supported by industry as part of the transition to a new dispensation. This is the final year that breeding and evaluation projects will be reported on in the Hortgro Science annual report. All the plant improvement focus areas (plant certification, plant improvement, breeding, independent evaluation, rootstocks, commercialisation) will be put together in one unit and will be reported on as an entity within the Hortgro annual report.



Researchers and Students.

04.

Cultivar Development Research Team Leader

01. Ms Louisa Blomerus

Researchers

02. Mr Werner Pieterse

03. Mr Taaibos Human

04. Ms Ester Lotz

05. Dr Khashief Soeker

06. Mr Irwin Meintjes

07. Mr Sonwabo Booi

Students

08. Mr Solomon Ntladi (PhD Student)

09. Mr Lawrence Kwal imba (MSc Student)

10. Ms Thembeka Nyawo (MSc Student)

Pome Fruit Breeding and Evaluation

Abstracts for these projects can be found on pages 123

Current Projects

• Breeding of pear cultivars. (JP Human and S Ntladi)
• Planting and maintenance of existing and new germplasm of pome and stone fruit (W Pieterse, L Kwalimba and T Nyawo) – *also Stone Fruit Breeding Programme*
• Cold storage characteristics of new cultivars and selections. (E Lotz) – *also Stone Fruit Breeding Programme*
• Phase two evaluation of pears in the Western Cape. (MK Soeker)
• Phase two evaluation of apples in the Western Cape. (MK Soeker)

Stone Fruit Breeding and Evaluation

Abstracts for these projects can be found on pages 128

Current Projects

• Breeding apricot cultivars for commercial and emerging farmers. (W Pieterse)
• Breeding of peaches and nectarines for commercial and emerging farmers. (W Pieterse and L Kwalimba)
• Breeding of new peach rootstocks for the first and second economy. (S Booi)
• Breeding of Japanese plums for commercial and emerging farmers (incorporating the S-genotyping work determining compatibility of plum cultivars). (W Pieterse and T Nyawo)
• Planting and maintenance of existing and new germplasm of pome and stone fruit (W Pieterse, L Kwalimba and T Nyawo) – *also Pome Fruit Breeding Programme*
• Cold storage characteristics of new cultivars and selections. (E Lotz) – *also Pome Fruit Breeding Programme*
• Evaluation of stone fruit in the summer rainfall region. (I Meintjes)
• Phase two evaluation of peach and nectarine selections in the winter rainfall region. (MK Soeker)
• Phase two evaluation of plum cultivars in the winter rainfall region. (MK Soeker)
• Phase two evaluation of apricot cultivars in the winter rainfall region. (MK Soeker)

2017/18 Annual Report.

05.

Crop Production Research Programme.

Hortgro Science.

Collaboration with The Water Research Commission, Dr Sebinasi Dzikiti

Over the past four years Hortgro was part of a collaborative project that yielded results regarding apple orchard water use.

The project "Quantifying water use of high performing commercial apple orchards in the winter rainfall areas of South Africa" led by Dr Sebinasi Dzikiti of the Council for Scientific and Industrial Research (CSIR) produced results that provide the pome industry with hard data on the actual water needs of high performing apple orchards. In addition, their research indicates how much water evaporates from the orchard floor or is used by the cover crop. The specific aim of the project was to determine the water use, yield and quality of selected high performing 'Golden Delicious' and 'Cripps Pink' apple orchards from planting to full-bearing in the Koue Bokkeveld and EGVV regions. The results of this project can be accessed online on our website at hortgroscience.co.za, and in the September 2018 edition of the Fresh Quarterly.

The project was funded by six entities, and employed seven researchers and four students. Hortgro hopes to collaborate with more institutions in the future.

Duration of Project

April 2014 to March 2018

Funded by: Hortgro, Water Research Commission, Parliamentary grants to Council for Scientific and Industrial Research (CSIR) and the Agricultural Research Council (ARC), National Research Fund (Thuthuka Grant), NRF-DST Professional Development Program, CSIR Young Researcher Establishment Fund

Team and Students

01. Dr Sebinasi Dzikiti (CSIR)
02. Dr Mark Gush (CSIR)
03. Dr Theresa Volschenk (ARC)
04. Prof Stephanie Midgley (SU)
05. Dr Elmi Lötze (SU)
06. Dr Michael Schmeisser (SU)
07. Dr Nicky Taylor (UP)
08. Solomon Zirebwa (SU, PhD)
09. Zanele Ntshidi (UWC, PhD)
10. Thelma Mobe (UWC, PhD)
11. Qamani Doko (UP, MSc)

Research within the Crop Production programme addresses current problems experienced by the grower, but is also future-directed.

Research has a long lead time and it is important to now already build the capacity and conduct the research for the solutions that we will need in the future. In this sense, the Crop Production research strategy is directed and aligned with the requirements and key risks to the Orchard of the Future. Hence, rootstocks, plant quality, water- and climate-related research are the strategic priorities of this programme. The Crop Production research programme is structured into six themes, namely Dormancy, Farming Technology, Irrigation and Nutrition, Rootstocks and Nursery Tree Quality, Growing Season Climate, and Reproductive Biology. Research strategy for each theme is determined by a workgroup (a workgroup per theme) consisting of fruit growers, technical advisors and researchers. When considering research strategy, the workgroups always keep in mind the changes we need to make to our orchards to remain internationally competitive as well as profitable. They also consider the major future risks, as identified within the overarching research strategy, which may jeopardise our profitability.

Dormancy

Abstracts for these projects can be found on pages 136

Research in this theme is aimed at understanding the progression of dormancy under mild winter conditions. We also study dormancy release in order to potentially identify new, safer rest breaking chemicals – Dr Xolani Siboza is currently busy with field evaluation of potential new rest breaking programmes that were based on lab work by Dr Esmé Louw and Laura Allderman. Dr Esmé Louw has presented a talk at the Hortgro Science Technical Symposium on the impact of insufficient winter chill on apple fruit quality. The results of this study indicate that it might be possible to reduce the impact of on-tree maturity variation by picking fruit from different positions on the tree into different bins.

Expertise

Dormancy Workgroup

Researchers and Students.

05.

Crop Production Programme Leader

01. Prof Wiehann Steyn

Researchers

02. Dr Esmé Louw

03. Dr Xolani Siboza

04. Ms Laura Allderman

Students

05. Mr Andrew van Lingen (MSc student)

06. Dr Janine Colling Postdoctoral Research Fellow

07. Ms Micheline Inamahoro (PhD student)

08. Dr Leandra Möller Postdoctoral Research Fellow

Dormancy.

Current Projects

• Evaluate rest breaking programmes for warm winter regions. (X Siboza)
• Quantifying the impact of insufficient winter chill on apple fruit quality. (E Louw, L Allderman and A van Lingen)

Completed Projects

• Determining the dormancy progression of commercial apple cultivars and clones available to the South African fruit industry. (E Louw and L Allderman)

Reports Due 2019

• Physiological dynamics of dormancy in apple buds grown in areas with insufficient cold. (E Louw, J Colling, L Möller and M Inamahoro)
• Investigating the effects of different autumn temperatures on endodormancy progression. (E Louw and L Allderman)

Events

• Hortgro Science Technical Symposium 28 May – 01 June 2018
• Hortgro Science Research Showcase, Crop Production Projects 19 September 2018

Research in this theme is aimed at understanding the progression of dormancy under mild winter conditions.

Finding more precocious and productive rootstocks adapted to South African conditions is integral to our Orchard of the Future vision.

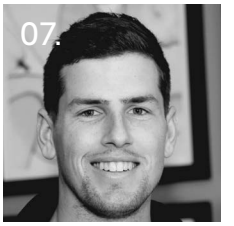
Rootstocks and Nursery Tree quality

Abstracts for these projects can be found on pages 140

Finding more precocious and productive rootstocks adapted to South African conditions is integral to our Orchard of the Future vision. For this reason, various pome and stone fruit rootstocks are evaluated in an increasing number of industry trials in commercial orchards. Hortgro Science has appointed Provar to run new rootstock trials under the supervision of Dr Xolani Siboza and with input from Dr Piet Stassen and the Rootstock Evaluation Committee. Together with the new funding strategy of rootstock evaluation, which involves co-funding by IP owners and licensees, this increases the number of trials that can be handled. More trials mean better data and hopefully earlier and more confident recommendations regarding new rootstocks. Completed research indicates that G.778 is a potential replacement for MM.109 while Dr Piet Stassen's comprehensive stone fruit rootstocks trials have also identified some clear winners. Other rootstock research is aimed at characterising new rootstocks in terms of adaptation and disease and pest tolerance.

Expertise

Rootstock and Nursery Tree Quality Workgroup
Rootstock Evaluation Committee



Researchers and Students.

05.

Crop Production Programme Leader

01. Prof Wiehann Steyn

Researchers

02. Dr Iwan Labuschagne
03. Dr Xolani Siboza
04. Dr Piet Stassen
05. Prof Stephanie Midgley
06. Prof Karen Theron

Students

07. Mr Werner Truter (MSc student)
08. Ms Lindsay Muchena (PhD student)

Rootstocks and Nursery Tree quality

New Projects

• Sensitivity of various apple rootstocks to water stress. (S Midgley and L Muchena)
• Evaluation of new apple rootstocks representing three vigour classes at Môrester and Oak Valley. (X Siboza and I Labuschagne)
• Evaluation of plum rootstocks for South African fruit Industry: Robertson planting (Roodehoogte). (P Stassen and I Labuschagne)
• Evaluation of peach rootstocks for South African fruit industry: Rawsonville planting (Slanghoek). (P Stassen and I Labuschagne)

Current Projects

• Evaluation of pear rootstocks for the South African industry. Packham's Triumph in Grabouw. (X Siboza and I Labuschagne)
• Evaluation of pear rootstocks for the South African industry. Forelle in Wolseley (Mostertshoek) (X Siboza and I Labuschagne)
• Evaluation of pear rootstocks for the South African industry. Cheeky in Wolseley (Mostertshoek). (X Siboza and I Labuschagne)
• Evaluation of peach rootstocks for the South African fruit industry at Vaalwater, Limpopo. (P Stassen and I Labuschagne)
• Evaluation of plum rootstocks for the South African industry at Simondium (Keunenberg). (P Stassen and I Labuschagne)
• Evaluation of new apple rootstocks and interstem combinations in Grabouw (Oak Valley). (X Siboza and I Labuschagne)
• Evaluation of new apple rootstocks and interstem combinations in Grabouw (Breëvlei). (X Siboza and I Labuschagne)
• Evaluation of new apple rootstocks and interstem combinations in the Langkloof (Helderwater). (X Siboza and I Labuschagne)

Completed Projects

• Apple rootstock evaluation in the Witzenberg valley. (X Siboza)
• Evaluation of plum rootstocks. (P Stassen)
• Evaluation of apricot rootstocks. (P Stassen)
• Evaluation of peach rootstocks. (P Stassen)
• Acclimation of apple peel to light and temperature and the effect thereof on red colour development and tolerance to sunburn. (S Midgley and P Barasu) – *see Summer Climate*

More trials mean better data and hopefully earlier and more confident recommendations regarding new rootstocks.

Reports Due 2019

• Evaluate methods to produce and handle containerised nursery trees. (K Theron and W Truter)
• Establishing quantitative relationships between water relations, growth, yield and quality of high performing commercial apple orchards. (S Midgley and S Zirebwa) – *see Irrigation and Nutrition*

Publications

• SAFJ October/November 2017: Lötze E, Van Zyl FJ, Taylor N. *White root growth dynamics of bearing apples trees in the Elgin area*
• SAFJ February/March 2018: McDonald D, Steyn W. *M9 not a 'weak' rootstock, studies show*
• Hortgro Science Technical Symposium Summary: *Rootstocks: When the easy choice, isn't the best choice (F Voigt and P Stassen)*

Events

Langkloof Seminar and Orchard Walk 04 December 2017
Orchard of the Future Grabouw 02 February 2018
Orchard of the Future Ceres 12 April 2018
Hortgro Science Technical Symposium 28 May – 01 June 2018
Hortgro Science Research Showcase, Crop Production Projects 19 September 2018

Of the “serious” pome fruit producers, South Africa, together with Brazil, have the production areas closest to the equator.

Growing Season Climate

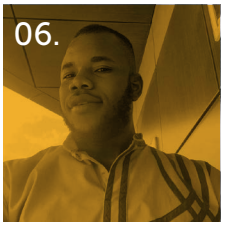
Abstracts for these projects can be found on pages 158

Of the “serious” pome fruit producers, South Africa, together with Brazil, have the production areas closest to the equator. This means higher summer temperatures and generally just altogether more plant stress and more fruit downgraded for processing compared to our major competitors. The great inefficiency of caring for fruit that ultimately ends up in a juice bin would have seriously endangered deciduous fruit production in South Africa if not for the (for now) favourable exchange rate.

It shouldn’t be surprising that research under this theme is predominantly aimed at decreasing sunburn and internal fruit quality defects brought about by photothermal stress.

Expertise

Growing Season Climate Workgroup



Researchers and Students.

05.

Crop Production Programme Leader

01. Prof Wiehann Steyn

Researchers

02. Prof Karen Theron

03. Prof Stephanie Midgley

04. Dr Elke Crouch

Students

05. Ms Nasreen van Rensburg (MSc student)

06. Mr Prince Barasu (MSc student)

07. Mr Brian Makeredza (PhD student)

08. Ms Liza-Marie Dippenaar (MSc student)

09. Dr Letitia Schoeman (Postdoctoral Research Fellow)

Growing Season Climate

New Projects

• Determining 'Forelle' pre-harvest mealiness / cavity development stage, due to environmental factors and exploring prevention of mealiness developing after storage and ripening. (E Crouch, L Schoeman and L-M Dippenaar) – *also Physiological Defects, Postharvest Programme*

Completed Projects

• Acclimation of apple peel to light and temperature and the effect thereof on red colour development and tolerance to sunburn. (S Midgley and P Barasu) – *also Rootstocks and Nursery Tree Quality*

Reports Due 2019

• Effect of nets on growth, yield and fruit quality as well economic feasibility in plums. (K Theron and N van Rensburg)
• Effect of climatic conditions and plant water status on plum pre-harvest quality and storability. (W Steyn and B Makeredza)

Publications

• SAFJ April/May 2018: Jooste M. *What breaks a plum's heart?*
• Fresh Notes 142—18 December 2017: *Heat damage plums preharvest*
• Fresh Quarterly June 2018: Steyn W. *The Oddity of Red Colour Development in Pears*
• Fresh Quarterly June 2018: Steyn W. *How to Achieve Good Red Colour in Apples and Pears*
• Fresh Quarterly June 2018: Steyn W. *The Recipe for Green Colour in Green Apples*
Hortgro Science Technical Symposium Summary: *Results of shade net studies in Washington State (G Mupambi)*
• Hortgro Science Technical Symposium Summary: *Preliminary findings of semicommercial drape net trials (A Muller)*

Events

Orchard of the Future Grabouw 02 February 2018
Orchard of the Future Ceres 12 April 2018
Hortgro Science Technical Symposium 28 May – 01 June 2018
Hortgro Science Research Showcase, Crop Production Projects 19 September 2018

Reproductive Biology

Abstracts for these projects can be found on pages 162

Research in this field is aimed at obtaining regular high yields of good quality fruit. The research is mostly applied and in recent years, the work done by Prof Karen Theron has provided us with a mechanical thinning option for stone fruit that considerably saves time and cost. Prof Theron has also evaluated a very promising chemical stone fruit option that is awaiting registration.

Expertise

Reproductive Biology Workgroup

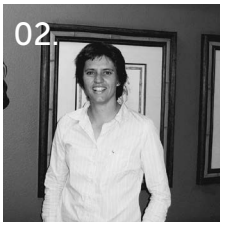
05”

Research in this field is aimed at obtaining regular high yields of good quality fruit.

Researchers and Students.

Crop Production Programme Leader

01. Prof Wiehann Steyn



Researchers

02. Dr Nicky Taylor

Students

03. Ms Suzann Oosthuizen (MSc student)

Reports Due 2019

• Carbon partitioning in low chill peach cultivars: the impact on yield in summer rainfall areas of South Africa. (N Taylor and S Oosthuizen)

Events

Langkloof Seminar and Orchard Walk 04 December 2017
Hortgro Science Research Showcase, Crop Production Projects 19 September 2018

Attendees to the 2015 Hortgro Science Technical Symposium rated water availability as the highest risk to the Orchard of the Future within the Crop Production programme.

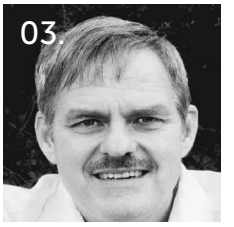
Irrigation and Nutrition

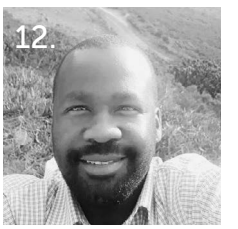
Abstracts for these projects can be found on pages 163

Attendees to the 2015 Hortgro Science Technical Symposium rated water availability as the highest risk to the Orchard of the Future within the Crop Production programme. Note that this was before the recent drought became severe. Even before 2015, Hortgro Science management has considered water availability a serious threat to future fruit production, given that the Western- and Eastern Cape provinces are water scarce, that climate change is driving a drying trend, and that competition with water is increasing with the rapidly growing human population. According to the 2014 minutes of this workgroup, the Crop Production water strategy involves 1) determining how much water highly productive apple trees use, 2) funding permitting expanding this research to include stone fruit, 3) conducting research on various water saving technologies (a new WRC co-funded project on water saving under fixed and draped nets will commence in 2018), and 4) conducting research to show growers the negative effects of over-irrigation on production and quality. Dr Sebinasi Dzikiti completed a WRC co-funded research project in 2018 that measured tree and orchard water use of high yielding 'Golden Delicious' and 'Cripps' Pink' orchards in the Koue Bokkeveld and EGVV. The results of this research will be widely distributed in the deciduous fruit industry.

Expertise

Irrigation and Nutrition Workgroup





Researchers and Students. 05.

Crop Production Programme Leader

01. Prof Wiehann Steyn

Researchers

02. Prof Stephanie Midgley
03. Dr Eduard Hoffman
04. Dr Johan van Zyl
05. Dr Sebinasi Dzikiti
06. Dr Theresa Volschenk
07. Dr Caren Jarmain

Students

08. Ms Aline Stofberg (MSc student)
09. Mr Solomon Zirebwa (PhD student)
10. Ms Zanele Ntshidi (PhD student)
11. Ms Nompumelelo Thelma Mobe (PhD student)
12. Mr Qwamani Doko (MSc student)

Irrigation and Nutrition

New Projects

• Water use of pome and stone fruit: knowledge status, relevance and gap analysis. (C Jarmain)

Current Projects

The effect of irrigation on the performance of young apple trees in newly established orchards. (E Hoffman, J van Zyl and A Stofberg)

Completed Projects

• Quantifying water use of high performing commercial apple orchards in the winter rainfall areas of South Africa. (S Dzikiti, Q Doko, S Zirebwa, Z Ntshidi and N Mobe)
• Evapotranspiration of high performance apple tree orchards. (T Volschenk)

Reports due 2019

• Establishing quantitative relationships between water relations, growth, yield and quality of high performing commercial apple orchards. (S Midgley and S Zirebwa) – *also Rootstocks and Nursery Tree Quality*

The results of this research will be widely distributed in the deciduous fruit industry.

Irrigation and Nutrition

Publications

• South African Fruit Journal (SAFJ): December 2017/January 2018

- *Hortgro Science Irrigation Seminar 2017—Farm Planning: Get all the experts around the table*
- *Hortgro Science Irrigation Seminar 2017—Pipeline Economics: Cheaper isn't always better*
- *Hortgro Science Irrigation Seminar 2017—Micro-irrigation Options: Time to rethink the use of low volume irrigation systems*
- *Hortgro Science Irrigation Seminar 2017—Irrigate–Monitor–Adjust: The irrigation cycle*
- *Hortgro Science Irrigation Seminar 2017—Water Availability: Future outlook for the Western Cape and implications for fruit growers*
- *Hortgro Science Irrigation Seminar 2017—Fruitlook supports efficient farming*
- *Hortgro Science Irrigation Seminar 2017—Function of water during different phenological stages: Phenology and water in the fruit tree*
- *Hortgro Science Irrigation Seminar 2017—Stages for irrigation practices during drought with plant phenology taken into consideration: Developing a drought based on plant physiology*
- *Hortgro Science Irrigation Seminar 2017—Practical experience regarding the effects of drought and drought management: A farmer's perspective on drought management*

• Fresh Quarterly September 2018: Midgley S, Steyn W, Schmeisser M. *What you need to know about orchard water use*
• Fresh Quarterly September 2018: Beerwinkel E. *Thirst trap – How much water do high performing apple orchards need*
• Fresh Quarterly September 2018: Beerwinkel E. *Stranger things – Invasive alien plants' coup of water catchment areas*
• Hortgro Science Technical Symposium Summary: *Sustainable groundwater use as the drought holds centre stage (R Parsons)*
• Hortgro Science Technical Symposium Summary: *The future of agricultural water availability in the Western Cape (A Petersen)*
• Hortgro Science Technical Symposium Summary: *Practical farming advice for drought management – the effect on fruit quality (W Burger and D Hamman)*

Events

Hortgro Science Technical Symposium 28 May – 01 June 2018
Hortgro Science Research Showcase, Crop Production Projects 19 September 2018

Farming Technology

Research in this theme used to focus mainly on orchard mechanization. One of the major outcomes of this research was to highlight inefficiencies in especially pome fruit tree structure, which emphasized the need to encourage industry towards planting higher density orchards with more two-dimensional trees on productive and precocious rootstocks. Mechanization research has, however, come to an end for now and there are currently no running projects under this theme. However, the theme has been expanded to also include research relating to

Technology drivers such as big data, remote sensing, robotics, and GIS that will all contribute to changing the way we produce our fruit in our orchards of the future.

Expertise

Farming Technology Workgroup

Publications

• Hortgro Science Technical Symposium Summary: *Application of machine learning in surveying production (A van Niekerk)*

Events

Orchard of the Future Grabouw 02 February 2018
Orchard of the Future Ceres 12 April 2018
Hortgro Science Technical Symposium 28 May – 01 June 2018
Hortgro Science Research Showcase, Crop Production Projects 19 September 2018

2017/18 Annual Report.

06.

Crop Protection Research Programme.

Hortgro Science.

This multidisciplinary programme includes research on nematology, entomology and plant pathology.

Both applied and basic research aspects are addressed by the programme. The Crop Protection Technical Advisory Committee assesses both research outputs and research priorities. In addition the Entomology and Pathology Peer Work Groups assess proposed and current research projects.

Ensuring the sustainability of the fruit production process is a critical aspect in crop protection research and emphasis is placed on biological control, orchard ecology, phytosanitary issues and precision agriculture.

Crop protection research during this season has been challenging, the drought, phytosanitary issues and invasive pests have all influenced the research programme.

Phytosanitary

Abstracts for these projects can be found on pages 169

The threat posed by phytosanitary issues are significant. The current spread of the invasive oriental fruit fly and the concerns regarding false codling moth are relevant examples. The current research projects address a number of relevant issues including applied research on fumigation using novel materials. The research programme is aimed at ensuring effective management of phytosanitary pests and diseases and ensuring access to markets.

Expertise

Integrated Pest Management Group

Researchers and Students.

06.

Crop Protection Programme Leader

01. Matthew Addison

Researchers

02. Dr Daleen Stenekamp
03. Dr Marelize de Villiers
04. Dr Shelley Johnson
05. Dr Pia Addison
06. Dr Tony Ware

Technical Assistance

07. Mr Terence Asia

Students

08. Ms Welma Pieterse (PhD student)
09. Ms Renate Smit (PhD student)

Phytosanitary

New Projects

• Comparison of cold disinfestation treatments of *Thaumatotibia leucotreta* (Lepidoptera: Tortricidae) in peaches, plums (*Prunus spp*.) and media. (T Ware)
• Ethyl formate fumigation technology – upscaling application towards commercialisation. (S Johnson and R Smit) – funded by the Post Harvest Innovation (PHI) Programme

Completed Projects

• CATTS and ethyl formate fumigation as post harvest phytosanitary treatments for stone and pome fruit and associated phytosanitary insect pests. (S Johnson and R Smit) – *also Market Access*
• Monitoring of false codling moth distribution and damage in nectarine orchards. (D Stenekamp and T Asia)
•Phytosanitary status of false codling moth, *Thaumatotibia leucotreta* (Meyrick) (Lepidoptera: Tortricidae) on pears.(M de Villiers)
• Phytosanitary status of false codling moth, *Thaumatotibia leucotreta* (Meyrick) (Lepidoptera: Tortricidae) on plum cultivars. (M de Villiers)
• The susceptibility of fruit to infestation by false codling moth, *Thaumatotibia leucotreta* (Meyrick) (Lepidoptera: Tortricidae) at different stages of development. (M de Villiers)
• A study on the biological and physiological traits of *Bactrocera dorsalis*, with special reference to its invasion potential into the Western Cape of South Africa. (P Addison and W Pieterse)

Publications

• SAFJ December 2017/January 2018: Johnson S. *Phytosanitary Measures Research Group Meeting 2017*
• SAFJ April/May 2018: Johnson S. *Setting the CATTS among the pests*
• Fresh Notes *143* – 03 January 2018: *Aanbeveelde protokol vir die risiko bestuur van graanstinkluis*
• Fresh Notes *144* – 23 January 2018: *Mites in a hot and dry 2017/18*
•Hortgro Science Technical Symposium Summary: *Overcoming phytosanitary obstacles (H Campbell)*

Events

Hortgro Science Technical Symposium 28 May – 01 June 2018
Hortgro Science Research Showcase, Crop Protection Projects 18 September 2018

The research programme on nematodes continues to be highly productive and relevant. Past and current research has allowed for the development of a number of potential biological control agents one of which is being commercialized.

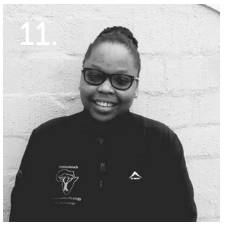
Nematology

Abstracts for these projects can be found on pages 175

The research programme on nematodes continues to be highly productive and relevant. Past and current research has allowed for the development of a number of potential biological control agents one of which is being commercialized. Both plant parasitic nematodes and entomopathogenic nematodes are being researched. Entomopathogenic fungi are also being integrated into the research programme. The research on plant parasitic nematodes is seen as critical and will lead to a better management of these pests.

Expertise

Integrated pest management group
Soil Health Workgroup



Researchers and Students. 06.

Crop Protection Programme Leader

01. Matthew Addison

Researchers

02. Prof Antoinette Malan
03. Dr Nomakholwe Stokwe
04. Dr Rinus Knoetze
05. Dr André de Klerk
06. Ms Sheila Storey
07. Ms Lené van der Walt

Students

08. Ms Maryna Odendaal (MSc student)
09. Ms Caro Kapp (PhD student)
10. Ms Deidré Odendaal (PhD student)
11. Ms Letodi Mathulwe (MSc student)

Nematology

Current Projects

• Host status of certain cover crops for the root lesion nematode, a major pest of economic importance in apples. (R Knoetze)
• Control of woolly apple aphid using entomopathogenic fungi. (N Stokwe and L Mathulwe)
• Incorporating entomopathogenic nematodes and fungi in an integrated pest management system for the control of codling moth. (A Malan and D Odendaal)

Completed Projects

• Control and management of lesion nematodes in apple rooted layers and nurseries. (A de Klerk)
•Ring nematode (*Criconemoides xenoplax*) distribution, the characterisation and culture methods. (A Malan and M Odendaal)
• A survey to determine *Pratylenchus* spp present in South African apple orchards. (L van der Walt)

Reports Due 2019

• Nematode community structure and function as a bio-indicator of the effects of soil amendments on soil health in deciduous fruit orchards. (S Storey and C Kapp) - *also Soil Health*

Publications

• Hortgro Science Technical Symposium Summary: *Nematode occurrence in the pome industries, effects and treatment (L van der Walt)*
• Fresh Quarterly June 2018: Beerwinkel E. *Soil's Trojan horse*
• Fresh Quarterly June 2018: Beerwinkel E. *War on Pests: The Mass Production of a Biological Wonder Weapon*

Events

Hortgro Science Technical Symposium 28 May – 01 June 2018
Hortgro Science Research Showcase, Crop Protection Projects 18 September 2018

Soil Health

Abstracts for these projects can be found on pages 183

Research on soil health is attracting a lot of attention and is seen as a critical part of future agriculture. The study of orchard floor ecology and hence soil health is an important component of sustainability. Current research is focused on cover crops and their effects on the pest and disease complex and well as fruit production.

Expertise

Soil Health Workgroup
Integrated Pest Management Group

Researchers and Students.

06.

Crop Protection Programme Leader

01. Matthew Addison

Researchers

02. Dr André Meyer

03. Dr Johan Fourie

04. Ms Sheila Storey

Researchers

05. Ms Caro Kapp (PhD student)

Soil Health

New Project

• Orchard floor management and soil health in deciduous fruit orchards. (M Addison)

Completed Projects

• Validation of an enzyme-based soil alteration index for testing soil health in local apple orchard soils. (A Meyer)
• The effect of different cover crop management practices on the soil and performance of apple trees. (J Fourie and C Kapp)

Reports Due 2019

• Nematode community structure and function as a bio-indicator of the effects of soil amendments on soil health in deciduous fruit orchards. (S Storey and C Kapp) - *see Nematology*

Publications

• Hortgro Science Technical Symposium Summary: *Managing apple replant disease without fumigants (A McLeod)*

Events

Hortgro Science Technical Symposium 28 May – 01 June 2018
Hortgro Science Research Showcase, Crop Protection Projects 18 September 2018

Research on soil health is attracting a lot of attention and is seen as a critical part of future agriculture.

06”

The plant pathology research programme addresses a number of important industry issues.

Plant Pathalogy

Abstracts for these projects can be found on pages 187

The plant pathology research programme addresses a number of important industry issues. The research on incidence and distribution of fungal pathogens in young trees is highly relevant as is the integrated management of apple scab. Apple replant disease and various aspects of postharvest pathology are also receiving attention.

Expertise

Integrated Pest Management Group

Crop Protection Programme Leader

01. Matthew Addison

Researchers

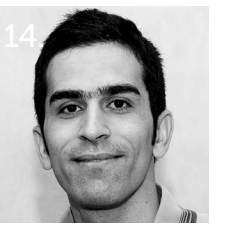
02. Prof Teresa Coutinho

03. Prof Adele McLeod

04. Prof Lizel Mostert

05. Mr Abraham Vermeulen

06. Ms Heleen Tayler



Students

07. Ms Rhona van der Merwe (MSc student)

08. Ms Khumbuzile Bophela (PhD student)

09. Ms Mateka Modiba (MSc student)

10. Mr Makomborero Nyoni (PhD student)

11. Ms Minette Havenga (MSc student)

12. Mr Greg Gatsi (MSc student)

13. Ms Doré de Villiers (MSc student)

14. Mr Shahrooz Moein (MSc student)

Plant Pathology

New Projects

• Evaluation of pruning wound protectants on nursery apple trees. (L Mostert and G Gatsi)
• Alternatives for the management of apple replant disease. (A McLeod and D de Villiers)
• Determine fungicide efficacy using qRT-PCR for detection and quantification of *Botrytis cinerea* inoculum and viability on pear leaves as a substrate, before and after fungicide application. (H Tayler)

Current Projects

• Management of apple replant disease using phosphonates. (A McLeod, M Nyoni and S Moein)
• Screening apple rootstocks for tolerance to *Phytophthora* crown rot. (A Vermeulen)
• Survey of stem canker pathogens on stone fruit propagation material and young stone fruit trees. (L Mostert and R van der Merwe)
• The role of stress factors in predisposing plum trees to invasion by bacterial pathogen *Pseudomonas syringae* pv. *syringae*. (T Coutinho, K Bophela and M Modiba)

Completed Projects

• Survey of stem cankers and dieback symptoms of young apple trees and possible inoculum sources. (L Mostert, M Havenga and G Gatsi)

Publications

• SAFJ October/November 2017: Wessels BA, Linde CC, Fourie PH, Lennox C, Mostert L. *New insights into the population dynamics and fungicide resistance of Botrytis cinerea in pear orchards*

Events

Hortgro Science Technical Symposium 28 May – 01 June 2018
Hortgro Science Research Showcase, Crop Protection Projects 18 September 2018

The IPM research programme deals with a wide variety of crop protection issues. The research is aimed at allowing for the more efficient and sustainable control of pests and diseases.

Integrated Pest Management

Abstracts for these projects can be found on pages 195

The IPM research programme deals with a wide variety of crop protection issues. The research is aimed at allowing for the more efficient and sustainable control of pests and diseases. Invasive insects such as oriental fruit fly and phytosanitary concerns have influenced the research programme. Research on false codling moth has yielded significant results as has research on biological control.

Expertise

Integrated Pest Management Group

Crop Protection Programme Leader

01. Matthew Addison

Researchers

02. Dr Daleen Stenekamp

03. Dr Pia Addison

04. Prof John Terblanche

05. Dr Ruan Veldtman

06. Mr Mike Allsopp

Technical Assistant and Students

07. Mr Terence Asia (Technical Assistant)

08. Dr Minette Karsten (Postdoctoral Research Fellow)

09. Mr Bonginkhosi Dlamini (MSc student)

10. Mr Meshack Magagula (MSc student)

11. Mr Vernon Steyn (PhD student)

12. Ms Monique James (MSc student)

13. Ms Erika Huisamen (PhD student)

14. Ms Bianca Stead (Honours student)

Integrated Pest Management

New Projects

•Sequencing the genome and transcriptome of false codling moth, *Thaumatotibia leucotreta*, for pest management. (J Terblanche and M Karsten)
• Exploration of orchard sanitation and the potential of parasitic wasps for the biological control of fruit flies in South Africa. (P Addison and B Stead)
• Determining the contribution of wild honey bees (pollination ecosystem service) to commercial deciduous fruit production. (R Veldtman and M Allsopp)

Current Projects

• False codling moth population genetics: gene flow in agricultural environments. (J Terblanche, M Karsten and E Huisamen)
• Using biological control against two sporadic pests in vineyards and orchards. (P Addison and B Dlamini)
• The effects of biotic and abiotic factors on the distribution of economically important weevils in the deciduous fruit industry. (P Addison and M Magagula)
• Maintaining and rearing of insect cultures. (D Stenekamp and T Asia)
• Integrated management of the control of false codling moth, *Thaumatotibia leucotreta*, on stone fruit and table grapes. (P Addison and V Steyn)
• Pest and disease monitoring in orchards under shade net. (M Addison)

Completed Projects

• Control of false codling moth, *Thaumatotibia leucotreta*, on stone fruit with mating disruption. (D Stenekamp and T Asia)
• Investigating biological control agents for the management of *Ceratitis capitate* (Wiedemann). (P Addison and M James)

Publications

• SAFJ February/March 2018: James M, Malan A, Addison P. *Can local natural enemies control the Mediterranean fruit fly?*
• SAFJ June/July 2018: Allsopp E, Knipe M. *Is a push-pull strategy for western flower thrips feasible?*
• Fresh Notes *137* – 17 October 2017: *Monitoring Guidelines for Bactrocera Dorsalis*
• Fresh Notes *141* – 13 December 2017: *Andrew Jessup on Preventing the spread of Bactrocera dorsalis*
• Hortgro Science Technical Symposium Summary: *Strategic changes in the crop protection environment and its impact on the deciduous fruit grower (R Geldenhuys)*
• Hortgro Science Technical Symposium Summary: *New technology in monitoring and spraying (G van Zyl)*

Events

Bactrocera dorsalis workshop 30-31 November 2017
Hortgro Science Technical Symposium 28 May – 01 June 2018
Hortgro Science Research Showcase, Crop Protection Projects 18 September 2018

The application of new technology in integrated pest management is important.

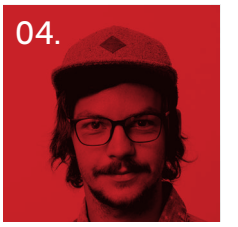
Precision Agriculture

Abstracts for these projects can be found on pages 207

The application of new technology in integrated pest management is important. The development of more efficient spray application methods is critical to efficient pest and disease control. Coupled to this is the use of predictive models and various decision support methods that allow for the accurate application of management methods. Current research addresses a number of these issues and included significant work on Mediterranean fruit fly.

Expertise

Spray Application Group
Integrated Pest Management Group



Researchers and Students.

06.

Crop Protection Programme Leader

01. Matthew Addison

Researchers

02. Prof Adele McLeod

03. Dr Pia Addison

Students

04. Mr Philip Rebel (MSc student)

05. Mr Francois Bekker (PhD student)

06. Ms Doré de Villiers (BSc Honours student)

The development of more efficient spray application methods is critical to efficient pest and disease control.

Precision Agriculture

Current Projects

•Replacing or modifying the Unrath model for optimal spraying in high density orchards, by using the principles of the MABO-dosing model. (A McLeod and P Rebel)
• Integration of GIS and spatial analysis with monitoring data of major pests for the purposes of area-wide management. (P Addison and F Bekker)

Completed Projects

• Evaluating an ascospore release forecasting model and orchard disease monitoring methods for improving apple scab management. (A McLeod and D de Villiers)

Publications

• SAFJ December 2017/January 2018: Van Zyl SA. *Impact of selected orchard spray application technologies and tree phenology on deposition properties on the leaf and fruit surfaces of apple trees*
• Hortgro Science Technical Symposium Summary: *New technology in monitoring and spraying (G van Zyl)*
• Hortgro Science Technical Symposium Summary: *The lay of the land: GIS, Machine Learning and fruit fly distribution (F Bekker)*

Events

Hortgro Science Technical Symposium 28 May – 01 June 2018
Hortgro Science Research Showcase, Crop Protection Projects 18 September 2018

2017/18 Annual Report.

07.

Post Harvest Research Programme.

Hortgro Science.

Post-harvest supports and enhances the processes throughout the supply-chain critical to ensuring that intrinsic product integrity is maintained.

Post-harvest supports and enhances the processes throughout the supply-chain critical to ensuring that intrinsic product integrity is maintained, and that a quality product is available to the end-consumer in local and distant global markets. Post-harvest covers producers, packhouses, marketing co-ordination, logistics and shipping, receivers/wholesalers and end consumers.

The Post-harvest Technical Advisory Committee (TAC), and now also the industry postharvest Store-It group, provide inputs into the gap analysis to ensure that problematic issues are incorporated for potential research projects. They then allocate priorities to the items listed. At the behest of the TAC, an Eating Quality Workgroup and an External Quality Workgroup have been formed under the guidance of Prof's Wiehann Steyn and Karen Theron. The newly appointed Assistant General Manager of Hortgro Science, Wiehann Steyn, will be taking Post-harvest Programme Management under his wing with the impending retirement of the current incumbent at the end of 2018.

Additional workgroups are formed as and when needed, for instance, the DPA Work Group was formed in 2008 to look at strategies to mitigate the potential loss of DPA to EU, which occurred in 2013.

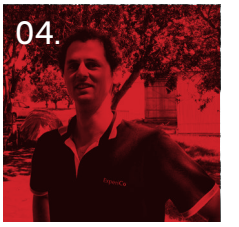
Quality Management

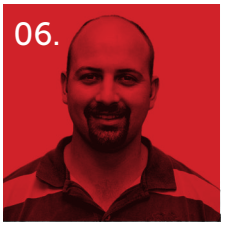
Abstracts for these projects can be found on pages 210

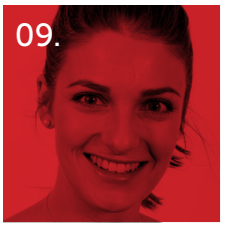
Quality management refers to maintaining quality throughout the logistical chain to the end consumer. With reference to stone fruit, an increase in the temperature tolerance to 3 °C for plums has been recommended. Shrivelling in stone fruit is being addressed by various projects outlined below.

Expertise

Fruit Eating Quality Workgroup
Fruit External Quality Workgroup







Researchers and Students.

07.

Post Harvest Programme Leader

01. Richard Hurndall

Researchers

02. Ms Anél Botes

03. Mr Barend Pienaar

04. Mr Daniël Viljoen

05. Mr Arrie de Kock

06. Mr Handré Viljoen

07. Dr Olaniyi Fawole

08. Dr Ian Crouch

Students

09. Ms Shannon Riva (MSc student)

Pome Fruit Projects

New Project

• The use of Harvista™ (pre-harvest 1-MCP) application to prevent green colour loss and reduce blush of Granny Smith apples. (I Crouch)

Current Projects

• The effect of DPA on fruit quality in pome fruit. (A Botes)
• Quantifying the effect of bag perforations on forced-air cooling cycles and post storage quality of apples. (D Viljoen)
• The use of Harvista™ (pre-harvest 1-MCP) application to control superficial scald on Packham's Triumph pears. (D Viljoen)

Completed Projects

• The maximum delay in SmartFresh℠ application from harvest to room filling for fruit destined for the FEMA programme. (B Pienaar)

Pome Fruit Projects

07”

Stone Fruit Projects

New Projects

• Develop a storage protocol for plums harvested from week 5 onwards for 6 weeks in bins. (H Viljoen)
• Application of postharvest edible coatings to alleviate shrivel in plums and nectarines. (O Fawole and S Riva)

Current Projects

• Identify and test improved packaging as well as humidity control in cold stores to reduce moisture loss and shrivel in nectarines. (H Viljoen)
• Identify and test improved packaging as well as humidity control in cold stores to reduce moisture loss and shrivel in plums. (H Viljoen)
• Develop optimum ripening protocols for nectarines and plums arriving too green (skin colour) or too firm in market. (H Viljoen)

Completed Projects

• Evaluation of the 8mm penetrometer plunger to determine harvest maturity on nectarines. (A de Kock)
• Revision of temperature tolerance at loading for plums. (A de Kock)

Publications

• SAFJ December 2017/January 2018: Viljoen HW, De Kock VA. *Fine-tuning the determination of optimum harvest maturity of cold stored African Delight® plums*
• Hortgro Science Technical Symposium Summary: *Physics of water: Understanding the basics of humidity (M Huysamer)*
• Hortgro Science Technical Symposium Summary: *Impact of cooling on lenticel damage (I Crouch)*

Events

Hortgro Science Technical Symposium 28 May – 01 June 2018
Hortgro Science Research Showcase, Post-Harvest Projects 20 September 2018

Internal quality defects receiving attention are watercore (Forelle), mealiness (Forelle) and internal browning (Fuji and Rosy Glow).

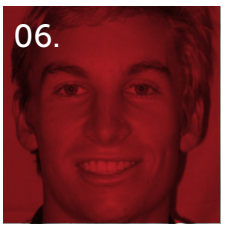
Physiological Defects

Abstracts for these projects can be found on pages 224

Internal quality defects receiving attention are watercore (Forelle), mealiness (Forelle) and internal browning (Fuji and Rosy Glow). It has been confirmed that the more-exposed outer canopy Forelle have a greater propensity for mealiness. As is often the case, internal defects do not manifest in seasons subsequent to when they were major problems. Nevertheless, knowledge of their potential causes has greatly increased.

Expertise

DPA Focus Group



Researchers and Students. 07.

Post Harvest Programme Leader

01. Richard Hurndall

Researchers

02. Dr Elke Crouch

03. Dr Ian Crouch

04. Mr Daniël Viljoen

Students

05. Mr Kenias Chigwaya (PhD student)

06. Mr Rudolph Cronje (MSc student)

07. Dr Walter Fourie (Postdoctoral Research Fellow)

08. Dr Letitia Schoeman (Postdoctoral Research Fellow)

09. Dr Tavagwisa Muziri (Postdoctoral Research Fellow)

10. Mr James Wonder Doe (MSc student)

11. Ms Liza-Marie Dippenaar (MSc student)

Physiological Defects

New Project

• Determining 'Forelle' pre-harvest mealiness / cavity development stage, due to environmental factors and exploring prevention of mealiness developing after storage and ripening. (E Crouch, L Schoeman and L-M Dippenaar) – *see Growing Season Climate, Crop Production Programme*

Current Projects

• Fuji browning types explored via x-ray CT in collaboration with existing trial. (E Crouch and K Chigwaya)
• To assess Internal Browning development potential from high watercore incidence FEMA Forelle. (D Viljoen)
• Post-harvest 'Forelle' (*Pyrus communis* L.) mealiness development, detected at harvest by CT-x ray scanning and semi-commercial colour pre-sorting influenced by canopy position at harvest as well as pollination. (E Crouch, R Cronje, W Fourie, T Muziri and L Schoeman)
• Identification of factors involved in the expression of internal browning in Fuji apples and the development of a strategy to reduce risk of incidence. (D Viljoen)

Completed Projects

• Harvest and storage condition plus duration influencing internal browning and fruit quality of 'Rosy Glow' (E Crouch and J Doe)

Publications

• SAFJ April/May 2018: Crouch E. *Can mealiness be nipped in the bud?*
• Hortgro Science Technical Symposium Summary: *Technologies for minimising physiological disorders in apples (R Beaudry)*
• Fresh Notes 142 – 18 December 2017: *Heat damage plums preharvest*
• Fresh Quarterly September 2018: Mouton A. *Internal browning in 'Fuji'*
• Fresh Quarterly September 2018: Mouton A. *When pink apples go brown*

Events

Hortgro Science Research Showcase, Post-Harvest Projects 20 September 2018

Storage technologies for Abate Fetel are still a work in progress, and further refinements are still required. The extended storage of Cripps' Pink in conjunction with SmartFresh℠ treatment is receiving attention.

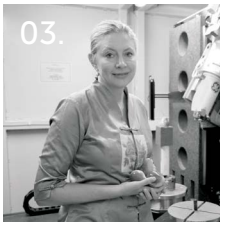
Storage techniques

Abstracts for these projects can be found on pages 229

Non-chemical scald control is a major focus of storage technologies. A positive result is the 10-month control of superficial scald using repeated low oxygen stress (RLOS). Storage technologies for Abate Fetel are still a work in progress, and further refinements are still required. The extended storage of Cripps' Pink in conjunction with SmartFresh℠ treatment is receiving attention.

Expertise

CA and Post-Harvest Group
DPA Focus Group



Researchers

06.

Post Harvest Programme Leader

01. Richard Hurndall

Researchers

02. Ms Anél Botes

03. Dr Elke Crouch

04. Mr Daniël Viljoen

05. Ms Heleen Tayler

Pome Fruit

Current Projects

• To investigate different step down cooling regimes, utilised in conjunction with SmartFresh℠, to reduce the risk of internal browning of Cripps' Pink apples and provide year round supply of good quality fruit. (H Tayler, D Viljoen, and E Crouch)
• Optimisation of RLOS protocol for superficial scald prevention on Packham's Triumph pears. (A Botes)
• Determine optimum storage conditions for Abate Fetel pears. (A Botes)

Events

CA meeting 07 November 2018
Langkloof Seminar and Orchard Walk 04 December 2017
Hortgro Science Research Showcase, Post-Harvest Projects 20 September 2018

With reference to pome fruit, the original project on Bull's Eye rot of apples has not reached its full conclusion in terms of an integrated management strategy.

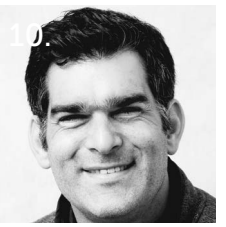
Post-Harvest Decay

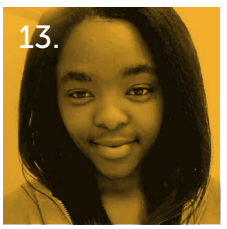
Abstracts for these projects can be found on pages 232

With reference to pome fruit, the original project on Bull's Eye rot of apples has not reached its full conclusion in terms of an integrated management strategy. Co-funding has been provided by the SA Pink Lady Association to complete the process. A one-year project to confirm the causal agents for core rot, using the latest research techniques, was completed. Core rot remains an intractable problem. *Botrytis* was detected and quantified in pears using a Real-Time PCR technique.

Expertise

Post-Harvest Pathology Group





Post Harvest Programme Leader

01. Richard Hurndall

Researchers

02. Mr Arrie de Kock
03. Dr Stephan Ferreira
04. Dr Cheryl Lennox
05. Dr Robbie Pott
06. Dr Julia Meitz-Hopkins
07. Ms Heleen Tayler
08. Dr Ida Wilson

Students

09. Mr André Russouw (MSc student)
10. Mr Benjamin Cloete (MSc student)
11. Mr Junré Marais (BSc Honours student)
12. Ms Dineo Baloyi (BEng Honours student)
13. Ms Sinovujo Magwebu (BSc Honours student)
14. Mr George Teke (MSc student)

Pome Fruit Projects

New Projects

• Pursuit of sanitiser products for potential use in the apple and pear industry. (H Tayler)
• Evaluating the relationship between quantified *Botrytis cinerea* levels in pear fruit at harvest and the *Botrytis* rot incidence and severity at the end of storage: Towards the development of a *Botrytis* rot management model. (S Ferreira)
• Purification of antimicrobial lipopeptides produced by *Bacillus* spp. for biological control of postharvest phytopathogens in the perishable fruit industry. (R Pott, D Baloyi and G Teke)
• Lipopeptides for the biological control of postharvest phytopathogens. (R Pott, G Teke, D Baloyi, J Marais and S Magwebu) – *funded by the Post-Harvest Innovation (PHI) Programme*
• Lipopeptides Fengycin and Iturin A as postharvest fungicide on pome fruit. (C Lennox, J Meitz-Hopkins and J Marais)

Current Projects

• The development of an integrated management strategy for Bull's Eye rot of apples. (C Lennox, J Meitz-Hopkins and A Russouw)

Completed Projects

• Development of a fungicide sensitivity monitoring service for SA pome fruit pathogens. (C Lennox, J Meitz-Hopkins and B Cloete)
• Pre and post-harvest monitoring of *Alternaria* spp. in orchards with historically high incidence of dry core rot. (S Ferreira and I Wilson)

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01 Pome Fruit Projects

Stone Fruit Projects

New Projects

• Factors that influence the retention of fungicide residues on plums. (A de Kock)

Current Projects

• Quantification of the presence of *Botrytis cinerea, Monilinia laxa* and *Penicillium expansum* in blossoms and plums at harvest, and correlation of relative pathogen presence to decay after shelf-life: Potential application of diagnostic information early in the season to use as a management tool of plum decay post storage and shelf life. (S Ferreira)
• Survey and investigation on the impact of various fungicide application methods and technologies on decay control of plums in the pack-house. (A de Kock)

Publications

• SAFJ October/November 2017: Wilson I. *Fine-tuning Fungicide Application: A new perspective on the control of postharvest decay in stone fruit*
• SAFJ December 2017/January 2018: Lennox C, Den Breeyen A, Meitz-Hopkins J. *Management of postharvest diseases of apples using appropriate methods: A South African perspective*
• Fresh Notes 139 – 10 November 2017: *Evaluations and Recommendations for Atomising Systems on Plums*

Events

Hortgro Science Research Showcase, Post-Harvest Projects 20 September 2018

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02 Stone Fruit Projects

Packaging/Logistics

Abstracts for these projects can be found on pages 238

Logistics projects are focussing on the optimisation of shipping container space utilisation.

Expertise

Packhouse Action Group

Researchers and Students.

07.

Post Harvest Programme Leader

01. Richard Hurndall

Researchers

02. Dr Tarl Berry

03. Prof Leila Goedhals-Gerber

Students

04. Ms Tiffany Adams (BCom Honours student)

05. Ms Chelna Neethling (BCom Honours student)

06. Mr Adewale Nuryan Tiamiyu (MSc student)

Packaging/Logistics

New Projects

• Logistical considerations and limitations of refrigerated containers used in the pome and stone fruit export markets. (L Goedhals-Gerber, T Adams and C Neethling)
• Implementation of Next-generation Packaging Systems in High Cube Refrigerated Containers for Efficient Cooling and improved Volume Usage. (T Berry and A Tiamiyu)

Publications

• Hortgro Science Technical Symposium Summary: *The opportunities and challenges of pre-sorting (J Moelich)*
• Fresh Notes 140 – 05 December 2017: *Packhouse Action Group Feedback*
• Fresh Notes 145 – 25 January 2018: *Forelle Early Market Access (FEMA) Programme*
• Fresh Notes 146 – 26 March 2018: *Packhouse Action Group Feedback*
• Fresh Notes 147 – 23 May 2018: *Packhouse Action Group Feedback*
• Fresh Notes 149 – 08 August 2018: *Packhouse Action Group Feedback*

Events

Packhouse Action Group Feedback Session 17 May 2018
Hortgro Science Research Showcase, Post-Harvest Projects 20 September 2018

Logistics projects are focussing on the optimisation of shipping container space utilisation.

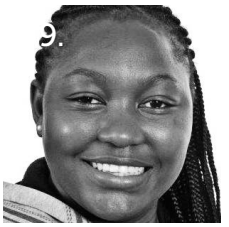
07”

It is important to have 10 – 15% of the research portfolio dedicated to more basic research in order to develop a fundamental understanding of fruit physiology.

Fundamental Understanding

Abstracts for these projects can be found on pages 240

It is important to have 10 – 15% of the research portfolio dedicated to more basic research in order to develop a fundamental understanding of fruit physiology. This often leads to solutions. There are elements of fundamental research in projects in the other categories. A current stone fruit project is looking at sugar metabolism of plums to categorise them according to their sorbitol content, and predict their storage regimes. This could potentially lead to a screening method for new cultivars.



Researchers and Students.

07.

Post Harvest Programme Leader

01. Richard Hurndall

Researchers

02. Dr Elmi Lötze

03. Dr Elke Crouch

04. Ms Anél Botes

05. Dr Patricia Mathabe

06. Dr Ian Crouch

07. Dr Olaniyi Fawole

Students

09. Ms Imke Kritzinger (PhD student)

10. Ms Taongashe Majoni (MSc student)

11. Mr Alone Hlungwani (PhD student)

Fundamental Understanding

New Projects

• Superficial scald on Granny Smith - understanding the mechanisms and limitations of the storage protocols used by industry and assess risk indicators in storage for scald development. (E Crouch, A Botes, P Mathabe, I Crouch and A Hlungwani)
• Profiling sugar metabolism and accumulation in plums as related to maturity, cultivar difference and postharvest storage regimes. (O Fawole and T Majoni)

Current Projects

• Postharvest moisture loss studies in Japanese plums (*Prunus salicina* Lindl). (E Lötze and I Kritzinger)

Events

Hortgro Science Research Showcase, Post-Harvest Projects 20 September 2018

A current stone fruit project is looking at sugar metabolism of plums to categorise them according to their sorbitol content, and predict their storage regimes.

The stone fruit post-harvest digital App, co-funded by PHI, started as a process to capture the embedded knowledge of senior Experico staff members, and more specifically, Arrie de Kock.

Technology Transfer

The stone fruit post-harvest digital App, co-funded by PHI, started as a process to capture the embedded knowledge of senior Experico staff members, and more specifically, Arrie de Kock. The App is in the final stages of development.

Events

Hortgro Science Research Showcase, Post-Harvest Projects 20 September 2018

Market Access

Abstracts for these projects can be found on pages 243

These projects are usually pre-emptive measures to deal with future anticipated problems. The carbon calculator has become a necessity to be able to do business in major export markets. Refer to Crop Protection for the development of a PHI funded container-based ethyl formate application system.

Researchers and Students.

07.

Researchers and Students. 07.

Post Harvest Programme Leader

01. Richard Hurndall

Crop Production Programme Manager

02. Prof Wiehann Steyn

Crop Protection Programme leader

03. Mr Matthew Addison

Researchers

04. Dr Shelley Johnson

05. Ms Anél Blignaut

Students

06. Ms Renate Smit (PhD student)

Market Access

Current Projects

• Confronting Climate Change Initiative (A Blignaut)

Completed Projects

• CATTS and ethyl formate fumigation as post-harvest phytosanitary treatments for stone and pome fruit and associated phytosanitary insect pests. (S Johnson and R Smit) – *see Phytosanitary*

Publications

• SAFJ April/May 2018: Johnson S. *Setting the CATTS among the pests*
• SAFJ August/September 2018: Blignaut A. *Confronting Climate Change: Understanding and addressing your hotspots*
• Fresh Quarterly June 2018: Beerwinkel E. *Yin and Yang: Understanding the Cold Sterilisation of Dual Temperature Plums*
• Hortgro Science Technical Symposium Summary: *Prevention is better than cure: Food safety and the consumer (C Lamprecht)*

Events

Hortgro Science Research Showcase, Post-Harvest Projects 20 September 2018

The carbon calculator has become a necessity to be able to do business in major export markets.

Return on Investment

Abstracts for these projects can be found on pages 245

"Why are you doing the research and what is the impact of that research" is a common and legitimate question that funders ask of researchers and research organisations. Hortgro Science, as a manager of research, requires an objective and ongoing measurement tool or matrix of tools to help quantify the outputs of research conducted. The Centre for Research on Evaluation, Science and Technology (CREST), based in the Faculty of Arts and Social Sciences at Stellenbosch University, has research evaluation and impact assessment studies as one of the core focus areas. The listed project is part of the process of addressing the identified need.

Researchers and Students. 07.

Researchers

01. Dr Nelius Boshoff

Students

02. Mr Harrie Esterhuyse (PhD student)

Current Project

• Developing a research information system for two South African agricultural industries: Learning about the impact of funded research. (N Boshoff and H Esterhuyse)

2017/18 Annual Report.

08.

Communication.

Hortgro Science.

“If a tree falls in a forest and no one is around to hear it, does it make a sound?”

This question on observation and perception can also be applied to research and how it is channelled to the industry.

Our overall communication strategy at Hortgro Science is to simplify research and keep our clients informed on the latest technologies to keep their businesses—and the entire industry—thriving. Namely, we want you to hear that metaphorical tree fall.

Since last year, the Hortgro Science team laboured to revitalise our image by updating our website, our annual report’s structure and look, modernising the Fresh Notes and Timely Hints technical bulletins, and creating a new popular science magazine covering industry funded research namely the *Fresh Quarterly* (which can be read and downloaded via our website).

Our researchers still produce semi-scientific content for the South African Fruit Journal which is sent to growers bi-monthly and which can also be accessed on www.safj.co.za. Apart from the above-mentioned channels of communication, we like to engage with our clients online. As part the greater Hortgro group, we share the latest in industry and research news in the monthly Hortgro News electronic newsletter, and on our social media platforms which include Facebook, Twitter, Instagram, and YouTube. To connect with us on these platforms, please search @Hortgro.

This past year we also hosted a range of events to engage with industry members. These events include a *Bactrocera dorsalis* workshop, Langkloof Seminar and Orchard Walk, Orchard of the Future Orchard Walks, Packhouse Action Group Feedback Sessions, the Hortgro Technical Symposium, and Research Showcase.

We also provided summaries and feedback of these events including a Hortgro Technical Symposium Summary Report and Summary Videos, Fresh Notes on our workshops and feedback sessions and various event updates on our social media platforms. A full list of events and attendance figures can be found in the Year at a Glance section of this report.

All other information regarding what we do and how we can help our industry’s growers is also available on our Hortgro and Hortgro Science websites.

Esté Beerwinkel, Science Communications Specialist

2017/18 Annual Report.

09.

Support Structures

Hortgro Science.

Support Structures

Hortgro Science is dependent on its extensive support structures that are made up of colleagues and role-players in the deciduous fruit industry. Approximately 200 individuals tirelessly give of their time, intellect and passion to serve the needs of the industry. The various committees that service the needs of Hortgro Science are noted below. We extend our heartfelt thanks and gratitude to each one of these individuals who have contributed to Hortgro Science.

Hortgro Science Advisory Council

01. Stephen Rabe – Chair	02. Grant Smuts – Vice-Chair
03. Linde du Toit	04. Matthew English
05. Joseph Hendricks	06. William Myburgh
07. Charl Stander	08. Louis von Broembsen

Peer Work Groups

Objectives of PWG

- Evaluate the scientific correctness of prioritised new research proposals
- Evaluate scientific standard of progress and final reports

Entomolgy Peer Work Group

01. Matthew Addison	02. Dr Brian Barnes
03. Hugh Campbell	04. Dr Martin Gilbert
05. Richard Hurndall	06. Dr Welma Pieterse
07. Dr Ken Pringle	08. Prof Wiehann Steyn

Soil Science Peer Work Group

01. Hugh Campbell	02. Dr Nigel Cook
03. Dr Eduard Hoffman	04. Richard Hurndall
05. Nelius Kapp	06. Dr Pieter Raath
07. Prof Wiehann Steyn	08. Dr Nicky Taylor
09. Dr Johan van Zyl	

Horticulture Peer Work Group

01. Hugh Campbell	02. Dr Nigel Cook
03. Richard Hurndall	04. Prof Gerard Jacobs
05. Jakkie Stander	06. Dr Piet Stassen
07. Prof Wiehann Steyn	08. Dr Nicky Taylor
09. Prof Karen Theron	

Pathology Peer Work Group

01. Matthew Addison	02. Lindi Benic
03. Hugh Campbell	04. Dr Johan Fourie
05. Richard Hurndall	06. Prof Lise Korsten
07. Dr Cheryl Lennox	08. Prof Adele McLeod
09. Prof Wiehann Steyn	10. Ferdi van Zyl
11. Prof Altus Viljoen	

Post-Harvest Peer Work Group

01. Hugh Campbell	02. Dr Paul Cronje
03. Dr Elke Crouch	04. Richard Hurndall
05. Prof Marius Huysamer	06. Dr Nhlanhla Mathaba
07. Prof Linus Opara	08. Prof Wiehann Steyn
09. Prof Karen Theron	

Technical Advisory Committees

Objectives of TACs

- Identify industry research needs or gaps
- Determine relevance of concept proposals
- Prioritise new project proposals
- Evaluate technical merits of progress and final reports
- Identify technology transfer opportunities
- Advisory to Hortgro Science

Crop Production Technical Advisory Committee

01. Daan Brink	02. Dr Nigel Cook
03. Peter Dall	04. Pierre du Plooy
05. Andrew Hacking	06. Hammies Hamman
07. Chris Jurisch	08. Nelius Kapp
09. Willie Kotze	10. Graeme Krige
11. Hannes Laubscher	12. Anton Muller
13. Stephen Rabe	14. Louis Reynolds
15. Mico Stander	16. Prof Wiehann Steyn
17. Christo Strydom	18. Tobie van Rooyen

Crop Protection Technical Advisory Committee

01. Matthew Addison	02. Lindi Benic
03. Nico Ferreira	04. Jacques Fouche
05. Gustav Groenewald	06. Andrew Hacking
07. Richard Hurndall	08. Anton Muller
09. Hendrik Pohl	10. Dr Ken Pringle
11. Stephen Rabe	12. Sheila Storey
13. Fanie van der Merwe	14. Steven Versfeld
15. Bekker Wessels	16. Martin Wohlfarter

Post-Harvest Technical Advisory Committee

01. Lindi Benic	02. Lohan Bester
03. Malcolm Dodd	04. Elizabeth Downes
05. Petru du Plessis	06. Jacques du Preez
07. Nico Ferreira	08. Anton Gouws
09. Henk Griessel	10. Richard Hurndall
11. Angelique Marais	12. Jaco Moelich
13. Bibbie Potgieter	14. Margaret Reinecke
15. Grant Smuts	16. Charl Stander
17. Adriaan Theron	18. Karin van Rensburg

Technology Transfer Advisory Committee

01. Matthew Addison	02. Esté Beerwinkel
03. Keith Bradley	04. Hugh Campbell
05. Dr Nigel Cook	06. Dr Ian Crouch
07. Peter Dall	08. Pierre du Plooy
09. Thea van Zyl	10. Linde du Toit
11. Richard Hurndall	12. Graeme Krige
13. Stephen Rabe	14. Charl Stander
15. Elise-Marie Steenkamp	16. Prof Wiehann Steyn
17. Christo Strydom	18. Marinus van der Merwe
15. Charl van Rooyen	16. Tobie van Rooyen

Advisory and Focus Workgroups

Objectives of Advisory Groups

• Assist programme with formulation of strategic research planning in defined areas of research
• Identify new technologies of relevance
• Seek collaborative research opportunities across local and international research/technical organisations
• Seek funding opportunities to ensure inputs into targeted research focus areas
• Meetings as required
• Advisory to programme manager

Objectives of Focus Groups

• Convene specific expertise to deal with specific industry issues
• Identify research requirements
• Evaluate research findings and make recommendations
• Identify technology transfer opportunities and communicate findings to industry via appropriate forums

- CA And Post-Harvest Group
- Dormancy Workgroup
- DPA Focus Group
- Farming Technology Workgroup
- Fruit Eating Quality Workgroup
- Fruit External Quality Workgroup
- Growing Season Climate Workgroup
- Integrated Pest Management Group
- Irrigation And Nutrition Workgroup
- Orchard Of The Future Workgroup
- Packhouse Action Group
- Post-Harvest Pathology Group
- Reproductive Biology Workgroup
- Rootstock And Nursery Tree Quality Workgroup
- Rootstock Evaluation Committee
- Soil Health Workgroup
- Spray Application Group

10.

The year at a glance.

10”

For those who enjoy graphs and charts, or perhaps prefer packaged highlights of the year’s activities, the following pages provide a snapshot overview of the 2017-18 year.

The year at a glance

For those who enjoy graphs and charts, or perhaps prefer packaged highlights of the year’s activities, the following pages provide a snapshot overview of the 2017-18 year.

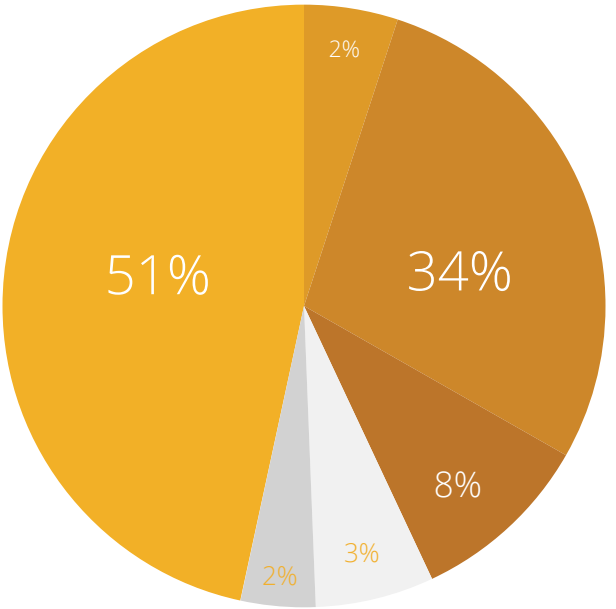
Information on our funding, projects and students is captured in the following graphs and tables.

Funding

External Funding Leveraged

This chart illustrates external funds leveraged as a result of industry project funding for the 2017/18 financial year.

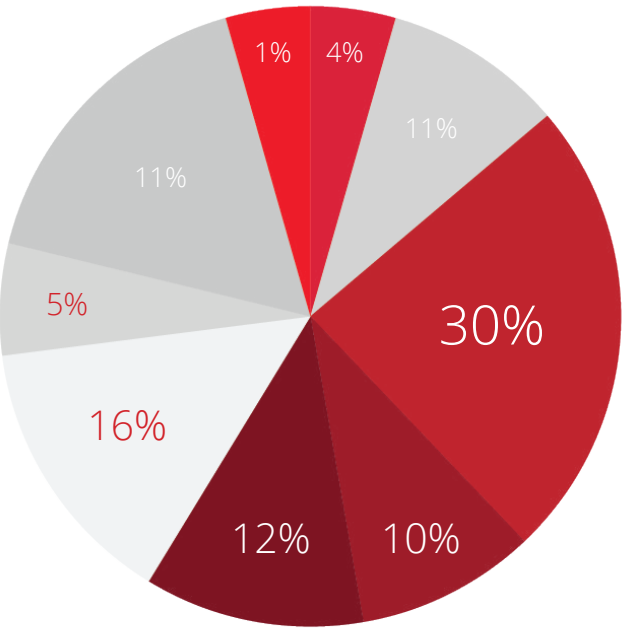
2017-18 Funding



- Pome/Stone Levy (Projects) - 51%
- Other Industries - 8%
- THRIP - 2%
- PHI - 3%
- Parlimentary grant (ARC) - 34%
- WCDoA - 2%

Funding allocations 2017-18

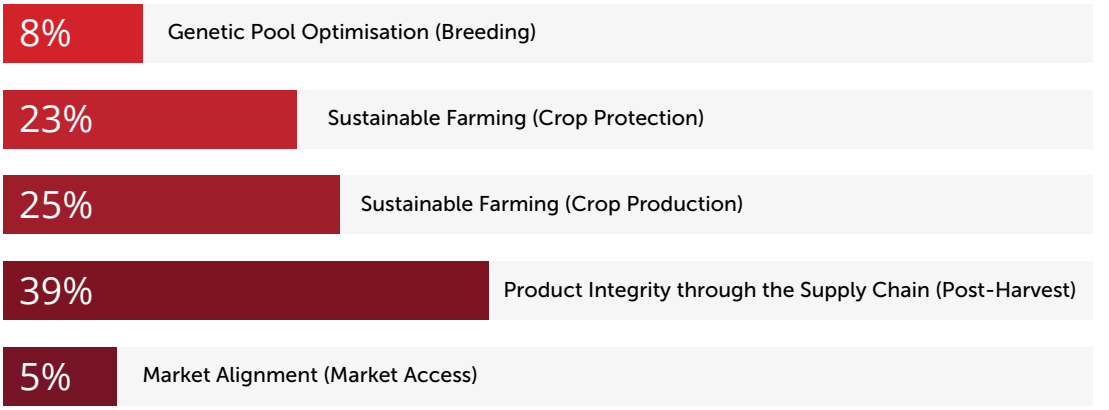
This chart illustrates the distribution of the industry's funding for research.



- ARC Project - 4%
- ARC Breeding - 11%
- Stellenbosch University - 30%
- ExperiCo - 10%
- Other research institutes - 12%
- Research Posts - 16%
- Tech Transfer - 5%
- Prog / project man / Tech services - 11%
- International congress etc - 1%

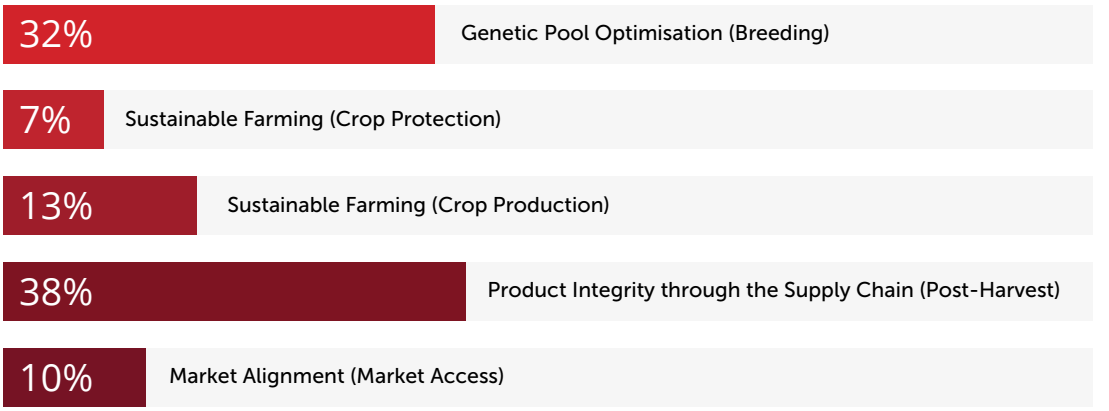
Investment per research focus area for 2017-18.

Pome Fruit



Investment per research focus area for 2017-18.

Stone Fruit



Executive Summary

Summary of research projects 2017-18, including market access projects

Description	Projects	Pome Fruit	Stone Fruit
Projects completed in 2017-18	28	21	09
Projects continuing in 2017-18	85	54	43
New projects in 2017-18	31	23	16
Total projects in 2017-18	116	77	59

Note: 20 projects are co-funded by Pome & Stone Fruit

Research projects by research institution from 2016-18

Research Institute	2016/17	2017/18
ARC Infruitec-Nietvoorbij	24	20
ARC Breeding	*16*	*15*
ARC Research Projects	*08*	*05*
Stellenbosch University	36	49
Dept Horticulture	*12*	*15*
Dept Pathology	*07*	*08*

Research Institute	2016/17	2017/18
Dept Entomology	*16*	*21*
Dept Engineering		*02*
Dept Soil Science	*01*	*01*
Dept Logistics		*01*
CREST		*01*
Hortgro Science Technical Services	20	04
ExperiCo	21	17
CA Science	01	01
Nemlab	02	01
Blue North	01	01
University of Pretoria	03	02
Dept Zoology	*01*	
Dept Soil Science	*01*	*01*
Dept Pathology	*01*	*01*
CSIR	01	01
Westcape Biotech	02	02
Provar	05	12

Research projects by research institution from 2016-18

Research Institute	2016/17	2017/18
Consultants		06
C Jarmain		*01*
P Stassen	*03*	*03*
SAPO		*01*
T Ware		*01*
Total number of Projects	116	116

Average cost per year

This graph illustrates the average cost per project per year, including inflation, over the past few years. The average cost is influenced by the nature of the research, as well as other factors such as external funding and student bursaries.

Students and Transformation

Transformation in research from 2013 - 2018

These tables show the percentage of projects with women leaders, projects with black leaders, and projects with postgraduate students.

% Projects with a female project leader

2013/14	2014/15	2015/16	2016/17	2017/18
37	53	44	42	39

% Projects with a black project leader

2013/14	2014/15	2015/16	2016/17	2017/18
13	22	22	22	20

% projects with a postgraduate student

2013/14	2014/15	2015/16	2016/17	2017/18
35	33	34	29	44

Profiles of Students working on Hortgro Pome and Stone funded projects

This table depicts the profile of the 59 postgraduate students working on projects funded by Hortgro Pome and Hortgro Stone.

Degree	Black Male	Black Female	White Male	White Female	Total
Hons		03	03	02	08
MSc	07	05	04	09	25
PhD	06	05	03	07	21
Postdoc	01			04	05
Total	**14**	**13**	**10**	**22**	**59**

Total bursary cost to Hortgro Pome and Hortgro Stone

R 3,416,000

Events List and Attendance Figures

The primary focus of technology transfer and communication within Hortgro Science is to close the research loop, that is, ensure that the research results get back to the users of the technology. This section summarises the events used to communicate with our growers and technical people in the industry.

CA Meeting

07. November 2017 | Stellenbosch | 78 Attendees

Bactrocera dorsalis workshop

30/31. November 2017 | Stellenbosch | 35 Attendees

Langkloof Seminar and Orchard Walk

04. December 2017 | Louterwater | 76 Attendees
SAFJ April/May 2018: Steyn W. *Langkloof boordstap en seminaar, Desember 2017*

Orchard of the Future

02. February 2018 | Grabouw | 86 Attendees

Orchard of the Future

12. April 2018 | Ceres | 72 Attendees

Packhouse Action Group Feedback Session

17. May 2018 | Groot Drakenstein | 27 Attendees

Hortgro Science Technical Symposium

28/01 May - June 2018 | Somerset West

Attendance figures:

- Pome Fruit Technical Tour – 214
- Stone Fruit Technical Tour - 117
- Fruit Farming 101 - 213
- Pre-Harvest Day 1 - 373
- Pre-Harvest Day 2 - 339
- Post-Harvest Day - 162

Research Showcase

18/20 September 2018 | Stellenbosch

Attendance figures:

- Crop Protection - 112
- Crop Production - 101
- Post-Harvest - 118

This section summarises the events used to communicate with our growers and technical people in the industry.

Awards

The following awards were made during the 2017/18 year. Hortgro Science would like to congratulate the award winners.

Hortgro Science / Daan Strydom Award for Best Student in Horticulture 2017

Marno van der Westhuizen

Best presentation by a student at the Research Showcase 18-20 September 2018

Integrated management of the control of false codling moth, *Thaumatotibia leucotreta*, on deciduous fruit, with focus on biological control. (VM Steyn)

Best final reports of 2018

- Evaluation of peach rootstocks, Evaluation of apricot rootstocks, and Evaluation of plum rootstocks (P Stassen)

- Survey of stem cankers and dieback symptoms of young apple trees and possible inoculum sources (L Mostert)

Overseas Tours and Sponsorship

South African researchers in the deciduous fruit industry continue to engage on an international level with researchers from around the world. The industry assisted in the financing of 3 international visits of South African researchers and research staff to international congresses and meetings during this past year. Hortgro Science also co-funded one event in South Africa that created greater exposure to our researchers, technical community and growers.

Visit by Australian fruit fly management expert, Andrew Jessup

26 November – 02 December 2017 | Co-sponsored with FruitFly Africa

Mass-Rearing of Insects Workshop, Stellenbosch, South Africa

23-27 October 2017 | Sponsored attendance of two scientific technicians from Plant Health Diagnostic Services (PHDS), the official plant health laboratory for the Department of Agriculture, Forestry and Fisheries (DAFF).

Apple Dormancy Workshop, Addis Ababa, Ethiopia

09-13 October 2017 | Attended by Prof Wiehann Steyn

Biobased Coatings Europe 2018, Antwerp, Belgium

20-21 June 2018 | Attended by Dr Olaniyi Fawole

Israeli Tour and XXX International Horticultural Congress (IHC2018), Istanbul, Turkey

05 August – 18 August 2018 | Attended by Hugh Campbell, Prof Wiehann Steyn and Dr Xolani Siboza

Hortgro Science Representation on Committees and Boards

Hortgro Science represents Hortgro Pome and Hortgro Stone as follows:

Elise-Marie Steenkamp

01.

- Hort Forum
- Fruit SA Communications Committee
- Stronger Together Steering Committee
- Agri's Got Talent Planning Committee
- Deciduous Fruit Gala Evening Committee
- Western Cape Government Drought Strategic Communications Committee

Hugh Campbell

02.

- Post-Harvest Innovation (PHI) Management Committee
- Plant Improvement South Africa (Plant SA) – Combined Board DPA & VIA
- Deciduous Fruit Plant Improvement Association (DPA) – Hortgro Pome Representative on Board
- Deciduous Fruit Plant Improvement Association Technical Committee - Chairman
- Western Cape Government Rural And Agriculture Sector Support Committee On Drought And Water Security
- *Bactrocera Dorsalis* National Steering Committee
- Polyphagous Shot Hole Borer Steering Committee
- National Agricultural Research Forum Steering Committee
- Western Cape Agricultural Research Forum
- Confronting Climate Change – Chairman
- Crop Protection Advisory Group (CPAG)
- SIZA Environmental Verification workgroup

Ken Pringle

03.

- Crop Protection Advisory Group (CPAG)
- Phytosanitary Risk Forum

Matthew Addison

04.
- Water Research Commission reference group: An Integrated approach to managing and mitigating the risk of agricultural nonpoint source pesticide pollution to the aquatic environment
- Polyphagous Shot Hole Borer National Steering Committee.

Richard Hurndall

05.
- Pome Joint Marketing Forum
- Stone Joint Marketing Forum
- Project Rebirth – national fresh produce markets
- Packhouse Action Group
- CA and Post-harvest Group
- Forelle Producer Association
- SA Pink Lady Association – technical representative
- DPA Work Group
- AfricaBio representative

Shelley Johnson

06.
- Phytosanitary Risk Forum
- Phytosanitary Measures Research Group
- Grain Chinch Bug Focus Group

Wiehann Steyn

07.
- Water Research Commission reference group: Investigating the potential of fixed and draped netting technology for increasing water use productivity and water savings in full bearing apple orchards under micro-irrigation
- Western Cape Agricultural Research Forum

Xolani Siboza

08.
- South African Society for Horticultural Sciences Board member
- Stellenbosch University-AgriSciences: Recruitment and Marketing Committee

Publications

Here is a list of all Hortgro Science related articles from 2017/18 that were published in the SAFJ, Fresh Quarterly and Fresh Notes.

SAJF

October/November 2017

• Wessels BA, Linde CC, Fourie PH, Lennox C, Mostert L. *New insights into the population dynamics and fungicide resistance of Botrytis cinerea in pear orchards*
• Lötze E, Van Zyl FJ, Taylor N. *White root growth dynamics of bearing apples trees in the Elgin area*
• Wilson I. *Fine-tuning Fungicide Application: A new perspective on the control of postharvest decay in stone fruit*

December/ January 2018

•Johnson S. *Phytosanitary Measures Research Group Meeting 2017*
• Van Zyl SA. *Impact of selected orchard spray application technologies and tree phenology on deposition properties on the leaf and fruit surfaces of apple trees*
• Viljoen HW, De Kock VA. *Fine-tuning the determination of optimum harvest maturity of cold stored African Delight® plums*
• Lennox C, Den Breeyen A, Meitz-Hopkins J. *Management of postharvest diseases of apples using appropriate methods: A South African perspective*
• *Hortgro Science Irrigation Seminar 2017—Farm Planning: Get all the experts around the table*
• *Hortgro Science Irrigation Seminar 2017—Pipeline Economics: Cheaper isn't always better*
• *Hortgro Science Irrigation Seminar 2017—Micro-irrigation Options: Time to rethink the use of low volume irrigation systems*
• *Hortgro Science Irrigation Seminar 2017—Irrigate–Monitor–Adjust: The irrigation cycle*
• *Hortgro Science Irrigation Seminar 2017—Water Availability: Future outlook for the Western Cape and implications for fruit growers*
• *Hortgro Science Irrigation Seminar 2017—Fruitlook supports efficient farming*
• *Hortgro Science Irrigation Seminar 2017—Function of water during different phenological stages: Phenology and water in the fruit tree*
• *Hortgro Science Irrigation Seminar 2017—Stages for irrigation practices during drought with plant phenology taken into consideration: Developing a drought based on plant physiology*
• *Hortgro Science Irrigation Seminar 2017—Practical experience regarding the effects of drought and drought management: A farmer's perspective on drought management*

February/ March 2018

- James M, Malan A, Addison P. *Can local natural enemies control the Mediterranean fruit fly?*
- Steyn W. *Travelling East, Down Under and to hell and gone...*
- McDonald D, Steyn W. *M9 not a 'weak' rootstock, studies show*

April/ May 2018

- Steyn W. *Langkloof boordstap en seminaar, Desember 2017*
- Johnson S. *Setting the CATTS among the pests*
- Crouch E. *Can mealiness be nipped in the bud?*
- Jooste M. *What breaks a plum's heart?*

June/ July 2018

- Allsopp E, Knipe M. *Is a push-pull strategy for western flower thrips feasible?*
- De Kock, L. *Which carbon calculator to use for my farm or agri-business?*

August/ September 2018

- Blignaut A. *Confronting Climate Change: Understanding and addressing your hotspots*

Our Fresh Quarterly content focuses on why the research was done, lessons learnt and its benefit to the industry.

Fresh Notes

• Fresh Notes 137—17 Oct 2017
Monitoring Guidelines for Bactrocera dorsalis

• Fresh Notes 139—10 Nov 2017
Evaluations and Recommendations for Atomising Systems on Plums

• Fresh Notes 140—5 December 2017
Packhouse Action Group Feedback

• Fresh Notes 141—13 December 2017
Andrew Jessup on Preventing the spread of Bactrocera dorsalis

•Fresh Notes 142—18 December 2017
Heat damage plums preharvest

• Fresh Notes 143—3 January 2018
Aanbeveelde protokol vir die risiko bestuur van graanstinkluis

• Fresh Notes 144—23 January 2018
Mites in a hot and dry 2017/18

• Fresh Notes 145—25 January 2018
Forelle Early Market Access (FEMA) Programme

• Fresh Notes 146—26 March 2018
Packhouse Action Group Feedback

• Fresh Notes 147—23 May 2018
Packhouse Action Group Feedback

• Fresh Notes 149—8 August 2018
Packhouse Action Group Feedback

Fresh Quarterly

June 2018

• Beerwinkel E. *Soil's Trojan horse*
• Beerwinkel E. *War on Pests: The Mass Production of a Biological Wonder Weapon*
• Steyn W. *The Oddity of Red Colour Development in Pears*
• Steyn W. *How to Achieve Good Red Colour in Apples and Pears*
• Steyn W. *The Recipe for Green Colour in Green Apples*
• Beerwinkel E. *Yin and Yang: Understanding the Cold Sterilisation of Dual Temperature Plums*

September 2018

• Midgley S, Steyn W, Schmeisser M. *What you need to know about orchard water use*
• Beerwinkel E. *Thirst trap – How much water do high performing apple orchards need*
• Beerwinkel E. *Stranger things – Invasive alien plants' coup of water catchment areas*
• Mouton A. *Internal browning in 'Fuji'*
• Mouton A. *When pink apples go brown*

Scan the QR code to visit the respective websites or publications. Alternatively visit www.hortgro-science.co.za.

How does it work?

1. Visit the Google Play Store (for Android), App Store (for Apple) or Microsoft Store (for Windows) on your cellphone to download NeoReader or any other QR scanner app.

2. Open the app, scan the code and voilà

Hortgro Science website

Hortgro Science Technical Symposium Summary Report 2018

Fresh Quarterly Issue One

Fresh Quarterly Issue Two

Research Showcase Crop Protection videos

Research Showcase Crop Production videos

Research Showcase Post-Harvest videos

Researcher Affiliation

ARC Infruitec-Nietvoorbij

Crop Development and Horticulture

01. Mr Sonwabo Booi	02. Mr Taaibos Human
03. Mr Irwin Meintjes	04. Mr Werner Pieterse
05. Dr Khashief Soeker	

ARC Infruitec-Nietvoorbij

Plant Protection

01. Mr Mike Allsopp	02. Dr Rinus Knoetze
03. Mr Abraham Vermeulen	

ARC Infruitec-Nietvoorbij

Post-Harvest and Processing Technology

01. Ms Anél Botes	02. Ms Ester Lotz
03. Dr Patricia Mathabe	

ARC Infruitec-Nietvoorbij

Soil Science

01. Dr Johan Fourie	02. Dr André Meyer
03. Dr Theresa Volschenk	

Stellenbosch University

Department of Conservation Ecology and Entomology

01. Dr Pia Addison	02. Prof Antoinette Malan
03. Dr Nomakholwe Stokwe	04. Prof John Terblanche
05. Dr Ruan Veldtman	06. Dr Ken Pringle (seconded)
07. Dr Shelley Johnson (seconded)	

Stellenbosch University
Department of Horticultural Science

01. Dr Tarl Berry	02. Dr Elke Crouch
03. Dr Olaniyi Fawole	04. Dr Elmi Lötze
05. Dr Esmé Louw	06. Prof Stephanie Midgley
07. Prof Karen Theron	08. Dr Xolani Siboza (seconded)

Stellenbosch University
Department of Logistics

01. Prof Leila Goedhals-Gerber

Stellenbosch University
Department of Plant Pathology

01. Dr Cheryl Lennox	02. Prof Adele McLeod
03. Dr Julia Meitz-Hopkins	04. Prof Lizel Mostert

Stellenbosch University
Department of Process Engineering

01. Dr Robbie Pott

Stellenbosch University
Department of Soil Science

01. Dr Eduard Hoffman

02. Dr Johan van Zyl

Stellenbosch University
Centre for Research on Evaluation, Science and Technology (CREST)

01. Dr Nelius Boshoff

Hortgro contracted positions funded through research projects

01. Ms Laura Allderman

02. Dr Marelize de Villiers

Provar

01. Dr Iwan Labuschagne

Independent contractors

01. Dr André de Klerk	02. Dr Caren Jarmain
03. Dr Piet Stassen	04. Dr Tony Ware

University of Pretoria
Department of Microbiology and Plant Pathology

01. Prof Teresa Coutinho

University of Pretoria
Department of Plant Production and Soil Science

01. Dr Nicky Taylor

Council for Scientific and Industrial Research

01. Dr Sebinasi Dzikiti

Nemlab

01. Ms Sheila Storey	02. Ms Lené van der Walt

Westcape Biotech

01.	Dr Stephan Ferreira

ExperiCo

01.	Dr Ian Crouch	02.	Mr Arrie de Kock
03.	Mr Barend Pienaar	04.	Ms Heleen Tayler
05.	Mr Sybrand van Zyl	06.	Mr Daniël Viljoen
07.	Mr Handré Viljoen		

Blue North

01.	Ms Anél Blignaut

11.

Project Abstracts.

Pome Fruit Breeding and Evaluation

01. *Breeding of pear cultivars. (JP Human and S Ntladi)*

Objectives and Rationale

The aim of this project is to provide the South African pear industry with new, well- adapted blushed cultivars for fresh consumption, meeting breeding objectives stipulated in the "Terms of Reference" document as well as with new processing cultivars.

Methods

The project uses conventional breeding techniques in generating genetic variation, establishing these seedlings in evaluation blocks and, once they start bearing, selecting the best for further commercial evaluation and maintaining germplasm.

Key Results

Phase 1 evaluation on bearing orchards at Drostersnes yielded thirty-two new selections. Small fruit samples of each selection were harvested, cold stored for eight weeks, and evaluated. After consulting with Culdevco, two fully red selections were assigned for further evaluation. This best selection, P18-20, harvested on 21 February, had a good appearance, attractive colour, good texture and taste and scored 24/30. Crosses by hand yielded 5 635 seeds, comprising 17% for blush, 55% for green and 28% for future genetic studies.

Conclusion and Discussion

The PBR application filed last year by DAFF (for the very early blush selection, P07-3, cultivar name of 'Cape Blush') was accepted under File no. PT 8410. Thirty-two new selections were initially selected in Phase 1 seedling orchards of which, after storage evaluation, two selections, P18-17 & P18-20, were promoted for further commercial evaluation in conjunction with Culdevco

02. *Planting and maintenance of existing and new germplasm of pome and stone fruit (W Pieterse, L Kwalimba and T Nyawo) – also Stone Fruit Breeding Programme*

Objectives and Rationale

The main objective is to maintain a clonal genebank of existing and newly imported cultivars, selections and species of pome and stone fruits, important to South African horticulture or research, and especially as a source of breeding material for the ARC programmes to develop improved deciduous fruit cultivars.

Methods

Typically, two or three trees per accession were maintained in field genebanks at Bien Donné, Drostersnes and Elgin.

Key Results

Four accessions in the pear collection were used as female parents and two were used as pollen donors in crosses of the breeding programme. Four new accessions were added to the pear collection comprising one ARC selection, two European pear cultivars, and one Japanese pear. A number of accessions were used in apple crosses, e.g. to combine the lower-chill phenotype with Vf scab resistance from 'Prima' and 'Priscilla', or to improve the general sensory of lower-chill selections through crossing with well-established commercial cultivars. A new peach rootstock HBOK1 with useful ring nematode resistance should be imported. Cuttings taken in the genebank from ARC-bred stone-fruit rootstock selections were rooted and top worked with scion varieties, and planted on different commercial farms. The MSc students, Lawrence Kwalimba and Thembeka Nyawu, graduated in December and the theses are available.

Conclusion and Discussion

Insights gained from the MSc theses are of great value to breeders and funding to continue future molecular analysis should be encouraged.

The new peach rootstock HBOK1 with ring nematode resistance should be imported from the United States.

03. *Cold storage characteristics of new cultivars and selections. (E Lotz) – also Stone Fruit Breeding Programme*

Objectives and Rationale

New selections from the ARC Breeding programme are evaluated for cold storage ability as part of the evaluation phase of new selections.

Objectives

• To evaluate new stone and pome fruit cultivars and selections from the Cultivar Development Programme of ARC Infruitec-Nietvoobij for cold storage ability
• To supply the researchers of the Cultivar Development Division with cold storage data and recommendations which will assist them and other stakeholders to decide on the future of new selections
• To remove selections that consistently perform poorly from the programme so that resources can be utilised more efficiently and the focus of the programme can be directed towards creating better genetic combinations
• To accumulate cold storage data of new selections in a database

Methods

Each fruit sample is stored according to a fruit kind specific cold storage protocol, designed in consultation with stakeholders. Appropriate maturity and quality evaluations are performed according to protocol. Cold storage data is integrated into the database of the Cultivar Development programme together with production data of new selections. Photographs of fruit at final evaluation are also recorded.

Key Results

Fruit were received for cold storage from 3 November 2017 until 13 March 2018. A total number of 215 fruit samples were received for cold storage during the 2017/18 season. Data and recommendations were compiled in MS Excel datasheets and shared with ARC cultivar development researchers. Feedback aimed at improving production practices (decay, insect damage and harvesting maturity) were also shared. The incidence of decay was again low. This can be attributed to lower than average rainfall experienced in the Western Cape for a third consecutive season. Fruit size was generally small.

Conclusion and Discussion

Storage data and recommendations on the cold storage ability of 215 samples were made to the relevant researchers of the Crop Development division of ARC Infruitec-Nietvoorbij. The data will contribute to the knowledge about new selections to ultimately improve the outputs of the breeding programme.

04. *Phase two evaluation of pears in the Western Cape. (MK Soeker)*

Objectives and Rationale

The project aims to evaluate locally bred pear selections and industry standard cultivars to identify new pears suitable for local as well as overseas markets.

Methods

Selections from the ARC Phase I breeding programme are planted in replicated trials and assessed for cropping and fruit characters after cold-storage.

Key Results

Fifty-one predominantly blush selections were harvested from Phase II plots and evaluated for fruit quality, after eight weeks in cold storage, and tested for cold storage ability at the Post Harvest Division at ARC Infruitec-Nietvoorbij. Of these, 13 selections stored well, eight were average and 13 were below average, while 17 did not store well. The best selection for blush, P07-3, scored 80% for consumer traits. No selections were tested for canning ability during the season. Sixty-eight selections will not be evaluated further in Phase II during the coming season. Fourteen new Phase II selections were planted at Elgin Experimental Farm in 2017 and these will be the last selections planted in Phase II. Preliminary GC-MS results of the decadienoate ester, which is reported to give 'Bartlett' its unique flavour, showed that this compound is not present in 'Rosemarie', as was initially suspected.

Conclusion and Discussion

P07-3 once again proved to be the best selection overall, but this has already been evaluated for 5 years and is already propagated in Phase III. Although many of the P10 range were attractive w.r.t appearance and blush, not many of them performed well during cold-storage trials. The selections that made the cut, as well as the P11 range, will be evaluated in the coming season. An in-depth study into the aroma of 'Rosemarie' needs to be started to identify the compounds responsible for its aroma, as preliminary results show that the decadienoate ester (from 'Bartlett') is not present in 'Rosemarie', as was initially suspected.

05. Phase two evaluation of apples in the Western Cape. (MK Soeker)

Objectives and Rationale

The project aims to evaluate ARC bred apple selections in order to identify well-adapted and promising apples, which produce heavy crops of quality fruit acceptable to all markets, locally as well as overseas.

Methods

Selections from Phase 1 are planted in replicated trials and assessed for cropping and fruit characteristics after storage.

Key Results

A total of 10 selections were harvested from Phase II orchards at Elgin Experimental Farm and evaluated and tested for cold storage ability at the Post Harvest Division at ARC Infruitec-Nietvoorbij. Of these, five stored well, five were average and one needs to be re-evaluated. The best selections, after quality assessment, were: 4-57-69, low chill, striped, 79%; A09-4, full red, 76%; 4-61-35, bicolour, 80% with balanced taste and excellent flavour and texture; and A09-55, striped, scoring 68% overall. Nine selections were identified for removal after the 2017/18 season, while 13 new selections (A15-1 to A15-13) were planted at Elgin in September 2017. Malic acid markers, developed and optimised in 2016, were used to screen the most promising Phase II selections. Results are not reported. For incompatibility, the SRB1 consensus primers were used to determine the S-genotypes of 88 Phase II selections. Results of selected Phase II selections are available on request.

Conclusion and Discussion

Feedback from industry contacts regarding selection A09-4 was positive, in 2017. This selection was fast-tracked and trees propagated for planting in a semi-commercial orchard later this year. The Phase II evaluation are on maintenance budgets, with reduced funding.

No further plantings are planned until funding formally concludes in the near future.

Stone Fruit Breeding and Evaluation

01. Breeding apricot cultivars for commercial and emerging farmers. (W Pieterse)

Objectives and Rationale

This project aims to breed yellow and blushed apricots for fresh consumption and for processing to extend the range and season of cultivars that are easy to grow and sell, while staying abreast of the recent developments in breeding and molecular genetics of stone-fruit research.

Methods

Traditional breeding practices and genebank maintenance are complemented by THRIP funded molecular marker work to fingerprint germplasm and move towards marker-assisted selection. Hortgro Science asked the ARC to place the breeding programme on hold for dessert fruit and only to perform maintenance as an interim measure until approval of the new terms of reference and project proposals.

Key Results

Five selections have been made. Negotiations with industry are in an advanced state to find a new site for the evaluation of seedlings derived from crosses. Two crosses were made aimed at processing. The apricot crosses planted at Robertson are doing very well and will be evaluated for the first time in 2018.

Conclusion and Discussion

The selection of crosses available in the nursery in collaboration with industry partners will put the breeding programme on a good footing once the negotiations with industry are concluded and a new site to plant an evaluation orchard has been identified.

02. *Breeding of peaches and nectarines for commercial and emerging farmers. (W Pieterse and L Kwalimba)*

Objectives and Rationale

The ARC peach and nectarine breeding programme focuses on developing cultivars with good cold storage ability adapted to the South African growing conditions and fruit quality traits aligned to the demands of the target markets – fresh, dried and canning - which include emerging farmers. This sets it apart from foreign breeding programmes.

Methods

Hortgro Science asked the ARC to place the breeding programme for fresh fruit on hold and to focus on maintenance as an interim measure until approval of the new terms of reference and project proposals. Planning of crosses and seedling selection is mainly based on fruit quality.

Key Results

The seedlings derived from crosses for the processing industry planted at Robertson are doing very well and will be ready for evaluation in 2018. Three crosses were performed to develop cultivars for the dried fruit industry and open pollinated seeds were collected with a view to rear seedlings suitable for canning. Negotiations with industry on the way forward are making progress.

Conclusion and Discussion

Despite the severe drought experienced on Bien Donné, all seedlings could be kept alive and once the new industry strategy concerning peach breeding is finalised, breeding can continue in all earnest.

03. *Breeding of new peach rootstocks for the first and second economy. (S Booi)*

Objectives and Rationale

The objectives for the current study were to screen rootstock hybrids for resistance to ring nematode (*Criconemoides xenoplax*) and another objective was to screen an apricot progeny for root-knot (*Meloidogyne javanica*) resistance under glasshouse conditions.

Methods

In the 2017/18 season, 24 ARC-bred stone-fruit rootstock selections (peaches, plums, apricots and interspecies) and 3 commercial rootstock varieties were screened for ring nematode resistance in five replicates. An apricot progeny consisting of 67 seedlings was randomly screened for root-knot nematode resistances in the Asbestos Glasshouse at Bien Donné Research Farm. In May 2018, 825 cuttings from 24 ARC-bred hybrids and 9 commercial rootstock cultivars were rooted to raise plants for resistance screening trials in 2018.

Key Results

From the twenty-four new ARC-bred selections screened for ring nematode species, nineteen were tolerant and five were susceptible to this nematode species. From the sixty-seven apricot seedlings screened for root-knot nematode species *M. javanica*, 16 showed no symptoms of galling in their root system, therefore these seedlings were considered resistant to root-knot nematode *M. javanica*. None of the rooted cuttings survived due to drought experienced last season.

Conclusion and Discussion

All milestones scheduled for 2017/18 season have been met, except the cuttings that were rooted in the nursery. All tolerant rootstock selections screened for ring nematode resistance and apricot seedlings screened for root-knot nematode resistance will need to be screened in a second resistant trial test to confirm their resistances.

04. *Breeding of Japanese plums for commercial and emerging farmers (incorporating the S-genotyping work determining compatibility of plum cultivars). (W Pieterse and T Nyawo)*

Objectives and Rationale

The aim of this project is to breed a full range of high quality yellow, red, and black Japanese plum cultivars, that ripen from very early to very late in the season and that are easy to grow and easy to sell. This involves staying abreast of the latest developments in breeding practices and the industry.

Methods

Hortgro Science requested the ARC to place the breeding programme on hold and only to perform maintenance as an interim measure until approval of the new terms of reference and project proposals.

Key Results

The seedlings in Phase 1 orchards were kept alive and an orchard has been prepared on the Robertson farm to plant a new orchard of trees derived from crosses. However, the site of a new planting will only be determined after conclusion of negotiations and the crosses to be planted will be selected in collaboration with industry representatives.

Conclusion and Discussion

The renewed relationship with Industry is very positive and we are looking forward to a mutual beneficial partnership.

05. *Evaluation of stone fruit in the summer rainfall region. (I Meintjes)*

Objectives and Rationale

The project aims to evaluate and release new peach, nectarine, plum and apricot selections in the Summer rainfall regions, which are better adapted to the various microclimates than the existing range of commercial cultivars, and to fill gaps in the harvesting and marketing season.

Methods

Fruit samples were harvested weekly from October to January at the two trial sites in Limpopo, Bufland Farm at Mookghopong, and Ginger Gypsy Farm at Modimole, and subjected to horticultural evaluation, where after the data were captured on a MS Access database.

Key Results

Observations were conducted on 212 Phase II and Phase III selections at the two evaluation sites in Limpopo, Mookghopong Bufland Farm, Ginger Gypsy farm, and 88 peaches and 21 nectarines were harvested and evaluated. Currently 13 promising selections (10 peach, 3 nectarine) should be re- evaluated in the 2018 season. Possible promotion to Phase III should be discussed in collaboration with Culdevco. Technology transfer was provided in terms of presentations to students from Unisa on 11, 25, 31 July, 15 August and 5 September 2017 at the ARC Infruitec-Roodeplaat demo block in Pretoria and at Bufland farm at Naboomspruit. A radio group talk with Mr and Ms Oosthuisen (SASPA representative for the northern area), his farm manager Mr J. van Staden and Mr I. Meintjes, ARC- Infruitec on farming with stone fruit and research on stone fruit was aired on "RSG Landbou" radio on 5 January 2018.

Conclusion and Discussion

The Phase II and Phase III evaluations and fruit exhibitions on the co-evaluator sites should continue. Final decisions in cooperation with Culdevco need to be taken on the 13 promising selections in order to create a short list for possible releases to the summer rainfall producers. One hundred and twenty- seven (127) selections remain for further evaluation in 2018 at both co-evaluator sites.

Special attention should be given to the selections already planted in Phase 3 semi-commercial blocks at the co-evaluator sites.

06. *Phase two evaluation of peach and nectarine selections in the winter rainfall region. (MK Soeker)*

Objectives and Rationale

The project evaluates locally ARC bred peach and nectarine selections adapted to South African growing conditions for the export, canning and drying industries.

Methods

Fruit samples were harvested each week from November 2017 to February 2018 at Bien Donné and Robertson Research Farms. No selections were planted in Phase II before the 2017/18 season. The samples were subjected to cold storage, canning and drying trials at the Post-Harvest and Agro-processing Technology Division. Representative fruit samples were also collected to evaluate their external and internal traits and the data captured on the MS Access database.

Key Results

Sixteen peach and seven nectarine selections stored well in the cold storage evaluation, and scored above 70%. Eleven peach selections, of which seven obtained 70% or higher in the final canning evaluation were submitted to Post-Harvest and Agro-processing Technology Division. One peach, five freestone nectarine and nine clingstone nectarine samples were submitted for drying evaluation, of which one peach, two freestone nectarines and four clingstone nectarines scored above 70%. At the request of Culdevco, several promising selections were given special attention regarding their horticultural traits. Fruit exhibitions are no longer held at ARC Infruitec-Nietvoorbij and are now held in collaboration with Provar, at their premises in Paarl. Several meetings were held with Culdevco, the processing industries, and its clients with regard to new peach and nectarine varieties.

Conclusion and Discussion

Meetings with the relevant industries were informative and priority lists for all industries were streamlined. Selections with complete data sets for the last 5 years will no longer be evaluated, and very old selections (older than 10 years) were removed from these lists. Only post-harvest and horticultural evaluations will continue in 2018/19. No new selections will be planted in Phase II at the Bien Donné and Robertson evaluation sites. Selections that did not perform well after three years of evaluation will be removed from the evaluation blocks at Bien Donné and Robertson Research Farms.

07. *Phase two evaluation of plum cultivars in the winter rainfall region. (MK Soeker)*

Objectives and Rationale

The project evaluates ARC bred plum selections adapted to South African growing conditions for the export industry.

Methods

Fruit samples were harvested each week from November 2017 to February 2018 at Bien Donné and Robertson Research Farms. The fruit samples were subjected to cold storage trials at single and double temperature regimes at the Post-Harvest and Agro-processing Technology Division. Representative fruit samples were also collected to evaluate their external and internal traits and the data was captured on the MS Access database.

Key Results

Thirteen selections, from either Robertson, Bien Donné or both, were harvested and sent to Post-Harvest and Agro processing Technology Division (previously Post-harvest division), for cold storage analysis. Eight of the 13 selections stored well under the dual temperature regime (three red-skinned with yellow flesh, three red-skinned with red flesh and one yellow-skinned with yellow flesh); scoring ≥80% (cut-off point). The eighth selection, PR12-10, evaluated in 2017 for the first time, performed very well during storage, and had good eating qualities as well. No new plum selections were planted at Bien Donné and Robertson Research Farms. At the request of Culdevco, several promising selections were given special attention regarding their horticultural traits. No fruit exhibitions were held at ARC Infruitec-Nietvoorbij as Provar now hosts these. Phase II provides fruit for these exhibitions. Several meetings were held with Culdevco and its clients with regard to new plum varieties and planting guidelines. Support was given to the second economy projects in the Crop Development Division. There was regular liaison with the deciduous fruit industry and technical support as well as technology transfer was provided. Plant Breeders' rights for PR06-30, 'Flavour Star' was granted in June 2018.

Conclusion and Discussion

Horticultural and post-harvest evaluations will continue in 2018/19, although at a smaller scale because a large numbers of selections have been removed from evaluation due to poor performance. Selections not performing well after three years of evaluation will be removed from the evaluation blocks at Bien Donné and Robertson Research Farms. PR06-30, Flavour Star, received it's PBR on 5 July 2018 and will be officially released by ARC and Culdevco in the near future.

08. *Phase two evaluation of apricot cultivars in the winter rainfall region. (MK Soeker)*

Objectives and Rationale

The project evaluates ARC bred apricot selections adapted to South African growing conditions for the export, canning and drying industries.

Methods

Fruit samples were harvested each week from November 2017 to February 2018 at Bien Donné and Robertson Research Farms, as well as at a commercial farm in Montagu. The samples were subjected to cold storage, canning and drying trials at the Post-Harvest and Wine Technology Division. Representative fruit samples were evaluated for external and internal traits and the data captured on the MS Access database.

Key Results

A single apricot selection, AP11-02, was sent for cold storage analysis, but this selection failed to store well and will be removed from evaluation. One selection, AP07-29, which scored ≥80% (threshold) in the cold storage evaluation in 2016/17 was only sent for canning evaluation, scoring 53%, due to poor texture and taste. AP02-04 scored 69% in the drying evaluation, but the best drying apricot this year was AP06-15, scoring 72%. This selection had a drying ratio index of 10, with good fleshiness and above average colour. Fruit exhibitions are no longer held at ARC Infruitec-Nietvoorbij, and are now held in collaboration with Provar. However, no apricot selections were displayed in these exhibitions. Several meetings were held with Culdevco and its clients with regard to new apricot varieties and planting guidelines.

Conclusion and Discussion

Postharvest and horticultural evaluations as well as occasional fruit exhibitions will continue in 2018/19. No new selections will be planted in Phase II since all future evaluations of promising selections will be conducted by Provar, independently.

Selections not performing well after three years of evaluation will be removed.

Crop Production Dormancy

01. *Evaluate rest breaking programmes for warm winter regions. (X Siboza)*

Objectives and Rationale

The objective of this project is to determine the effectiveness of RBA programs to alleviate delayed foliation symptoms in the EGVV area and assess effects on yield, fruit size (by facilitating thinning) and fruit maturity.

Methods

The following rest breaking treatments were applied in the 2017 season.

Fuji apple trees (Cortina Farm)	Rosy glow apple trees (Corner Farm)
3% Dormex (control)	4% Oil (control)
0.5 % Dormex + 3% Oil	1% Dormex + 4% Oil
0.5 % Dormex + 3% Oil + 100 mg/L Promalin	1% Dormex + 4% Oil + 100 mg/L Promalin
3.4% $NaNO_2$ + 3% Oil	3.4% $NaNO_2$ + 4% Oil
10% KNO_3 + 3% Oil	10% KNO_3 + 4% Oil
2% LB Urea + 2% KNO_3 + 0.5% Dormex + 3% Oil	1.5% Oil + 1% KNO_3 + 0.5% Dormex

01. *Evaluate rest breaking programmes for warm winter regions. (X Siboza)*

Key Results

Treatment with 3% Dormex gave lower total bud break in 'Fuji' compared to other treatments due to a phytotoxic effect on mixed reproductive buds. None of the other treatments differed in efficacy on 'Fuji'. Treatment with 3% Dormex significantly decreased the yield, but increased fruit size due to the decreased reproductive bud break. Fruit from trees treated with 2% Urea + 2% KNO_3 + 0.5% Dormex + 3% Oil did not differ in size from those treated with 3% Dormex.

In 'Rosy Glow', treatment with 1% Dormex + 4% Oil + 100 mg/L Promalin gave the highest total bud break, but not significantly different from other treatments except for 1.5% Oil + 1% KNO_3 + 0.5% Dormex. 1% Dormex + 4% Oil increased fruit size compared to all other treatments.

Conclusion and Discussion

Alternative rest breaking treatment combinations generally compared well with industry standard treatments. The phytotoxic effect of high concentrations Dormex on flowers is noted.

02. *Quantifying the impact of insufficient winter chill on apple fruit quality. (E Louw, L Allderman and A van Lingen)*

Objectives and Rationale

Insufficient winter chill is a reality in most of the apple producing areas of South Africa but little scientific data is available to quantify the effect that this has on the quality of the fruit. This study aims to quantify the variability in fruit quality in two climatically contrasting areas and to locate the origin of the possible variability.

Methods

Twenty-six 'Golden Delicious' orchards (13 Elgin and 13 Koue Bokkeveld) were harvested by selecting 6 trees and removing the fruit from 2 branches into six categories: position on the tree (top and bottom), bearing position (spur and shoot) and degree of sun exposure (full sun and shaded). Destructive and non-destructive quality parameters were measured before and after storage. The data set was calibrated for maturity (% starch conversion) and statistical analysis was performed to identify the variability.

Key Results

Preliminary results suggest that for peel colour (lightness) and starch breakdown producers in the Koue Bokkeveld will benefit from segregating the top and bottom fruit at harvest and Elgin producers will sort starch content by segregating sun exposed and shaded fruit.

Colour at harvest and after storage correlated well, but poorly with firmness, suggesting that pre-harvest colour sorting should result in homogenous colour batches after storage but the firmness will be variable. Data analysis is continuing.

Conclusion and Discussion

The project is currently in progress and no firm conclusions can be made. However, understanding the magnitude of different pre-harvest aspects contributing to the variability in fruit maturity and quality gives direction to the development of pre- and postharvest horticultural practices that can lead to increased Class 1 pack outs.

03. *Determining the dormancy progression of commercial apple cultivars and clones available to the South African fruit industry.*

(E Louw and L Allderman)

Objectives and Rationale

Healthy dormancy progression synchronises budbreak in the next season and increases the fruiting potential. Dormancy progression is influenced by, and dependent on, environmental factors, especially low temperatures and chill accumulation, both factors that vary greatly between production areas. This makes the selection of well-suited cultivars and rootstock/scion combinations important, but also challenging in South African's diverse apple producing conditions. Understanding the progression of dormancy of a specific cultivar (and its clones) and its robustness to annual changes in autumn/winter temperatures is not just beneficial when establishing a new orchard, but also in managing existing orchards. This project aims to determine the dormancy progression patterns of commercially important apple scions and their respective clones, in two climatically contrasting production regions over two winter seasons.

Methods

Shoots from 22 different apple clones were collected every 14 days from two apple producing areas (Elgin and Koue Bokkeveld) in 2016 and 2017. Shoot collection started at budset until budbreak or application of rest breaking agent. The shoots were exposed to standard forcing conditions (25˚C, continuous light) and monitored until 50% budbreak occurred. From this, dormancy progression curves were constructed and a two linear joint line model was fitted to present 11 variables that describe dormancy progression. The means of the variables were compared and subjected to a principle component analysis followed by a cluster analysis to rank the cultivars according to their dormancy behaviour.

Key Results

The dormancy progression of the most important commercial apple cultivars (and their respective clones) are presented for two of the biggest production areas in South Africa. The cultivars were ranked according to their dormancy start date, maximum dormancy level and dormancy end date. Results show that clones have different dormancy progression patterns that change when subjected to different climatic conditions (season and region). Some cultivar specific behaviour is discussed and the results of a case study are presented to illustrate different modes of action in chill/cold perception cultivars.

Conclusion and Discussion / Recommendation

In the Koue Bokkeveld the dormancy patterns show annual differences that relate to Utah chill unit accumulation. In warmer years their dormancy patterns start later and exit later compared to cooler years. For similar cultivars grown in warmer climates such as Elgin, the cultivars behave more erratically during the entrance into dormancy, possibly due to different autumn conditions. These trees also have extended dormancy release periods that end late in the year. In Elgin, dormancy progression differences are seen between years despite similar Utah chill accumulation, expressing again the unsuitability and risk of using the Utah model in warm winter climates. The results can be used by growers to match cultivars with climatic areas when planning new orchards and in managing expectations of budbreak in existing orchards based on the chill conditions of the preceding autumn and winter. The data also cautions against expecting similar dormancy behaviour in clones selected for non-dormancy related traits such as colour.

Crop Production Rootstocks and Nursery Tree Quality

01. *Sensitivity of various apple rootstocks to water stress. (S Midgley)*

Objectives and Rationale

The apple industry needs a better understanding of tree responses to irrigation deficits (given the scarce water resources) and approaches to mitigating this risk. Rootstock choices are critical to achieving high yield and fruit quality, but very little is known on possible differential sensitivities to water stress between rootstocks. The objective of this study is to assess the influence of rootstocks of varying vigour on tree water relations and growth under conditions of sub-lethal water stress.

Methods

Two drought stress cycles were imposed on trees in the 'Rosy Glow' rootstock evaluation trial at Paardekloof. We used the rootstocks RN29, G222, MM109/M9, M7 and M793. We assessed changes in soil water content, stem/leaf water potential, leaf gas exchange, fruit maturity/quality (partially analysed) as well as whole tree transpiration, shoot/fruit growth, and white root growth (not yet analysed). This was done continuously (e.g. sap flow) or before, during and after each drought cycle (e.g. water potential).

01. *Sensitivity of various apple rootstocks to water stress. (S Midgley)*

Key Results

Partial data analysis was conducted on ecophysiological data. Results confirm that the drought treatments were successfully implemented, and significant reductions in leaf water potential were achieved. It appears that the more dwarfing rootstocks RN29 and G222 experienced greatest stress at the end. Leaf gas exchange rates were reduced during the first drought cycle but not the second, but it is not yet clear whether this differed between rootstocks. Fruit maturity and quality were not affected by drought stress.

Conclusion and Discussion

The milestones associated with the first season of the study have been mostly met. The analysis of all data will be completed before the second season's measurements start.

02. *Evaluation of new apple rootstocks representing three vigour classes at Môrester and Oak Valley. (X Siboza and I Labuschagne)*

Objectives and Rationale

Continuous evaluation of newly released rootstocks will stay relevant for a well organised and prosperous apple industry. The aim of this project is to evaluate new apple rootstocks representing three vigour classes in three separate trials.

Methods

The presented trials were conducted with 'Big Bucks' as scion cultivar in three randomised block plantings in two commercial orchards on two farms i.e., 'Môrester' in Koue Bokkeveld and 'Oak Valley' in Grabouw. Trees were prepared for planting during the 2017 season on rootstocks representing three vigour classes.

Key Results

Group A: Trees on MM.109 rootstocks had the highest survival percentage compared to the other trees. The trees on G.228 and G.778 rootstocks were the tallest and largest at planting and still remain the tallest and largest during the 2018 season compared to the trees on MM.109, and M.793 rootstocks.

Group B: Trees on M.7, G.222, and G.5757 rootstocks had the highest tree survival percentage compared to the trees on G.890, and Supporter 4 rootstocks. The trees on M.7 and G.890 rootstocks are growing taller than the trees on G222, G.5757 rootstocks. The trees on Supporter 4 rootstocks are shorter than all the trees on other rootstocks.

Group C: The trees on G.202 rootstocks were the tallest and largest in size while the M.9 Nic29 rootstock trees were shorter and smaller than all trees. According to the 2018 tree height, trees on G.202, and M.9 EMLA rootstocks remained taller than the trees on M.9 Nic29. However, there were no clear significant differences on 2018 scion diameter between trees on M.9 EMLA and M.9 Nic29 rootstocks.

Conclusion and Discussion

All trees were planted in 2017 and have only been evaluated for vegetative performance. It is still early days for recommendations.

03. *Evaluation of plum rootstocks for South African fruit Industry: Robertson planting (Roodehoogte). (P Stassen and I Labuschagne)*

Objectives and Rationale

The main objective is the evaluation of high potential imported and local rootstocks on different soil types and climatic conditions and to make recommendations that can complement yield and fruit quality of plum cultivars.

Methods

At the Robertson trial site, 9 rootstocks were planted in a randomized complete-block trial lay-out using 10 replications included as part of a commercial orchard. The new ARC bred rootstock selections OSK99-6 and 8B-35-10 were included. These selections were highly recommended for phase 3 evaluation by the Rootstock Evaluation Committee.

Key Results

On this high potential soil (25 % silt and clay) with moderate high pH (KCl 7), trees on GF 677 yielded significantly higher compared to all other rootstocks. Trees on Cadaman gave the second highest yield but did not differ significantly from trees on Garnem and Viking. Trees on 8B-35-10 had the lowest yield but did not differ significantly compared to trees on Guardian, Marianna, OSK 99-6 and Atlas. Fruit of trees on Garnem had the highest fruit weight but it did not differ significantly from those on Atlas, Cadaman, 8B-35-10, GF 677, Marianna and Viking. Trees on GF677 and Cadaman had the highest yield efficiency. Trees on Atlas, Cadaman, GF 677, Garnem and Viking showed the highest trunk circumference.

03. *Evaluation of plum rootstocks for South African fruit Industry: Robertson planting (Roodehoogte). (P Stassen and I Labuschagne)*

Conclusion and Discussion

At this early stage (first harvest), trees on GF 677 performed the best in terms of yield, yield efficiency and fruit weight. It is too early to draw any substantial conclusions from the first year's results.

04. *Evaluation of plum rootstocks for the South African industry at Simondium (Keunenberg). (P Stassen and I Labuschagne)*

Objectives and Rationale

The main objective is the evaluation of high potential imported and local rootstocks on different soil types and climatic conditions and to make recommendations that can complement yield and fruit quality of plum cultivars.

Methods

At the Simondium trial site, 13 rootstocks were planted in a complete randomized trial lay-out in 10 blocks. Trial trees and side row trees were included in the trial in a commercial orchard. The new ARC bred rootstock selections OSK99-6, 7B-25-21 and 5A-05-34 were pre-selected for root-knot and ring nematode resistance. According to results obtained during pre-screening trials, these selections were highly recommended for phase 3 evaluation by the Rootstock Evaluation Committee.

Key Results

In this high risk sandy soil, trees on GF 677, Atlas, Garnem, Guardian, Marianna, SAPO 778 and Viking did not differ significantly in their first yield. Of these trees those on Atlas, GF 677, Guardian, SAPO 778 and Viking did not differ significantly for yield efficiency. The biggest fruit weight came from trees on Cadaman and Flordaguard and the poorest from trees on 5A-05-34 and SAPO 778. Trees on 5A-05-34 were very weak when planted (6.13 mm) and two trees died after plant.

Conclusion and Discussion

At this early stage (first harvest) trees on GF 677 performed the best in terms of yield and yield efficiency. Fruit of trees on Cadaman and Flordaguard had the best fruit weight.

05. *Evaluation of peach rootstocks for South African fruit industry: Rawsonville planting (Slanghoek). (P Stassen and I Labuschagne)*

Objectives and Rationale

The main objective for this project is to evaluate high potential imported and local rootstocks on high risk sandy soil in low-lying area in the Slanghoek, Rawsonville growing region.

Methods

Trial done with 'Earliblush' as scion, using 12 rootstocks on a sandy/stony soil. The trial layout consists of a randomised complete-block designs with 10 replications.

Key Results

When planted in 2016 trees on Flordaguard (15.45 mm) and Guardian (14.73 mm) were the strongest according to their trunk circumference. On the other hand, trees on Coast Guard, Rootpack 70, Garnem, Viking, GF 677, Cadaman and OSM 99-3 were smaller (between 10-11 mm). Smaller peach trees with effective feeder root systems can easily catch up during the first growing season (2017). Semi-dwarfing rootstocks like Kakamas seedling and Rootpack 70 however remained smaller, whilst GF 677 was smaller due to poorer feeder roots when planted. Trees on all rootstocks grew well. During 2018 trees on Kakamas seedling, Rootpack 70 and GF 667 remained smaller compared to those on Flordaguard, Barrier, Garnem, and Cadaman. Trees on OSM 99-2 and OSM 99-3 also grew slower compared to 2017. Sandy soils have a stress influence on a rootstock like Kakamas seedling and maybe this is also true for some other rootstocks.

Conclusion and Discussion

It is too early for any conclusions at this stage. However, this trial will provide valuable information of the influence of sandy soils on rootstocks like Guardian, Garnem, Rootpack 70, OSM 99-2 and OSM 99-3.

06. *Evaluation of peach rootstocks for the South African fruit industry at Vaalwater, Limpopo. (P Stassen and I Labuschagne)*

Objectives and Rationale

The main objective for this project is to evaluate high potential imported and local rootstocks on two different soil types in the Vaalwater growing region.

Methods

Two trials have been planted during 2015 in the Vaalwater region. One with 'Snow Angel' as scion, using 8 rootstocks on a 79% sandy soil and the second planting with 'Snow Angel' on 12 root-stocks on high clay soil (42% clay). The trial layouts are randomised complete-block (10) designs with 10 replications. Infruitec cold units for 2017 were 300.

Key Results

On sandy soil, 'Snow Angel' trees on the rootstock Okinawa gave the highest yield, but not significantly higher compared to trees on Coast Guard and OSM 99-3. Trees on Kakamas seedling had the lowest yield. Trees on Okinawa gave the highest yield on high clay soil, but trees on Flordaguard and Coast Guard did not differ significantly in yield.

Conclusion and Discussion

This is only the first harvest season and too early to reach any real conclusions. This is a low chilling region and 'Snow Angel' is a very early cultivar that put pressure on fruit growth and development. Fruit weight is poor at the sandloam site at Boekenhout and even poorer at the high clay site at Waterval.

Fruit of trees on Rootpack 70, Montclair and Cadaman are especially small. Trees on Okinawa, OSM 99-3 and Flordaguard performs well in terms of yield and fruit weight in the sand loam soil whilst trees on Okinawa and Flordaguard performs well in high clay soil.

07. *Evaluation of pear rootstocks for the South African industry. Packham's Triumph in Grabouw. (X Siboza and I Labuschagne)*

Objectives and Rationale

Pear rootstocks, like any other rootstocks, vary in their adaptation to various soils, climatic conditions and pest and disease resistance. Therefore, a selection of appropriate rootstocks is crucial to the South African pear industry.

This study will generate new knowledge on precocity, vegetative and reproduction performance of these new rootstocks under our marginal winter chilling conditions, poor soils, low water availability, high temperatures and the presence of pests and diseases. This information will then be used by the industry to advice growers on rootstock selection and planting of future pear orchards with higher productivity and commercial value.

Methods

Packham's Triumph trees on selected rootstocks were planted at the Jackal River Farm. The following 9 rootstocks were planted on BP1, BP3, OHF40, OHF217, QC51, Pyriam, BA29/BH, QC51/BH, and QA/BH. Rootstocks were planted in a randomised block design with 10 blocks of 2 trees per plot. The experimental trees were planted at 4.5 m × 2 m (1111 trees ha^{-1}).

Key Results

The trees are relatively young and have not reached the bearing stage. Therefore, these are preliminary results. The 'Packham's Triumph' with the largest scion diameters were on BA29/BH, QC51/BH, QA/BH, OHF217, BP3, and QC51 rootstocks than the Pyriam, BP1, and OHF40 rootstocks. This suggested that the BA29/BH, QC51/BH, QA/BH, OHF217, BP3, and QC51 rootstocks may have induced greater scion vigour growth than the Pyriam, BP1, and OHF40 rootstocks.

Conclusion and Discussion

The rootstock evaluation is still in preliminary stages. Therefore, it is too early for any conclusions.

08. *Evaluation of pear rootstocks for the South African industry. Forelle in Wolseley (Môstertshoek) (X Siboza and I Labuschagne)*

Objectives and Rationale

Pear rootstocks, like any other rootstocks, vary in their adaptation to various soils, climatic conditions and pest and disease resistance. Therefore, a selection of rootstocks is crucial to the South African pear industry. This study will generate new knowledge on precocity and vegetative and reproduction performance of these new rootstocks under our marginal winter chilling conditions, poor soils, low water availability, high temperatures and of pests and diseases. The industry will then use this information to advise growers on rootstock selection and planting of future pear orchards with higher productivity and commercial value.

Methods

Forelle pear trees were planted on the following selected rootstocks at the Môstertshoek farm in Wolseley: OHF40, OHF217, QC51, BA29/BH, QC51/BH, BP1, QA/BH and Pyriam. All rootstocks were planted in a randomised complete block design with 10 blocks of 2 trees per plot. The experimental trees were spaced at 4.5 m × 1.5 m (1481 trees ha^{-1}).

Key Results

Using OHF40 and BP1 rootstocks on 'Forelle' scions induced greater tree vigour than most of the rootstocks, although not different from the trees on OHF217, QC51, QC51/BH, Pyriam, and QA/BH rootstocks. The trees on BA29/BH rootstocks were more dwarfing than the rest of the other trees. The 'Forelle' scions with the greatest leader growth between the 2016/18 seasons were on OHF217, BP1, and OHF40 rootstocks. This showed that OHF217, BP1, and OHF40 rootstocks are more invigorating than the BA29/BH rootstocks which appeared to produce dwarfing trees. Regarding the 2018 tree scion diameter, the BP1, OHF40, QC51/BH, QC51, and BA29/BH rootstocks induced greater growth of the scion than the Pyriam, QA/BH, and OHF217 rootstocks.

Conclusion and Discussion

Since this trial is in initial stages of progress, it is too early to make any conclusions.

09. *Evaluation of pear rootstocks for the South African industry. Cheeky in Wolseley (Môstertshoek). (X Siboza and I Labuschagne)*

Objectives and Rationale

Pear rootstocks, like any other rootstocks, vary in their adaptation to various soils, climatic conditions and pest and disease resistance. Therefore, a selection of rootstocks is crucial to the South African pear industry. This study will generate new knowledge on precocity and vegetative and reproduction performance of these new rootstocks under our marginal winter chilling conditions, poor soils, low water availability, high temperatures and of pests and diseases.

The industry will then use this information to advise growers on rootstock selection and planting of future pear orchards with higher productivity and commercial value.

Methods

Cheeky pear trees were planted in 2016 at the Môstertshoek farm in Wolseley on the following rootstocks: BP1, OHF40, OHF217, BA29/BH, QC51/BH, QA/BH, and Pyriam. Rootstocks were planted in a randomised complete block design with 10 blocks of 2 trees per plot.

Key Results

The trees on all rootstocks grew rapidly and reached a similar height during the 2018 season. The rootstocks did not influence the 2018 tree height.

However, the results show that there was a significant increase in tree leader growth between the 2016 and 2018 season, with trees on BP1, and OHF214 rootstocks showing to be the most vigorous growing trees while the trees on QC51/BH and BA29/BH rootstocks being the most dwarfing. According to the 2018 tree scion diameter, the trees on QC51/BH, Pyriam, BA29/BH, and BP1 rootstocks had the largest scion diameters compared to the trees on OHF217, OHF40, and QA/BH rootstocks.

Conclusion and Discussion

The preliminary results show that most of the trees seem to have a vigorous growing tendency, but it is still early days for any solid conclusions.

10. *Evaluation of plum rootstocks. (P Stassen)*

Objectives and Rationale

The main objectives for this project are: to evaluate high potential imported and local rootstocks on different soil types and climatic conditions and to make recommendations that can complement yield and fruit quality of plum cultivars.

Methods

All experimental trees were planted in a randomised complete-block design with 10 replications and form part of a bigger commercial orchard. All cultivation practises were the same as recommended for the commercial orchard.

Key Results

Sandy soils with fluctuating water tables and high numbers of ring nematodes are a high risk for planting plum trees especially on Marianna. Stress situations occur that predisposed trees to bacterial and fungal infestation/development and dieback. Effective drainage systems are the only way to solve the problem. After being drained results showed that 'African Delight' trees on several rootstocks can be recommended for these reclaimed soils. On 90% sandy, high pH soil (KCl of 7.6) and high ring nematode numbers (more than 1000/300 cm^3 soil) in Robertson region, 'African Delight' plum trees on the rootstocks Cadaman and Atlas performed well. Forty plus tons per hectare might be the optimal tree potential to assure good fruit weight. Fruit weight of trees on rootstocks like Marianna, Flordaguard, Maridon and Tsukuba 5 are negatively affected by high numbers of ring nematodes whilst fruit of trees on SAPO 778 (cuttings and seedlings) and Flordaguard are negatively affected by the high pH. The rootstock Garnem was not available for this trial.

On less sandy soil (75% sand) with moderate high pH (KCl 7.2) and ring nematode number of less than 400/300 cm^3 soil in the Robertson region, trees on GF 677, Atlas and Marianna performed well. Trees on Marianna showed symptoms of iron deficiency, but no effect on yield and fruit weight.

On high clay soils (31% clay) and high numbers of ring nematodes, trees on the rootstocks, Maridon, SAPO 778 (cuttings and seedling) as well as trees on Viking performed well. Dieback occurs when trees are under stress. The peach x almond rootstocks are very sensitive and not recommended for high clay soils.

Conclusion and Discussion

On drained low-lying sandy soils with fluctuating water tables, Maridon can be recommended because it is less sensitive to bacterial canker, but ring nematodes must be controlled. SAPO 778 is tolerant to ring nematodes, but not suitable for early cultivars and low chilling areas. Atlas will be a good choice because it can handle the sandy soil and tolerate the effects of ring nematodes. On calcareous sandy soil with high numbers of ring nematodes trees on GF 677, Atlas and Cadaman perform the best. On high potential soil with moderate numbers of several nematodes, trees on GF 677, Viking, Atlas and Marianna performed well in terms of yield, fruit weight and yield efficiency. On heavier clay soils (31%) trees on SAPO 778, Viking and Atlas performed well. Maridon can be recommended if ring nematodes are controlled.

11. *Evaluation of apricot rootstocks. (P Stassen)*

Objectives and Rationale

The aim of this project was to identify rootstocks for apricot trees to optimise the performance of the scion cultivar and broaden the rootstock base available to apricot producers. Breakage at the bud union is an important aspect when selecting rootstocks for apricots. Currently only apricot seedling (Royal and Soldonne) are compatible with apricot scion cultivars used in South Africa. This puts a limitation on the choice of rootstocks available to cover aspects like high pH, nematode infested soil and horticultural traits.

Methods

Four trials using a randomised complete-block design with 10 replications were planted. Two were planted in Bonnievale and Montagu during 2012 using Solitaire and Rustic as scion cultivars as well as two in Bonnievale and McGregor during 2013 using Rustic as scion cultivar. The first two plantings were done using seedlings that may help to broaden the rootstock base. The last two were planted on rootstocks used in the peach and plum industry (Atlas, Viking, Cadaman and GF 677 at Bonnievale site and added to these, Guardian, SAPO 778 and Tskuba 4 at McGregor site) with Royal interstems to ensure compatibility. Royal seedling was used as the industry standard.

11. *Evaluation of apricot rootstocks. (P Stassen)*

Key Results

During the 2014 season growers who planted Solitaire and Rustic during 2011 expressed their discontent about these new releases that did not set fruit. The ARC, who released these cultivars concluded that 'Rustic' does not appear to be self-compatible and based on their results, 'Bulida', 'Royal', 'Cape Babeco' and 'Palsteyn' could be used as cross-pollinators. Most producers decided to remove their orchards. Our first two plantings were removed during the 2014/15 season by the land owners and the third one during the 2015/16 season. Only trunk circumferences were measured.

Four years after planting trees at Thornvilla, on Cadaman, Guardian and Royal seedling had the biggest trunk circumference, but it was not statistically bigger compared to trees on Atlas, Viking and SAPO 778. No signs of breakage at the bud-union occurred over this period. Moderate to high numbers of ring, root-lesion and spiral nematodes are present in this soil. The orchard at Thornvilla was successfully worked over to Bulida during January 2017 and new growth reached an average of 40 cm at the end of March 2017. All trees had three to four new Bulida shoots to form the new leaders. Unfortunately, the owners decided to remove this orchard during the winter of 2017.

Conclusion and Discussion

The cultivar Rustic was highly recommended, but unfortunately it was a disaster under commercial conditions due to pollination problems that were experienced in orchards during 2014. Cross-pollinators and flower bouquets were introduced in the Thornvilla, McGregor orchard. No fruit-set occurred during the 2015 and 2016 seasons. Over a four-year period, trees grew excellently and no incompatibility occured.

Trees were successfully worked over to Bulida during January 2017. However, the owners decided to remove the apricot orchard during July 2017. An article was written for Die Krat to make recommendations for the apricot producers.

12. *Evaluation of peach rootstocks. (P Stassen)*

Objectives and Rationale

The main objective for this project is: To evaluate high potential rootstocks and make recommendations to the benefit of the peach industry.

Methods

Six trials have been planted in different climatic and abiotic conditions where different soil textures and plant-parasitic nematodes occur. All trial layouts were randomised complete-blocks designs with 10 replications.

Key Results

'Alpine' trees on well drained sandy soils (90%) in a low chill region performed well on the rootstock Flordaguard, but Atlas and Cadaman also performed significantly better compared to Kakamas seedling. Atlas and Cadaman may perform even better in higher chilling requirement regions and for late cultivars. Flordaguard is not suitable for calcareous and wet soils and where high numbers of ring nematodes occur.

'Alpine' trees performed excellent in medium potential (17.7% silt and clay), calcareous soil with high numbers of ring nematodes on the rootstocks Atlas, Garnem, Cadaman and Filenem.
'Artic Star' trees performed well on high potential (43% silt and clay), calcareous soil with low nematode numbers on the rootstocks Atlas, Viking, Garnem and Monegro. The rootstocks Garnem, Monegro and Cadaman grow extremely strong in these soils and need more summer pruning.

'Summer Sun' peach trees on pear replant soil (29% silt and 23%clay) performed well on the rootstocks Atlas, Viking, SAPO 778 and Guardian.
'Cascade' peach trees on Garnem and Atlas performed well on high clay (17.55 %) soil with high numbers of root-lesion nematodes. GF 677 and Garnem are more prone to infection with fungal diseases compared to Atlas.

On high risk, sandy soil (5.7% silt and clay) with periodic high-water tables and moderate ring nematodes. 'Summertime' peach trees are predisposed to fungal diseases. A high number of dead or dying trees occur on all rootstocks due to *Leucostoma* and *Botryosphaeria* infections. This high-risk soil must be drained and managed as recommended before it can be considered for peach rootstocks.

12. *Evaluation of peach rootstocks. (P Stassen)*

Conclusion and Discussion

Soil texture, climatic and abiotic conditions as well as plant-parasitic nematodes play an important role in rootstock performance in terms of yield, fruit weight as well as tolerance to stress conditions. Several excellent rootstocks for peach growing are available for specific situations to complement high performing cultivars. The rootstocks Flordaguard, Atlas, Garnem, Cadaman, SAPO 778, Viking and Guardian resulted positively during several years of statistical evaluation in different situations. Flordaguard is recommended for well drained, sandy soils and very low chill regions. It is resistant to root-knot, but sensitive to high numbers of ring nematodes. It is sensitive to wet and calcareous soils. In sandy soils not suitable for Flordaguard, Atlas and even Cadaman can take their place. In calcareous soils we have GF 677, Atlas, Viking, Garnem and Cadaman. GF 677, Garnem and Cadaman are prone to fungal infections when ineffective irrigation or poor drainage occur. On replant soil with high numbers of root-lesion nematodes, the rootstocks, Atlas and Garnem can be considered. In high clay soil the rootstocks, SAPO 778, Atlas, Viking, Garnem and Guardian are available after considering all the pros and cons.

13. *Evaluation of new apple rootstocks and interstem combinations in Grabouw (Oak Valley). (X Siboza and I Labuschagne)*

Objectives and Rationale

The objective of this project is to assess various new apple rootstocks (most of the Cornell Geneva range) that have recently become available against the industry standard M793, M7 and MM109. The use of G222 and M9 Emla as potential interstems will also be assessed.

Methods

The more dwarfing (M9 Emla, M9 Nic 29, GA222, M7, MM109/M9, MM109/G222, M793/M9, M793/G222, G778/M9, G778/G222) and more vigorous rootstocks (M7, G202, G778, M793, MM109, G228) were grouped together in two adjacent, but separate plantings. Trees were planted during spring 2013 using randomised complete block designs for both plantings**.** All tree scion diameters were measured at 50 cm above the soil level.

Key Results

The trees on G.778, G.228, G.202, and G.222 rootstocks, and G.778 rootstocks with either G.222 or M.9 EMLA interstems of 30 cm length appeared to be more precocious and yield efficient than the industry standard rootstocks, especially M.793 and MM.109.

Conclusion and Discussion

It is still early days for recommendations. However, the G.778, G.202, and G.778 with G.222 or M.9 EMLA interstems were the most precocious and top performing rootstocks.

14. *Evaluation of new apple rootstocks and interstem combinations in Grabouw (Breëvlei). (X Siboza and I Labuschagne)*

Objectives and Rationale

The objective of this project is to assess the various new apple rootstocks (most of the Cornell Geneva range) that have become available against the industry standard M793, M7 and MM109. The use of G222 and M9 EMLA as potential interstems will also be assessed.

Methods

The more dwarfing (M9 EMLA, M9 Nic29, G222, M7, MM109/M9, MM109/G222, M793/M9, M793/G222, G778/M9, and G778/G222) and more vigorous rootstocks (M7, G202, G778, M793, MM109, and G228) were grouped together in two adjacent, but separate plantings. Trees were planted during spring 2013 using randomised complete block designs for both plantings**.** Tree scion diameter, fruit production and fruit quality were evaluated during the 2017/2018 season.

Key Results

The most dwarfing rootstock, G.202, was the most yield efficient but not different from G.788. MM.109 showed the lowest cumulative yield efficiency. The G.778 produced a higher cumulative yield than M.7 and G.228. The G.202 trees produced a higher yield than M.793/M.9, MM.109/M.9 and M.9 Nic29 in 2018. The G.778/M.9 EMLA had the highest cumulative yield, but not different from M.7, G.778/G.222, G.222, M.793/G.222, and M.9 EMLA.

14. *Evaluation of new apple rootstocks and interstem combinations in Grabouw (Breëvlei). (X Siboza and I Labuschagne)*

Conclusion and Discussion

The study is still in a preliminary stage to draw a solid conclusion, but the trees on G.778 rootstocks appears to be more productive than the trees on MM.109 rootstocks. The trees on G.778/M.9 EMLA rootstocks appears to be more yield efficient than the trees on M.7 rootstocks.

15. *Evaluation of new apple rootstocks and interstem combinations in the Langkloof (Helderwater). (X Siboza and I Labuschagne)*

Objectives and Rationale

The objective of this project is to assess the various new apple rootstocks (most of the Cornell Geneva range) that have recently become available against the industry standard M793, M7 and MM109. The use of G222 and M9 EMLA as potential interstems will also be assessed.

Methods

The more dwarfing (M9 EMLA, M9 Nic29, G222, M7, MM109/M9, MM109/G222, M793/M9, M793/G222, G778/M9, and G778/G222) and more vigorous rootstocks (M7, G202, G778, M793, MM109, and G228) were grouped together in two adjacent, but separate plantings. Trees were planted during spring 2013 using randomised complete block designs for both plantings**.** Tree scion diameter, fruit production and fruit quality were evaluated during the 2017/2018 season. Trees have reached the optimum height. Central leaders were cut back, therefore, tree height measurements were omitted during the 2017/2018 season to avoid biases.

Key Results

On the vigorous site, the greatest cumulative yield was with trees on the G.778, G.228, G.202, and MM.109 rootstocks while on the dwarfing site, the greatest cumulative yield was found on G778/G222, G.778/M.9 EMLA, M.7, MM.109/M.M.9 EMLA, and M.9 EMLA rootstocks.

Conclusion and Discussion

The preliminary data show that the trees on G778, G.228, G.202, G.222 rootstocks, and G.778 with either G.222 or M.9 EMLA as interstems appeared to be among the most productive rootstock, however, it is too early for any solid conclusion.

16. *Apple rootstock evaluation in the Witzenberg valley. (X Siboza)*

Objectives and Rationale

The objective of this study was to evaluate new dwarfing, semi-dwarfing and semi-vigorous rootstocks from the GENEVA® range against the South African industry standard rootstocks.

Methods

'Rosy Glow' scions grafted on G222, CG3007, Cepiland, Lancep, M793, M7, MM106, M9 RN29, MM109/M9 rootstocks were planted in 5 blocks at 4 x 1.25 m spacing as the "more dwarfing site" while scions grafted on G222, G.228, G778, CG934, M25, M793, Maruba and MM109 rootstocks were planted in 6 blocks at 4 x 1.5 m spacing as the adjacent "more vigorous site" in the Witzenberg Valley. The scions on M793 and G222 rootstocks were included in both plantings for comparison. Both plantings were made in 2010 on a fumigated site previously planted to apple. Trees were managed. Trees were managed according to industry recommendations and assessed for vegetative and reproductive performance.
Key Results

The trees on CG3007 and M7 rootstocks were the biggest while the trees on G222, M793 and M9 RN29 were the smallest at planting in the more dwarfing site. At the more vigorous site, trees on M25 were the tallest at planting while trees on G222, M793 and MM109 rootstocks were much smaller. In 2013, the Cornel Geneva® rootstocks produced better yields than the industry standard rootstocks at both sites (dwarfing and vigorous). During the 2014 harvest season, the greatest yield efficiency at the more dwarfing site was obtained with trees on CG3007, M9 RN29 rootstocks while the lowest yield efficiency was with trees on M793, MM106 and M7 rootstocks. During the 2015 harvest season, the trees on G778, M9 RN29, and MM109/M9 rootstocks were more yield efficient than expected from their respective trunk diameters.

Trees on M9 RN29 and MM109/M9 rootstocks performed better than other dwarfing rootstocks during the 2015 season. The trees on M9 RN29, MM109/M9, and G778 rootstocks were again yield efficient during the 2016 season. The trees on M9 RN29, MM109/M9, and G778 rootstocks appeared to be more yield efficient than expected from their size. Trees on Lancep rootstocks yielded efficiently but seem stunted with smaller average fruit size compared to other M9 clones. During the 2017 season, the trees on G778, M9 RN29, and MM109/M9 outperformed all the rootstocks and were more yield efficient than the other rootstocks.

16. *Apple rootstock evaluation in the Witzenberg valley. (X Siboza)*

Conclusion and Discussion

As expected, tree productivity increased with decreased vigour of rootstocks. Hence, at high planting densities (3 m x 1 m) in good soils and with more vigorous scion cultivars, M9 RN29 would be a very good choice.

G778 would be a much more productive choice than MM109 when planting weak scion cultivars or in weak soils, or for producers who prefer to plant at a lower tree density (4 m x 1.5 m). In fact, G778 outperformed even much less vigorous rootstocks in terms of yield efficiency. G228 would be a better choice than M793 and M7 in situations where producers would normally use the latter two rootstocks.

Crop Production Growing Season Climate

01. *Determining 'Forelle' pre-harvest mealiness / cavity development stage, due to environmental factors and exploring prevention of mealiness developing after storage and ripening. (E Crouch, L Schoeman and L-M Dippenaar)*

Objectives and Rationale

At harvest outside canopy 'Forelle' pears have a high risk of becoming mealy and are associated with a lower neck density prior to storage. This study aims to understand when, outside canopy fruit develop cavities, by shading them over time and determine their fruit structure and mealiness development.

Methods

Outer canopy pears were shaded bi-weekly, 14 weeks before harvest. Fruit surface temperature and irradiance of outside canopy, inside canopy and under the shaded outside canopy were measured at each interval. Macro and nano X-ray CT scanning was performed to determine tissue density. Fruit were harvested at commercial harvest and evaluated after 8 weeks of cold storage at -0.5 °C, plus 0, 4 and 7 days of ripening at 20 °C. Standard maturity indexing was done.

Key Results

The closer to harvest shading was done, the more improved fruit size and blush colour was. The earlier the shading occurred, the riper the fruit were. Mealiness was present in all fruit, but higher incidence in earlier shaded fruit that ripened to a softer firmness. Outside canopy fruit intercepted a higher irradiance and fruit surface temperature compared to inside canopy and capped outside canopy fruit.

Conclusion and Discussion

These results oppose previous findings, possibly due to fruit shaded closer to harvest not sufficiently ripening after 7 days at 20 °C and influencing mealiness evaluations. In the next season more outside fruit per shading time will be capped in order to include a further evaluation date of 11 days at 20 °C.

02. *Effect of climatic conditions and plant water status on plum pre-harvest quality and storability. (W Steyn and B Makeredza)*

Objectives and Rationale

The primary objective of this study was to investigate the relationship between tree water relations and sunburn development under South African conditions. Cultural practices that may affect sunburn development through modification of plant water status and the effect of microclimate on fruit peel anatomy was also studied.

Methods

Various trials were conducted and the word limitation of the abstract doesn't allow the detailed description of all methodology (Please refer to dissertation and publications for detail).

Key Results

Induced water stress increased sunburn necrosis and incidence in 'Granny Smith' and sunburn severity in 'Cripps' Pink' apple. Chlorophyll fluorescence pointed to photochemical changes within the peel under water stress while changes in ascorbic acid levels in peel indicated the occurrence of oxidative stress.

Pulsing irrigation involves application of extra water to the orchard floor during a heat wave, with the intention to reduce sunburn. Treatments during 2013-2014 consisted of a control scheduled per the farmer's current practice using microsprinklers, and pulsing irrigation at 25, 37 and 75 L h^{-1} per tree in addition to normal irrigation when ambient air temperature ≥30 °C (5 min on and 20 min off). Pulsed irrigation reduced sunburn incidence in 'Golden Delicious' and 'Granny Smith'. However, the control treatment was under irrigated and the reduction in sunburn might be attributed to either improved plant water status or comparatively more vegetative growth resulting in shading of fruit.

Foliar S-ABA (active form of abscisic acid) application had no effect on sunburn incidence and severity over three growing seasons. S-ABA application resulted in lower stomatal conductance with a consequent decrease in gas exchange and reduction in fruit size. Tree water status in terms of stem water potential was improved due to the reduction in transpiration.

Fruit transpiration and water loss was higher in young compared to mature fruit, which seemingly corresponds with increasing susceptibility of fruit to sunburn during fruit growth. Stomata are present in young fruit and are under regulatory control, which makes them more effective for transpiration. In mature fruit, lenticel density and morphology varied considerably within and between cultivars, between different canopy positions, and between production areas. The contribution of transpiration and water loss to the fruit heat balance was negligible. Hence, differences in fruit surface morphology may not explain differences in cultivar and fruit sunburn sensitivity.

Conclusion and Discussion

This study provided insight into ecophysiological and biochemical changes that occur under water stress and that might have a bearing on sunburn development in apple fruit. The study provides further proof of the link between plant water status and sunburn development and shows that good management of plant water status through irrigation is instrumental to controlling sunburn in a warm production region. Results on the potential benefit of supplemental, pulsed irrigation was inconclusive due to the under irrigation of the control treatment.

03. *Acclimation of apple peel to light and temperature and the effect thereof on red colour development and tolerance to sunburn. (S Midgley and P Barasu)*

Objectives and Rationale

Sunburn and poor red colour are the two biggest abiotic fruit quality defects in South African apples. Apples exposed to different microclimates respond differentially to solar radiation and temperature because of biochemical and physiological adjustments ("acclimation") in the peel. This influences susceptibility to sunburn and poor colour. The overall objective of the study was to assess the influence of rootstock on the innate peel sensitivity to photothermal damage, sunburn and ability to develop red colour, and the role of acclimation to microclimatic conditions in the colour response.

Methods

1. Trials on peel photothermal damage (change in F_v/F_m) and visible sunburn damage (2015/16, Objectives 1, 2): These used 'Rosy Glow' and 'Golden Delicious' fruit from more dwarfing to more vigorous rootstocks, exposed to stress for 1-5 hours and monitored over a five-day recovery period.

2. Laboratory trials on the influence of rootstock and temperature on peel red colour (hue angle) development (2016/17, Objective 3): 'Rosy Glow' and 'Fuji' fruit on various rootstocks were cold-treated followed by treatment (under lights) of peel discs to a range of six temperatures.

3. Trials to assess the influence of reduced peel temperatures (*in situ*) in 'Cripps' Pink' during the mid to late season (Jan-April, Jan-Feb, Feb-March, March-April) on short-term and final red colour development (2016/17, Objective 4).

03. *Acclimation of apple peel to light and temperature and the effect thereof on red colour development and tolerance to sunburn. (S Midgley and P Barasu)*

Key Results

1. The duration of exposure, recovery period, and canopy light exposure influenced damage to peel photosystems and visible damage. Apples exposed for one hour generally recovered whereas apples exposed for two hours and longer did not recover fully. Shaded inside canopy fruit on all rootstocks responded differently to sun-exposed fruit. The rootstock did not influence photosystem damage and recovery and only minor rootstock effects were found for visible damage.

2. Rootstocks differed in their red colouring ability, with RN29 showing the largest change, M793 significantly less, and G007 and 'Rosy Glow' (own roots) the lowest colouring ability. Rootstocks did not differ in the response of colour development over different temperatures. A broad optimum temperature range for red colour development was found (peak at 23°C) for all rootstocks.

3. *In situ* fruit cooling stimulated red colour development during and sometimes after the cooling period. No final colour differences were found between treatments in 2016. In 2017, fruit cooled between mid-January and mid-March had better final colour (hue angle, % red cover and anthocyanin concentration) than those not cooled.

Conclusion and Discussion / Recommendation

Objectives 1 and 2: Rootstock did not affect the innate apple peel sensitivity to photothermal stress, with only minor rootstock effects on sunburn symptoms. However, sun/shade canopy position and stress duration influenced photodamage irrespective of rootstock.

Objective 3: Rootstock influenced the innate ability of fruit to develop red colour but did not influence the temperature response of colour development.

Objective 4: Mid- to late-season peel colour responses to lowered temperature did not decrease the red colour development at harvest but increased final red colour in 2017.

Rootstock choices are not constrained by microclimate effects on sunburn and poor red colour, and red colour development following cool weather or evaporative cooling does not jeopardise final fruit colouring.

Crop Production Reproductive Biology

01. *Carbon partitioning in low chill peach cultivars: the impact on yield in summer rainfall areas of South Africa. (N Taylor and S Oosthuizen)*

Objectives and Rationale

The aim of the project is to establish whether the partitioning of carbon in low chill and early maturing cultivars in the summer rainfall area of South Africa will be affected by increased competition between organs for available carbohydrates and high spring temperatures.

Methods

Measurements were made on two farms and two cultivars, near Modimolle, in the summer rainfall area of South Africa. The dates for the progression of the cultivars through the various key phenological stages were noted and related to temperature through the calculation of growing degree days for the 2014/2015, 2015/2016 and 2016/2017 seasons. This was then related to both shoot and fruit growth. Root growth measurements, through the use on a mini-rhizotron, were also made during the course of the study.

Key Results

The periods of rapid fruit growth and shoot growth overlapped at the beginning of the season indicating competition between organs for a finite pool of stored reserves. As previously reported for low chill cultivars a double sigmoid fruit growth curve was not very evident, suggesting a very short or absent stage II of fruit growth, and therefore minimal slowing down of fruit growth during this stage. Root growth was also evident in late winter and early spring which will also place a demand on stored reserves.

Conclusion and Discussion

The overlapping fruit and shoot growth at the start of the season has implications for carbon partitioning in these cultivars, which in turn has implications for final fruit size and possibly even fruit quality.

Crop Production Irrigation and Nutrition

01. *The effect of irrigation on the performance of young apple trees in newly established orchards. (E Hoffman, J van Zyl and A Stofberg)*

Objectives and Rationale

Apple trees in newly established orchards must fill their allotted space as soon as possible in order to be profitable. Soil water status and root growth are believed to be major determining factors in achieving such a favourable effect. The objective of this study is therefore to determine the most effective irrigation schedule for the optimum performance, including root growth and root distribution, of young apple trees in newly established orchards on gravelly soils which are wide-spread in apple-growing regions of South Africa.

Methods

The irrigation treatments were continued in the trial apple orchard which was in its second leaf during 2017/18 and soil water data have been captured throughout the season. Irrigation started on 12/10/2017 and was terminated on 21/04/2018 when winter rain made further water applications unnecessary.
Aboveground measurements of tree response were conducted in June 2018 followed by installation of additional tubes for measurement of soil water content and soil sampling for the re-calibration of CS650 sensors. Root distribution was measured by root scanning in the plexiglass rhizotrons.

Key Results

Irrigation treatments were applied successfully according to the planned depletion levels between October 2017 and April 2018. The short cycle treatment (T1) received 13 mm every 4.1 days, the medium cycle treatment (T2) 19 mm every 8.4 days and the long cycle treatment (T3) 39 mm every 15.2 days. In total the three irrigation treatments, T1, T2 and T3 received 623 mm, 409 mm and 491 mm respectively.
A significant response of aboveground apple tree growth occurred for the first time in the 2017/18 season. Stem circumferences of the high frequency irrigation plots (T1) surpassed those of the two lower frequency irrigation treatments (T2 and T3). Shoots of T1 were also longer than those of the lowest irrigation frequency treatment (T3). Root studies in the rhizotrons suggested that more roots penetrated deeper into the soil with larger quantities of water applied less frequently.

Conclusion and Discussion

The second season of the irrigation trial was completed successfully. The experiment should continue to allow investigation of the longer-term effect of tree response to irrigation cycles and to determine how evapotranspiration and root distribution of young trees will further increase with the concomitant effect on water requirement. Investigations on the experiment will also be extended to include measurement of several other tree responses and soil water properties.

02. *Quantifying water use of high performing commercial apple orchards in the winter rainfall areas of South Africa. (S Dzikiti, Q Doko, S Zirebwa, Z Ntshidi and N Mobe)*

Objectives and Rationale

Water supply in key apple producing regions in the country is experiencing significant strain and the situation is expected to get worse in future as demand outstrips supply. Major drivers of increased water use include the rising competition as a result of the population growth e.g. in the Cape Town Metropolitan, and the increasing frequency and severity of droughts in recent years. Currently there is no accurate quantitative information on the water requirements of apple orchards from planting until the trees reach full-bearing age. Little is also known about how orchard water use varies with production regions and with cultivar. In addition, exceptionally high yielding apple orchards (>100 t/ha) are becoming common in the industry and their water requirements are not known. This study therefore aimed to close these important information gaps to ensure sustainable use of the limited water resources. Accurate information on the unstressed orchard water use is essential: 1) to improve irrigation scheduling, 2) for water allocation decision-making, 3) for water licensing, and; 4) for developing water saving strategies to cope with water shortages induced by droughts such as the ones that gripped the Cape provinces in recent years. A further objective of the study was to quantify the impact of the exceptionally high crop loads on fruit quality and to derive the water productivity (i.e. Rands per cubic meter of water used) of the orchards.

Methods

The study was conducted in twelve orchards, six of them in the Koue Bokkeveld (KBV) and another six in the Elgin/Grabouw/Vyeboom/Villiersdorp (EGVV) production regions in the Western Cape. Both regions have a Mediterranean-type climate although their microclimates differ. KBV experiences cold winters with the long-term average minimum daily air temperatures for the coldest month (July) being 3 to 4 °C and occasional snowfalls. Summers are generally hot and dry with a mean maximum air temperature for the hottest month (February) reaching 28 to 29 °C. In contrast, EGVV experiences milder winters and summers as the weather is moderated by proximity to the Atlantic Ocean to the south west. Mean minimum daily temperatures in winter are between 8 and 9 °C while average maximum summer temperatures are between 25 and 26 °C.

02. *Quantifying water use of high performing commercial apple orchards in the winter rainfall areas of South Africa. (S Dzikiti, Q Doko, S Zirebwa, Z Ntshidi and N Mobe)*

Methods

Cultivars studied were the Golden Delicious/Reinders, which is most widely planted in South Africa occupying approximately 24% of the area under apples, and the blushed cultivar Cripps' Pink and its close relatives Cripps' Red and Rosy Glow. Both the Golden Delicious and the blushed cultivars are high yielding. The blushed cultivars were selected as these are high value late season cultivars with the highest growth potential. The specific blushed cultivar variant used depended on the availability of suitable orchards in a particular growing region. However, as the blushed cultivar variants are all close relatives, no differences in eco-physiological responses and water use patterns were expected.
Data were collected over three growing seasons namely 2014/15, 2015/16 and 2016/17. In 2014/15, data were collected from October to June in two full-bearing and two non-bearing orchards in KBV. The mature full-bearing orchards had a high effective canopy cover varying from 45 to 52% while the young non-bearing orchards had a low canopy cover between 14 and 26%. In the 2015/16 season, data were collected also in four orchards, comprising two full-bearing and two non-bearing orchards, but in the EGVV region. In the 2016/17 season measurements were taken in two orchards in each production region with medium canopy cover ranging from 30 to 44%. Soil types were predominantly sandy to sandy loam except for the full-bearing 'Cripps' Pink', non-bearing 'Golden Delicious' and the 'Cripps' Pink' all in EGVV. These orchards had dark red clayey loam soils with a high stone content.
All orchards were irrigated using the micro-sprinkler system. There was one micro-sprinkler per tree delivering between 30 and 35 litres of water per hour.

Three methods were used to quantify the orchard evapotranspiration (ET) to reduce uncertainties in the water use estimates. These included direct measurements with the open path eddy covariance method, which was deployed at selected window periods during the growing season. The second technique was the soil water balance approach which was used in two orchards each season due to equipment limitations. Thirdly, additional ET data were derived from the remote sensing "FruitLook" product. Interpolation of the eddy covariance ET to seasonal water use was done using a dual source ET model. We adopted and propose improvements to the Shuttleworth and Wallace model applied to apple orchards with varying canopy cover. Fruit quality was determined using standard horticultural practices.

Key Results

The measured maximum unstressed seasonal transpiration of mature high yielding 'Cripps' Pink' and 'Golden Delicious' orchards was in the range 6 000 to 8 000 m^3 ha^{-1} depending on canopy cover. The maximum orchard ET varied from 9 000 to just over 10 000 m^3 ha^{-1} $season^{-1}$. In young orchards, seasonal total transpiration ranged from 1 330 m^3 ha^{-1} in the low density plantings in EGVV to 2 710 m^3 ha^{-1} in the high density orchards in KBV. Seasonal ET was very high (> 5 000 m^3 ha^{-1}) in all the young orchards. This was due to the large exposed orchard floor area with large wetted areas which increased the soil and cover crop evapotranspiration fluxes. Tree transpiration contributed between 65 and 82% to the total orchard ET in full-bearing orchards - depending on canopy cover. In young orchards, orchard floor evaporation accounted for more than 60% of ET, which was clearly excessive.

The seasonal total transpiration of the trees was strongly related to canopy cover than to crop load. Orchards with high yields e.g. the full-bearing 'Cripps' Pink' in KBV and EGVV did not necessarily have the highest transpiration rates. Variations in tree transpiration rates in full-bearing orchards were a result of differences in canopy size. 'Cripps' Pink' orchards, for example, had a relatively low leaf area index (m^2 of leaf area per m^2 of ground area) due to pruning and use of shoot growth retardants such as Regalis® (a formulation of Prohexadione-Ca). Open canopies expose the fruit to solar radiation for anthocyanin synthesis to occur and to promote the development of the red fruit colour. On the other hand, full-bearing 'Golden Delicious' orchards had larger canopies and a higher leaf area index since these are managed to provide more shade to fruit which are susceptible to sunburn.

There were no clear effects of the high crop load on most fruit quality attributes. Only the full-bearing 'Golden Delicious' orchards in both production regions had smaller fruit size which affected packout of export quality fruit. The water use efficiency varied with production region and with cultivar given the different microclimates and canopy management practices for the Cripps' Pink and Golden Delicious cultivars. The key driver of the water use efficiency of the trees was the leaf area which determined transpiration. Lastly, the water productivity (Rand of gross income per cubic metre of water transpired) was higher for 'Cripps' Pink' than for 'Golden Delicious' averaging R 83 and R 48/m^3, respectively. The primary reason for this is that export-quality 'Cripps' Pink' (Pink Lady®) fetches a higher price than export- quality 'Golden Delicious' and this has a significant influence on orchard gross value. A secondary reason was that the two full-bearing 'Golden Delicious' orchards produced a high proportion of small fruit of lower value. The medium canopy cover 'Golden Delicious Reinders' orchard in KBV had a lower water productivity than expected due to losses ascribed to sunburn and bruising. Generally, water productivity was found to be higher under higher yields, but in 'Golden Delicious' it is likely that a maximum water productivity is reached between 75 and 100 t/ha, where after further increases are constrained by fruit size issues.

02. *Quantifying water use of high performing commercial apple orchards in the winter rainfall areas of South Africa. (S Dzikiti, Q Doko, S Zirebwa, Z Ntshidi and N Mobe)*

Conclusion and Discussion

This study showed that high apple yields can be produced sustainably without using excessive amounts of water provided the canopy is managed optimally. Current 'Cripps' Pink' canopy management practices promote the development of the red colour on the fruit, but they also have water saving benefits. High crop loads in this study did not necessarily have a negative effect on most fruit quality attributes in the high yielding orchards. In the high yielding 'Golden Delicious' orchards only fruit size was affected, and management of crop load is essential in this cultivar to produce export quality fruit and maximise water productivity. Length of the growing season of different cultivars appeared not to influence the seasonal total water use. Thus, our hypothesis relating to water use and season length must be rejected.

Recommendations from the study are that:

• Exceptionally high yielding apple orchards can be sustainably farmed in the Western Cape, but effective canopy management is essential to avoid excessive water use;

• Crop load should be carefully managed in the Golden Delicious cultivar as high fruit numbers reduce fruit size and hence the packout of export quality fruit;

• Water use efficiency and water productivity increase as orchards mature and achieve higher yields. However, in 'Golden Delicious' there appears to be a ceiling to water productivity relating to small fruit size at very high yield;

• Orchard floor evaporative losses in young micro-sprinkler irrigated orchards is currently very high. It is therefore important to implement water saving techniques e.g. accurate irrigation scheduling, mulching, drip irrigation and shade-nets to reduce water wastage.

• Apple growers with limited or unreliable access to water resources should consider focusing on high value cultivars for new plantings, and gradually remove lower value cultivars. This would gradually increase the farm level water productivity and so maximise profitability for every unit of water that is available for irrigation.

• The use of shade netting over trees on more dwarfing rootstocks which are managed for smaller canopy size, could provide further opportunities for water savings and should be investigated.

03. *Evapotranspiration of high performance apple tree orchards. (T Volschenk)*

Objectives and Rationale

Information on orchard water use is crucial for irrigation scheduling and on-farm water management to ensure growth and sustainability of the fruit industry. A greater WRC/Hortgro Science funded study proposes a multi-disciplinary approach to establish unstressed water use by high performing orchards and orchards at different growth stages from planting to full-bearing age and to develop models to extrapolate the results of the study to other apple cultivars and growing regions in the country. The ARC/Hortgro Science project forms an integrated part of this study by monitoring soil water status, estimating water use according to a soil water balance and assisting in apple orchard water balance modelling.

Methods

Data were collected over three growing seasons (2014/15, 2015/16 and 2016/17) in two production regions. Soil physical properties (texture, chemical status, and soil water retention curves) of twelve orchards in the Koue Bokkeveld (KBV) and Elgin, Grabouw, Vyeboom and Villiersdorp (EGVV) regions were determined. Soil water content sensors were installed and calibrated, soil water content monitored throughout the season and evapotranspiration (ET) calculated according to a soil water balance for two of the four selected micro-irrigated orchards per season due to equipment limitations.

Key Results

The maximum monthly averaged soil water balance based ET in low canopy cover non-bearing orchards, medium canopy cover intermediate bearing orchards and high canopy cover full bearing orchards, respectively, ranged between 2.5 mm and 3.8 mm; 4 and 5.3 mm and 3.9 and 5.2 mm. Differences in orchard water use were mainly caused by variation in tree size, presence/absence of weeds and cover crops and irrigated area wetted width. Increased ET from the work row of full surface compared to short-range micro-sprinkler irrigated orchards can be attributed to water use of tree roots, weeds and cover crops. Under-irrigation of full surface micro-irrigated apple trees may result in a twofold increase in water usage from the work row area compared to that of sufficiently watered orchards. The KBV had higher evaporative demand and lower rainfall compared to EGVV, creating the expectation that more irrigation will have to be applied to orchards of comparable properties. However, the total amounts of irrigation applied did not increase from non-bearing to full-bearing in similar production regions, nor was more irrigation applied in KBV than in EGVV for orchards of comparable properties. These anomalies were best explained by the soil water dynamics, which indicated that, even though farmers attempted best irrigation practices, dry and/or overly wet conditions were present periodically in all six orchards.

03. *Evapotranspiration of high performance apple tree orchards. (T Volschenk)*

Conclusion and Discussion

Measures to improve on-farm irrigation scheduling are necessary. Knowledge regarding soil water holding capacity and water requirements of individual orchards can enable accurate irrigation scheduling. Properly calibrated continuous logging soil water content equipment can aid to improve irrigation scheduling. Longer irrigation intervals and deeper irrigations can reduce evaporative losses. Cover crops and weeds increase orchard water use and should be managed to minimise orchard water loss. Proper soil preparation and a well-developed root system will enable trees to access water from the work row area during drought conditions.

Crop Protection Phytosanitary

01. *Ethyl formate fumigation technology – upscaling application towards commercialisation. (S Johnson and R Smit) – also Postharvest Market Access. Funded by the Postharvest Innovation (PHI) Programme*

Objectives and Rationale

Ethyl formate fumigation is the most promising alternative to replace methyl bromide fumigation as a postharvest treatment for a wide range of phytosanitary pests. Also, ethyl formate is highly effective against a key phytosanitary pest of South African export fruit, the grain chinch bug, *Macchiademus diplopterus*, a pest that until now, has been very difficult to control. The aim of this project is to develop technology for large scale fumigation of export fruit using ethyl formate, as opposed to Vapormate® (a formulation of ethyl formate with some challenges for large scale application).

Methods

We visited international research centres where other scientists are also working on the development of ethyl formate fumigation technology for postharvest use, to gain insight and knowledge from their experiences and expertise. We have contracted engineers to design and build an ethyl formate dispensing unit for application of the fumigant in a modified shipping container.

Key Results

The research visits provided valuable networking opportunities with relevant postharvest research scientists, and contributed to the design and decision-making around the dispensing unit and protocols for fumigation.

Conclusion and Discussion

Design of the dispensing unit and component sourcing has taken longer than anticipated, but we are at a stage where the researchers and engineers involved are in agreement with the process flow and safety precautions required, and manufacture of the unit can begin.

02. *CATTS and ethyl formate fumigation as postharvest phytosanitary treatments for stone and pome fruit and associated phytosanitary insect pests. (S Johnson and R Smit) – also Market Access*

Objectives and Rationale

Two alternative postharvest treatments were investigated for use against false codling moth, banded fruit weevil and grain chinch bug. In addition to achieving insect pest mortality, we also investigated the effect of both treatments (CATTS –controlled atmosphere temperature treatment system, and ethyl formate fumigation) on fruit quality, and considered physiological reasons for the apparent high tolerance of grain chinch bug to thermal phytosanitary treatments.

Methods

We tested the potential of CATTS and heat treatments to pre-condition chill-sensitive plums against chilling injury, and evaluated the effect of such treatments on false codling moth mortality. We investigated the biochemical composition of grain chinch bugs throughout aestivation to better understand this insect's high tolerance for thermal stress. Finally, we investigated the effect of ethyl formate fumigation on grain chinch bug mortality, as well as the phytotoxic effect of fumigation on a number of stone and pome fruit cultivars. We also assessed the effect of packaging on grain chinch bug mortality when fumigating packed fruit.

02. *CATTS and ethyl formate fumigation as postharvest phytosanitary treatments for stone and pome fruit and associated phytosanitary insect pests. (S Johnson and R Smit) – also Market Access*

Key Results

Heat treatment significantly reduced chilling injury in cold-stored plums, however, the combination of SmartFresh™ and heat treatment resulted in zero chilling injury. Heat treatment also increased false codling moth mortality during cold storage.

Results of the biochemical composition of grain chinch bugs indicate that physiological changes occur before and during aestivation that may assist in the insect's survival during adverse thermal conditions. Protein analysis indicated a difference in the presence and level of expression of different proteins as the grain chinch bug moves into and through aestivation, giving insight into the insect's ability to tolerate thermal stresses during its aestivation period.

Ethyl formate can effectively control grain chinch bug at concentrations that do not produce phytotoxic damage in the tested stone and pome fruit cultivars.

Conclusion and Discussion / Recommendation

Both alternative treatments tested here have the potential to be successfully applied in the respective pest-commodity interactions to meet the phytosanitary requirements related to each. A pre-conditioning effect of CATTS treatments does reduce chilling injury in chill-sensitive stone fruit, and has an effect on FCM mortality, however, hydro-cooling immediately after treatment must be included in protocols to reduce heat damage, and this may be a challenge for maintaining fruit quality.

Ethyl formate fumigation is the most successful postharvest treatment tested against grain chinch bug to date, and has the very positive attribute of having very little phytotoxic effect on fruit quality.

Ethyl formate fumigation provides a postharvest treatment option that will not only help maintain current markets which are constrained by the incidence of phytosanitary pests and available mitigation options, but will also allow for market expansion and growth of the industry. Using the effective concentrations determined here, large scale fumigation trials are the next step in the development of ethyl formate fumigation technology, which is currently underway as a Postharvest Innovation Fund project for this year.

03. *Monitoring of false codling moth distribution and damage in nectarine orchards. (D Stenekamp and T Asia)*

Objectives and Rationale

False codling moth (FCM) is a phytosanitary pest and the export of peaches and nectarines to the European Union are subjected to phytosanitary regulations. To mitigate this risk, continuous monitoring and identifying FCM fruit damage is important. As oriental fruit moth (OFM) is also a key pest on peaches and nectarines, it is important to distinguish between the extent of FCM and OFM damage found in the orchards.

The objective is to determine the phenology of the adults, the distribution of the insect in different areas and percentage damage of FCM on stone fruit, comparing early, middle and late nectarine and peach cultivars. It was also important to determine if there is a relationship between trap counts and fruit damage.

Methods

Six orchards were monitored for FCM in Ceres and in Tulbagh in 2016. Cultivars harvested in December 2016, January 2017 as well as February 2017 were used (middle and late cultivars). Traps were placed in each orchard and twenty five trees per orchard were selected and marked to monitor for fruit damage. Every fortnight fruit damage assessments were done by examining ten fruit per tree and cutting fruit open when damage was suspected. Pre-harvest damage assessments were done a week prior to harvest.

In 2017/2018 FCM trap and fruit damage data for peaches and nectarines were collected from growers from different areas. This data included early, middle and late cultivars.

Key Results

No damage was found in any of these orchards that we monitored in 2016/2017, although moths were caught in the traps. Trap counts continued to increase after harvest in most of the orchards. No FCM damage was detected in any of the peach and nectarine orchards that we collected data from in the 2017/2018 season although some orchards caught some moths.

Conclusion and Discussion

Trap counts could not be used to determine a threshold for fruit damage. Damage assessments and monitoring fruit infestation throughout the season is a more reliable method to assess the extent of the FCM problem in the orchard than monitoring the traps alone.

04. *Phytosanitary status of false codling moth, Thaumatotibia leucotreta (Meyrick) (Lepidoptera: Tortricidae) on pears. (M de Villiers)*

Objectives and Rationale

There have been unpublished reports of false codling moth infesting pears. However, the physiological stage of these pears was not determined, which is crucial for determining whether or not pears are a pathway for entry into our importing countries. Pears can only be a pathway if it is a host for false codling moth at the physiological stage of ripeness at which the fruit are exported. The above-mentioned reports have resulted from work done in situations where pears were grown in close proximity to stone fruit orchards. However, we are unaware of such reports from areas in which pome fruit are grown in monoculture.

Methods

False codling moth activity was monitored in twenty orchards across the Western Cape, with ten in areas where pears are grown in pome fruit monoculture, and the other ten where pears are grown alongside stone fruit. Delta traps, baited with false codling moth lure, were used to trap the moths at biweekly intervals. In each orchard, 500 pears were harvested during the same period that the fruit were harvested on the farms for exports. All fruit were cut open in the laboratory and inspected for the presence of false codling moth larvae. Statistical analysis was done to determine the phytosanitary status of pears as a non-host for false codling moth, which will be achieved if 99.99% of fruit are uninfested. The confidence level of achieving this level of quarantine security was determined by $C = 1-(1-p_u)^n$, where C is the level of confidence, p_u is the acceptable infestation level, 0.0001 (1 - 0.9999) in this case, and n is the number of fruit inspected.

Key Results

False codling moth adults were found in traps in all orchards throughout the sampling period. However, fruit infestation was low, occurring in one orchard, with one pear being infested by one larva. There is a possibility that two other larvae that were found in two pears could have been false codling moth, but this could not be confirmed. All these larvae were found in pear orchards that were grown adjacent to stone fruit.

Conclusion and Discussion

Due to the presence of false codling moth inside the fruit, pears cannot be considered a non-host of false codling moth at the 95% confidence interval. However, the risk of infestation appears to be low, with the confidence that the true infestation level will not exceed 0.0001 (0.01%) 95%. The larvae should also be able to develop into moths that are able to produce viable offspring. In this study, there is no evidence for this, since it was not investigated. In addition, for establishment in an importing country, a breeding pair (male and female in the same consignment) must be present.

05. *A study on the biological and physiological traits of Bactrocera dorsalis, with special reference to its invasion potential into the Western Cape of South Africa. (P Addison and W Pieterse)*

Objectives and Rationale

Fruit flies are of quarantine importance for the export market. The invasive fruit fly *Bactrocera invadens*, recently synonymized with *B. dorsalis s.s*., was first detected in Kenya in 2003 and in Limpopo province in 2011. *B dorsalis* does not occur in the Western Cape. Experiments were conducted to test the suitability of host fruits produced in the Western Cape for infestation by *B. dorsalis* as well as the probability that the invasive fruit fly might establish as a pest in this area.

Methods

We carried out comparative host-specific demographic studies on *B. dorsalis* and *Ceratitis capitata* on nectarine and plum to determine the potential threat of *B. dorsalis* to the fruit industry in the Western Cape. Test fruits were offered to 50 2-week old adults of each species and sting marks were counted after 48 hours. Egg hatch, number of pupae and adults were recorded. Treatments were replicated three times. Experiments exploring the thermal tolerance and rapid thermal responses of *B. dorsalis* were also conducted.

Key Results

While *B. dorsalis* and *C. capitata* were equally successful in utilizing most fruits tested, there were differences in development between the fruit fly species in some fruit types such as apple. On apple, *C. capitata* produced higher number of adults compared to *B. dorsalis*. *Bactrocera dorsalis* was however able to offset this by producing eggs over a longer period of time than *C. capitata* on apple. *B. dorsalis* had a more dominant presence on fruit as compared to *C. capitata*. *Bactrocera dorsalis* also displayed intraspecific aggressive behaviour, but not interspecific aggressive behaviour. *Bactrocera dorsalis* out-competed *C. capitata* on most deciduous fruit tested, especially when the competition was between adults. Pear was the only fruit type where *B. dorsalis* could not dominate. However, if *B. dorsalis* and *C. capitata* successfully oviposited in the same fruit in an orchard, *C. capitata* might have the competitive edge in terms of development in the larval stage. In the control experiments where there was no competition between the larvae, significantly more adult flies of *C. capitata* emerged from all the fruit crops tested. The eggs of *B. dorsalis* were the life stage most resistant to the high (42.7°C) and low (-6.5°C) discriminating temperatures. We found that adult *B. dorsalis* heat-hardened at 37°C and 39°C, but a brief 2 h cold exposure at a mild (non-lethal) temperature did not result in statistically significant increased survival at the low discriminating temperature of -6.5°C

05. *A study on the biological and physiological traits of Bactrocera dorsalis, with special reference to its invasion potential into the Western Cape of South Africa. (P Addison and W Pieterse)*

Conclusion and Discussion

The overall possibility of *B. dorsalis* establishing in the Western Cape and displacing *C. capitata* in deciduous fruit is high. The fly populations will probably be reduced to undetectable levels during the winter, with a rapid increase in the population in summer. As the flies complete more life cycles under local conditions, *B. dorsalis* will probably adapt and become a potential problem for fruit growers. Fruit like apple and pear are not good hosts for *C. capitata* (Manrakhan & Addison, 2014), but might be better hosts for *B. dorsalis*, since *B. dorsalis* deposited a significantly higher number of eggs on pear, lived longer and produced low numbers of eggs over a long time on apple. This could increase the cost of spray programmes, since fruit types with low incidence of spraying could now require more frequent control interventions. All the experiments in this project were executed in a laboratory and results from field studies may differ. It is, however, an indication of what might happen in orchards if *B. dorsalis* should become established in the Western Cape.

Crop Protection Nematology

01. *Host status of certain cover crops for the root lesion nematode, a major pest of economic importance in apples. (R Knoetze)*

Objectives and Rationale

Currently the most preferred method of orchard management is to plant a cover crop in the work row to improve fertility and soil structure, and reduce erosion. However, in choosing a cover crop it is important to ensure that it is not a good host for lesion nematodes (*Pratylenchus* spp.), the main nematodes of economic importance on apples in South Africa. The aim of the study is to assess the susceptibility of selected cover crops to different lesion nematode species by estimating nematode reproduction on these crops. The objectives for 2018/2019 were to optimise of the in vitro culturing method for lesion nematodes; isolate the most important lesion nematodes from SA apple orchards; propagate and inoculate 5 different cover crops and evaluate their susceptibility to these lesion nematodes

Methods

To successfully culture the lesion nematodes it was necessary to optimise an in vitro culturing method using carrot discs. After propagation of the cover crops, they were inoculated with lesion nematodes that were harvested from the carrot discs. After 13 weeks, the crops were evaluated for their susceptibility to lesion nematodes. To do this, the reproductive potential (Rf) of the nematodes in each crop as well as the percentage of the nematodes g-1 roots of each crop in relation to the nematodes g-1 roots of the most susceptible crop (%R) was calculated.

Key Results

The in vitro culturing method for *Pratylenchus* was successfully optimised during this period and significant yields from this culturing method (>1000 nematodes/disc) was achieved. Three species of lesion nematodes, *P. hippeastri, P. vulnus* and *P. penetrans*, were isolated from apple orchards, with *P. hippeastri* being the most abundant. Thirteen weeks after inoculation, it Rf values indicated that *P. hippeastri* only reproduced successfully on susceptible sweetcorn, while it seems that rye will be able to maintain a low population of *P. hippeastri*, but not increase the population size. When considering %R, all of the cover crops can be classified as either resistant or moderately resistant to *P. hippeastri* when compared to the number of nematodes gram roots-1 of the most susceptible crop.

Conclusion and Discussion

The culturing of lesion nematodes with the carrot disc method, when properly optimised for local conditions, is able to produce large numbers of nematodes for use in screening protocols. The diversity of lesion nematodes in apple orchards in SA is not as high as expected, with only 3 species isolated (*P. hippeastri, P. vulnus* and *P. penetrans*). None of the cover crops evaluated in this season appears to be a good host for *P. hippeastri*.

02. *Control of woolly apple aphid using entomopathogenic fungi. (N Stokwe and L Mathulwe)*

Objectives and Rationale

The objectives of this study are: 1) To do a survey of for the presence of EPF in local apple orchards and identify isolates to species level using molecular techniques; 2) To screen selected identified EPF isolates for their virulence against WAA in laboratory conditions and; 3) To apply the most virulent EPF isolate to apple bark and determine persistence and contact infection in laboratory conditions.

02. *Control of woolly apple aphid using entomopathogenic fungi. (N Stokwe and L Mathulwe)*

Methods

Screening of EPF isolates against WAA

A dipping bioassay was used to screen the different fungi isolates against WAA. A total of 60 WAA were used to test each fungal isolate. After dipping, WAA was placed in 9 cm diameter Petri-dishes (10 WAA per dish) and incubated at 22 ± 2 °C. Laval mortality was recorded 5 days post-treatment and mortality data was Abbott-corrected.

Concentration dose-response bioassays

The two most promising isolates, based on screening bioassays, were used in the concentration dose-response and exposure time-response bioassays. Four different concentrations (1 x 10^4, 1 x 10^5, 1 x 10^6 and 1x 10^7 conidia/ml) were tested.

Concentration dose-response bioassays

The two most promising isolates, based on screening bioassays, were used in the exposure-time response bioassays. Conidial suspensions were prepared following the procedure detailed above. Four different inoculation periods were tested (1, 3, 5 and 7 days) at a concentration of 1x107 conidia/ml for each isolate.

Key Results

Seven different entomopathogenic fungal species were obtained across the six apple farms. Collected fungal isolates based on the screening bioassays showed the potential to be used effectively for control of WAA.

Conclusion and Discussion

The laboratory studies are progressing as planned. Results analysis still in progress.

03. *Incorporating entomopathogenic nematodes and fungi in an integrated pest management system for the control of codling moth. (A Malan and D Odendaal)*

Objectives and Rationale

The success of entomopathogenic fungi (EPF) in controlling a wide range of insect pests indicates the method to be a biological control option for the control of codling moth (CM). Research on the use of EPF as an additional tool for the control of CM is lacking in South Africa, thus further knowledge into the use of entomopathogenic nematodes (EPNs) under natural field conditions, and use of EPF in an integrated pest management (IPM) system is required.

The project aim is to build on previous research undertaken with CM and EPNs, and to incorporate EPN and EPF individually, and in combination, into an IPM system directed towards the effective control of diapausing CM populations.

Methods

Soil samples were collected from apple orchards around the Western Cape Province, and various EPNs and EPF were isolated. Pathogenicity tests were conducted, the most pathogenic EPN and EPF determined, and their efficacy against CM larvae alone and in combination tested.

Key Results

The most effective EPN and EPF were *Steinernema jeffreyense* and *Metarhizium robertsii*. *W*hen combined these organisms achieve synergistic/additive control – resulting in higher control than when either isolate was used as an alone-standing control measure. In EPF-EPN combination trials against CM pupae, although resulting in higher control than the EPN, it resulted in lower control (60% control) than when the EPF was used alone (80% control).

Conclusion and Discussion

Most objectives have been met. Identification and screening of all pathogenic EPN and EPF have been completed, and the most virulent EPN and EPF determined. Effect of EPN-EPF combinations still need to be completed in the field.

04. *Control and management of lesion nematodes in apple rooted layers and nurseries. (A de Klerk)*

Objectives and Rationale

The Lesion nematode (*Pratylenchus*) is the most important nematode attacking apples. They feed inside the roots causing retarded growth and low yields. As no visible root symptoms are present, infected nursery trees may unknowingly be a great source of infecting newly planted commercial orchards. As general international knowledge on management and control of this important pest is very few, various experiments were conducted over six years to solve this problem for the apple industry.

Methods and Results of each experiment

Especially for applying chemical control, it is very important to know what stages of Lesion nematodes occur where and at what time of the year. As this information was not known under South African conditions, observations on the seasonal occurrence over two consecutive seasons showed population peaks either in February or March. Adults as well as larvae occurred in the roots and also in the soil during the whole growing season at rooted layers as well as nurseries. This information was used to determine the best time to apply chemicals and also what kind of chemical to be used.

Chemical control in nurseries was usually done by leaf application with Vydate but with poor control of 30 – 40%. A field experiment was therefore performed to compare Vydate with Nemacur both as leaf applications at the same time of the year. Excellent control of 76% was obtained with Nemacur. Poor control of only 52% was obtained with Vydate.

Hotwater treatments with various temperatures and different duration times were evaluated in different trials and a combination of 45°C for 30 minutes showed the best results. Lower temperatures resulted in unsatisfactory control while higher temperatures caused a high mortality rate of rooted layers as well as nursery trees.

The immersion technique was also evaluated to control Lesion nematodes in the roots of rooted layers and good control (77%) was obtained with 30ml of Nemacur per 100L water at immersion time of 5 hours.

During 2017 this technique was also evaluated for control in two year old nursery trees and the dosage was increased to 50ml per 100L water and immersion time was increased to 8 hours because of the larger root size of the trees. Four nematicides were evaluated and Nemacur again gave fairly good control of 72% while the other three supplied control of 52% on average.

To reduce the operating time of the immersion technique the time of immersion was reduced from 8 hours to 2 hours with the same control (71%) with Nemacur.

With a third experiment Nemacur was evaluated again with trees covered totally with leaves as well as trees without any leaves. The success of control was the same in both cases (71%).

In all the experiments the Baermann technique was used with a milk filter as usual. In a fourth experiment the milk filter was replaced with a denser tissue paper filter and Nemacur was again used to evaluate the percentage control which increase from 71% to 99% with the change of the filters.

During 2018 the Baermann technique with two different kinds of filtering material was evaluated for three other chemicals than Nemacur. The percentage control of Actara increased from 66,2% to 97,2%. Nem-001 increased from only 46,4% to 86,1%. With the results obtained during 2017 and 2018 it is clear that the immerging technique is a very promising method to manage the Lesion nematode problem for the apple industry.

Nursery trees treated with three separate systemic insecticides were kept at cold storage of 10°C for 8 weeks as is normal practice before planting in an orchard. This treatment could possibly help to decrease the number of nematodes in the roots, however, the population increased between 59% and 94%. At the end of the 8 weeks many new rootlets were present and could have been the reason for this unexpected increase.

Conclusion and Discussion

Positive results were obtained with all experiments conducted that could be of great value to solve the problem. The information obtained will soon be published as one or more articles in a practical Fruit Journal.

05. *Ring nematode (Criconemoides xenoplax) distribution, the characterisation and culture methods. (A Malan and M Odendaal)*

Objectives and Rationale

The ring nematode, *Criconemoides xenoplax, is a* migratory ectoparasitic nematode that feeds on the roots of plants, mainly those of woody perennials. The ring nematode is regarded, worldwide, as a significant pest in stone fruit and grapevine, and it has become a common soil pest in South African production areas. To determine the distribution and characterization of the ring nematode, a survey was conducted in stone fruit and vineyards of the Western and Northern Cape provinces. Soil samples were obtained from randomly selected farms, with additional data acquired from the diagnostic laboratory, Nemlab.

05. *Ring nematode (Criconemoides xenoplax) distribution, the characterisation and culture methods. (A Malan and M Odendaal)*

Methods

Ring nematode specimens collected during the study were characterised morphometrically, morphologically and molecularly to determine the ring nematode species present. To determine the susceptibility for *C. xenoplax*, five commercially available grapevine rootstocks were assessed in a glasshouse pot trial. An investigation was conducted to determine whether a monoxenic, *C. xenoplax* population could be cultured *en masse* on annual alternative hosts, thus providing a more successful and rapid method of culturing the nematodes for future use.

Key Results

Criconemoides xenoplax occurred in 100% of soil samples obtained during the survey, with nematode numbers ranging from 20 to >2000 individuals per 250 ml of soil. The samples from Nemlab indicated that vineyards and orchards with zero ring nematode, as well as do some with excessively high numbers of ring nematode. The RF values calculated for all annuals tested were > 1, thus using these annuals as an alternative option to culture *C. xenoplax* is not a viable option for future mass culture. The use of grapevine and stone fruit plants should, as a result, remain the primary hosts for the sustained ring nematode populations in culture, with grapevine being the preferred host.

Conclusion and Discussion

Criconemoides xenoplax infestation in South Africa shows similar trends, as has been observed globally, demonstrating its importance as an economically significant pest. It is, therefore, essential to develop alternative management options to minimise the amount of damage incurred, and to manage *C. xenoplax* in the areas concerned, so as to sustain production. *Criconemoides xenoplax* is a significant nematode that requires more research in South Africa grape production. Doing so would enhance the understanding and amount of knowledge pertaining to the biology of such an economically important pest, as well as promote the understanding of future host damage and plant resistance. The above-mentioned research will be critical for the employment of efficient control methods to manage nematode populations in future. The amount of chemical application required to control this nematode would otherwise be to the detriment of soil health expectations for the future. The search for tolerant and resistant rootstocks in both grapevine fruit should serve as the way forward in terms of the control of ring nematode. The samples from Nemlab indicated that vineyards and orchards with zero ring nematode occurrence do exist, as well as do some with very high numbers of ring nematode. Such extremes should be investigated, in terms of their general environmental conditions and current management practices, to find solutions for dealing with situations of massively high ring nematode numbers, other than chemical control.

06. *A survey to determine the Pratylenchus spp. present in South African apple orchards. (L van der Walt)*

Objectives and Rationale

Pratylenchus spp. are widely known to cause serious damage to apple trees (Colbran, 1963; Bosher and Newton, 1957; Goss, 1961; Palmiter and Braun, 1962). In addition to the direct damage caused to the roots *Pratylenchus* spp. have been associated in some sites where Apple Replant Disease (ARD) is present in South Africa (Tewoldemedhin, 2011). The role of the specific *Pratylenchus* species in the ARD complex is yet to be determined. *Pratylenchus penetrans* has been identified as being part of the ARD complex in Washington, USA (Mazzola, 1998), whereas *P. jordanensis* was identified in Queensland, Australia (Stirling *et al,* 1995).
Most of the research and resistance breeding in other countries is focused on *Pratylenchus penetrans* (Mazzola, 2012). From the few samples taken from ARD soils, in conjunction with the ARD research group at Plant Pathology, Stellenbosch University, four species were identified. From this very limited survey and the survey in 1984 (Hugo, 1984) it would seem that *P. penetrans* is not the primary species in South Africa.

In the survey by Hugo (1984), a list of *Pratylenchus* spp. was compiled, but in more recent projects and samples analysed more species were identified. This shows that the diversity of species could have increased or a shift in the population present has taken place in this area.
The long-term plan with this project was to determine the different species of *Pratylenchus* in South African apple orchards and subsequently determine which species are the most virulent.

Methods

A survey was conducted of the *Pratylenchus* spp. present in apple orchards. Samples were initially taken from 50 orchards in 2016/17. The samples were taken in Elgin (2), Grabouw (21), Villiersdorp (2), Vyeboom (5) and the Langkloof (20). The initial plan was to take one sample per 250ha. Only the roots were processed to extract *Pratylenchus* spp., as the species in the roots will be the infective ones.
During 2017/18 samples were received in the laboratory (Nemlab) and samples with high numbers of *Pratylenchus* spp. were included in the survey so that more specimens were available for identification purposes. A total of 48 samples were sequenced, 3 individuals per samples, of which 40 (a total of 120 individuals) could be used.

Key Results

Low numbers of *Pratylenchus* spp. were initially extracted from root samples collected in the field. From the random samples received by Nemlab from different production areas, *Pratylenchus* spp. were extracted and sequenced. After a few individuals were sequenced it became clear that an overwhelming percentage of specimens were identified as *P. hippeastri*. *P. hippeastri* were identified from 84.17%, *P.vulnus* from 9.17% and *P.penetrans* also from 9.17%.

06. *A survey to determine the Pratylenchus spp. present in South African apple orchards. (L van der Walt)*

Conclusion and Discussion

The initial idea of isolating over 14 different species of *Pratylenchus* in apple orchards was soon changed when over 80% of sequenced samples came back as *P. hippeastri*. The only 2 other species found were *P. vulnus* and *P. penetrans* both from 9.17% of sequenced samples.
Going forward, the project will not end and samples coming through Nemlab will still be scanned for *Pratylenchus.* These samples will also be sequenced and added to the database.
Dr. Knoetze will continue with the maintenance of the populations on carrot disks to maintain the pure cultures which will be used in the rootstock screening trial. An in-depth survey of the apple nurseries is also recommended.

Crop Protection Soil Health

01. *Orchard floor management and soil health in deciduous fruit orchards. (M Addison)*

Objectives and Rationale

The development of integrated orchard floor management methods is critical as they will allow for more sustainable fruit production. Current information on orchard floor management is limited. It is proposed that various combinations of cover crops be planted and assessed in order to determine the basic information needed. The two trial sites selected are in separate climatic areas (Koue Bokkeveld and Warm Bokkeveld

Methods

Objective 1: Establish four cover crops.

Objective 2: Assess cover crop performance and the long term effects of the various management practices on soil ecology and yield.

Objective 3. Assessment of additional cover crop species at a small scale.

Key Results

Cover crops were planted in May 2017 and all blocks were replanted in May 2018 due to poor germination and low seeding rates. Soil samples were taken in November 2017, nematode populations were assessed, and lesion nematode populations in the diverse cover crop treatment appeared to be supressed. Cover crop performance was assessed (height and biomass production). Small scale cover crop plantings were established in autumn and plant performance is being assessed.

Conclusion and Discussion

Establishment of cover crops in both orchards was problematic and initial plantings were poor. Seeding rates were amended and the second planting was successful. Cover crops have established well and assessments are underway. Small scale assessment of various plant species planted in autumn were successful. Base line soil analyses are complete.

02. *Validation of an enzyme-based soil alteration index for testing soil health in local apple orchard soils. (A Meyer)*

Objectives and Rationale

Enzyme-based soil alteration index, AI3, may prove to be effective for quantifying soil health in local apple orchards (Meyer et al., 2014a). This hypothesis was tested by evaluating AI3 in relation to (1) compost/mulch treatments, (2) ARD/fumigation treatments, and (3) different cover crop treatments, and to soil/tree data.

Methods

Compost/mulch treatments were applied at Oak Valley (Grabouw), ARD/fumigation treatments at Vergelegen (Elgin), and different cover crop treatments at Vyeboom Boerdery. AI3 indices were generated using the formula of Puglisi et al. (2006). All trials followed a statistical design.

Key Results

AI3 indices were generally better in the top- than in the subsoil layers, at the respected trial sites. Indices were generally better under mulching than bare soil at the Oak Valley trial site. In accordance with AI3 indices, mulch-compost combinations performed better than the unmulched control. AI3 indices were generally better one year post-fumigation (sterile soils) compared to ARD plots and AI3 was also able to differentiate between the different rootstock genotypes response post-fumigation. Positive correlations between AI3 and soil parameters, notably soil C, as well as tree parameters, was mainly observed at the Vyeboom cover crop trial.

02. *Validation of an enzyme-based soil alteration index for testing soil health in local apple orchard soils. (A Meyer)*

Conclusion and Discussion / Recommendation

After testing, it can be concluded that the AI3 was able to:

• Reflect gradients in mineralizable substrates across a transect of different soil layers in apple orchards (Oak Valley, Vergelegen and Vyeboom trials).

• Distinguish between mulched and unmulched treatments, confirming wider experience that mulching favours microbial decomposition processes in the soil relative to bare soil conditions (Oak Valley trial).

• Distinguish between mulch-compost treatments combinations (Oak Valley trial).

• Confirming the "recovery" of soil health status of Apple Replant Diseased soil after soil fumigation (Vergelegen trial).

• Differentiate between the capacities of various apple rootstock genotypes to support rhizosphere-inhabiting organisms and susceptibility of rootstocks to soilborne pathogens in ARD soils subjected to fumigation (Vergelegen trial).

• Predict soil nutrient status in apple orchards, e.g. being consistent with soil C availability (Vyeboom trial).

• Predict apple tree performance, e.g. being consistent with stem circumference, tree height, cane mass and yield mass (Vyeboom trial).

•Forewarn heavy metal contamination in apple orchard soils, e.g. Cu (Vyeboom trail).

The findings presented in this report are thus proof that the AI3 index is a suitable method for quantifying soil health in Western Cape apple orchards, under the range of conditions set out in this report. The method is more sensitive (accurate), rapid and cheaper than current traditional chemical tools, which will help achieve the twin objective of making the biological quality of agricultural soils better 'measurable' and 'manageable'.

Further validation of the AI3 is strongly recommended for wider application in Western Cape deciduous fruit orchards. Longer-term soil and tree effects of soil management should also be included in subsequent research since current findings are limited to more short-term effects.

03. *The effect of different cover crop management practices on the soil and performance of apple trees. (J Fourie and C Kapp)*

Objectives and Rationale

The study aimed to supply guidelines for soil management practices that will improve soil health and promote sustainable apple production.

Methods

The nematode and soil nutrient status, cover crop performance and weed control efficacy, as well as tree performance and nutrient status were monitored.

Results, Discussion and Conclusions

Soil preparation disturbed the soil biology. After three to four years, the nematode community structure stabilised. Dwarf Fescue (T1) and a Saia oats monoculture (T2) facilitated recovery. The nematode communities serve as an effective bio-indicator.

Cover crops increased the organic C in the soil. Pink Seradella combined with full surface chemical control early October and early December (CC) (T3) and the pink Seradella/ Saia oats mixture combined with CC (T4) increased the available N. Fertiliser P does not correct the P concentration in the 150-300 mm soil level, but creates an over-supply in the 0-150 mm soil level. The non-bearing trees did not need from April to November, when receiving rainfall of between 482 mm and 1219 mm. T1 (applied by industry) increased the irrigation amount by between 7 mm and 35 mm compared to the other treatments.

The canola/Caliente 199 mixture (T5) is not suitable for the relatively wet apple producing areas. The best weed control up to the end of November was achieved with T2 and T4. T1 gave the best weed control from December to March. However, T1 could eradicate only two of the thirteen dominant weeds, namely tiny club-rush and bur clover. In contrast, T3 eradicated an additional three species, namely sheep sorrel, hairy wild lettuce and narrow- leaved ribwort. T4 eradicated the same species as T3, with the exception of narrow-leaved ribwort. T2 eradicated narrow-leaved ribwort, bur clover, tiny club-rush, hairy wild lettuce, catchflies, sowthistle and the Lolium species.

The treatments did not affect tree performance significantly. However, the 2017 harvest of T3, T4 and T5 was lower than that of 2016. In contrast, the second harvest of T1 and T2 increased compared to the first harvest, with that of T2 exceeding that of T1 by 5 t/ha.

The fine roots of the apple trees were distributed throughout the soil profile under full surface irrigation. However, the fine root distribution tended to be denser up to 1.3 m from the trunk (constrained by tractor traffic) and in the 0.2 to 0.8 m soil layer. Pink Seradella maintained the same fine root density throughout the work row.

03. *The effect of different cover crop management practices on the soil and performance of apple trees. (J Fourie and C Kapp)*

Recommendations

A Saia oats monoculture should be established in apple orchards during the first two years after establishment on loamy sand and sandy soils. Thereafter, an annual rotation with pink Seradella should be maintained. Full surface post-emergence chemical control should be applied early October and early December or early January.

Cover crop management in the dryer apple producing areas, as well as on the heavier soils in the apple producing areas needs clarification. This will supply the industry with scientifically based guidelines for sustainable 'soil and tree friendly' soil management practices in apple orchards.

Crop Protection Plant Pathology

01. *Evaluation of pruning wound protectants on nursery apple trees. (L Mostert and G Gatsi)*

Objectives and Rationale

Wounds made when rootstock shoots are pruned back on nursery trees can get infected by canker and wood rot pathogens. These infections can develop into cankers causing dieback of young apple trees. Alternatives to current wound protectants need to be investigated to improve the protection provided on these wounds.

Methods

Four fungicides were evaluated *in vitro* for their efficacy towards mycelial growth inhibition of three canker pathogens and one wood rot pathogen. Field trials were initiated to test 11 pruning wound products or potential products on two rootstock varieties (M793 and MM109) occulated with Royal Gala in two nurseries. These trees are exposed to natural inoculum. Potted trials with M793 plants was started to evaluate the same treatments on rootstock wounds exposed to artificial inoculum of *Diplodia seriata*.

Key Results

One fungicide, imazalil has been tested *in vitro* against four pathogens (*Diplodia seriata*, *Diaporthe eres*, *Trametes versicolor* and *Didymosphaeria rubi-ulmifolii*.). The EC_{50} values for where possible 20 isolates per species were tested and calculated. The field trials (two nurseries) and potted trials were initiated. Eleven treatments were applied as well as the non-treated control. The pruning wounds will be harvested end of January 2019.

Conclusion and Discussion

More progress on the *in vitro* fungicide testing was expected. No conclusions can be drawn at this stage.

02. *Alternatives for the management of apple replant disease. (A McLeod and D de Villiers)*

Objectives and Rationale

Apple replant disease (ARD) is caused by a complex of biological agents, which results in the reduced growth of young apple trees on replanted apple soils. Management of ARD consists of fumigation with chloropicrin/1,3-dichloropropene, which is expensive and unsustainable. In a previous project (*Identification of inoculum sources of oomycetes, a major contributor to apple replant disease, and the management thereof*.), semi-selective chemicals, which also included fenamiphos, were shown to have potential for managing ARD. Fenamiphos will likely be removed from the market in the near future. The objectives of this project are to (i) evaluate cost effective and environmentally friendly alternatives for the management of ARD, (ii) determine if fluopyram has a broader spectrum of activity against ARD pathogens than fenamiphos and (iii) develop quantification methods for additional ARD causative agents.

Methods

Three orchard trials were established and treatments were applied in September 2017. Another two trials were fumigated in July 2018, and will be planted in September 2018. The efficacy of treatments applied in the 2017 trials were evaluated by measuring tree growth, and roots samples were taken for analyses of ARD causative agents. An apple seedling glasshouse trail was established using five ARD soils for evaluating the efficacy of fluopyram.

02. *Alternatives for the management of apple replant disease. (A McLeod and D de Villiers)*

Key Results

In the three 2017 orchard trials, analyses of the combined trial data showed that there were no significant differences in increase in trunk diameter ($P = 0.1107$) and shoot length ($P = 0.1812$) between treatments, which included the (i) untreated control, (ii) standard chloropicrin/1,3-dichlorpropene fumigation (Chl/1,3-dichl), (iii) Chl/1,3-dicl combined with semi-selective chemicals, (iv) semi-selective chemicals, (v) compost combined with mulch, metalaxyl and phosphonates and (vi) metham sodium combined with semi-selective chemicals. Nonetheless, there was a trend that the compost containing treatment was the best treatment. Root samples must still be analysed for microbial pathogens. Nematode analyses of roots showed that only one of the trials contained *Pratylenchus* spp., which was not affected by any of the treatments. The glasshouse trial will be evaluated in August 2018.

Conclusion and Discussion

The orchard trials must be continued for another 4 to 5 years before conclusions can be made regarding the efficacy of treatments.

03. *Management of apple replant disease using phosphonates. (A McLeod, M Nyoni and S Moein)*

Objectives and Rationale

The major apple replant disease (ARD) pathogens in South Africa consist of oomycetes, with plant parasitic nematodes occasionally being involved. A selected group of fungi (Cylindrocarpon-like and *Rhizoctonia* spp.) can also play a role. The first aim for this reporting period was to determine whether semi-selective chemicals (phenylamides, fenamiphos, imidacloprid and phosphonates) can increase yields in orchards established on ARD non-fumigated and fumigated soils and if fumigants differing in chloropicrin content differ in their yield response. The other aim was to determine the best method for applying phosphonate treatments to young apple trees for controlling *Phytophthora* root rot.

Methods

The efficacy of ARD management treatments were evaluated in three orchard trials by determining yield.

The effect of phosphonate application methods (soil drench, stem spray, stem paint and foliar sprays) on root phosphonate (syn. phosphite) concentrations, tree growth responses, yield, fruit residues and *Phytophthora* root concentrations were evaluated in three orchard trials.

Key Results

The higher dosage chloropicrin fumigant product in one of the three ARD trials resulted in significantly higher yields than the low chloropicrin fumigant. The semi-selective chemical treatment combined with the low chloropicrin fumigant was most consistent across the three trials in increasing yields.

The data from the *Phytophthora* trials (tree growth, yield and fruit residues) must still be analysed statistically before conclusions can be made regarding the efficacy of different phosphonate application methods in suppressing *Phytophthora* root rot on young apple trees. The phosphonate treatments showed potential for increasing yields by approximately 25% in the two trials where yield data could be obtained. A second set of root phosphite concentration data and *Phytophthora* root infection quantification data are still outstanding for the three trials.

Conclusion and Discussion

The use of a higher chloropicrin containing fumigant (57% chloropicrin and 38% 1,3-di chloropropene) is recommended for fumigation of ARD trials. Semi-selective chemicals can increase yields when combined with fumigants.

Two years of phosphonate applications on young apple orchards suffering from Phytophthora root rot showed that the treatments have potential for increasing yields.

04. *Screening apple rootstocks for tolerance to Phytophthora crown rot. (A Vermeulen)*

Objectives and Rationale

This project aims to test apple rootstocks for tolerance to crown rot (*Phytophthora cactorum*) as part of an integrated disease management strategy.

Methods

ARC Infruitec-Nietvoorbij prepared tissue culture plants of rootstocks G202, G222, G228, G890, G41, M7, M793 and MM109. Rootstocks M9 Emla, M9 (NIC29), G210, G778, G969 and MM106 were not included in the trial, as no tissue culture plants were available.

Soil was inoculated by mixing the sand-bran inoculum into sterilized soil at different concentrations. Pots were filled with the inoculated soil mixture and one seedling of each rootstock was planted in the pots and left to grow for 14 weeks. At plant the stem lengths were recorded. Six weeks after plant, isolations were made from inoculated soil to determine the presence of *Phytophthora* in the soil. After the 14 week growing period the plants' stem lengths and total weight were recorded.

Key Results

Isolations from soils after plant showed that the inoculation procedure worked as *Phytophthora* was isolated from the soil samples. Isolation from the roots were done on all the plants and no isolates were recovered from any of the rootstocks.

No visual differences were observed in the growth of the seedlings. No statistical differences were obtained between the different concentrations in both percentage growth and total weight. Three rootstocks (G228, M7 and G41) yielded statistically better growth. Rootstock G228 compares good with M7 and G41, which are believed to be resistant to crown rot and root rot, respectively. Rootstock G202 resulted in the lowest percentage growth increase; although it is resistant to root rot. Rootstock G202, M793 and G41 resulted in the lowest total weight.

Conclusion and Discussion

Comparing percentage growth of the different rootstocks, it shows rootstocks G202 and M793 to be the most affected by the pathogen and M7 the least. Comparing total weight, rootstock G228 and MM109 performed significantly better than most other rootstocks. Taking all the data into consideration it looks like rootstock G228 shows potential resistance to root rot. No definite conclusions can be made from these results.

05. *Survey of stem canker pathogens on stone fruit propagation material and young stone fruit trees. (L Mostert and R van der Merwe)*

Objectives and Rationale

The phytosanitary status of stone fruit nursery trees is not known, since canker and wood rot pathogens can be present inside the plant and not necessarily visible to inspectors. The objectives were: i) to identify the fungal stem canker pathogens present in nursery stone fruit trees; and ii) to evaluate the pathogenicity of possible stem canker pathogens.

Methods

One nectarine scion on two nectarine rootstock varieties and three plum scion on two plum rootstock varieties were sampled from three nurseries. Forty of each graft combination were collected with 1080 trees sampled in total. Isolations were made from the crown, bud union and rootstock pruning wound. Fungal isolates were identified by cultural characteristics and sequencing of the relevant barcoding genes and phylogenetic analyses conducted.

Key Results

Out of 1080 nursery trees 39% had fungal species associated with canker, wood rot or replant disease. The seedling nectarine variety had the lowest infection level. When evaluating the different plant parts isolated from, the crown region had the highest infection levels (30%) versus the bud union (9%) and the wound on the rootstock (7%). Fifty-four percent of the total fungal isolates were species associated with replant and 46% with canker. Of the replant associated pathogens *Dactylonectria novozelandica*, *Dactylonectria torresensis* and *Dactylonectria macrodidyma* occurred most abundant. The canker causing pathogens that occurred the highest were *Cadophora luteo-olivacea* and *Diplodia seriata*.

Conclusion and Discussion

The results of this research show that nursery stone fruit trees harbour latent infections. Different management practices need to be evaluated to prevent the infection of crowns, bud unions and pruning wounds of the rootstock.

06. *The role of stress factors in predisposing plum trees to invasion by bacterial pathogen Pseudomonas syringae pv. syringae. (T Coutinho, K Bophela and M Modiba)*

Objectives and Rationale

Our research objectives are to: i) determine if there is a link between ring nematode infestation and bacterial canker outbreaks, ii) determine if there is a link between *Phytophthora* and bacterial canker outbreaks, iii) study the effect of drought and ring nematode stress combination in predisposing plum trees to *Pseudomonas syringae* infection, and iv) the effect of *Phytophthora* as a biotic stress factor in predisposing plum trees to infection. Anecdotal evidence supports the hypothesis that abiotic and other biological factors influence the outbreaks of bacterial canker of stone fruit trees.

Methods

Two additional field surveys were conducted in October 2017 and March 2018 in major plum-producing farms in the Western Cape. Rhizospheric soil samples were collected from plum trees displaying symptoms of bacterial canker. Nematodes were extracted from the rhizospheric soil samples and ring nematodes were specifically counted. The internal transcribed spacer genomic region was sequenced for representative ring nematodes and a phylogenetic tree constructed using a maximum likelihood analysis.
Phytophthora spp. were isolated from the soil samples using a soil baiting technique. Lesions on plant material used as the baits were plated on to *Phytophthora* selective media. *P. multivora* and *Pythium irregulare* were isolated from one and two farms, respectively. Whether or not they are pathogenic to plum trees as yet to be determined.

Key Results

The ring nematode densities were higher in the soil samples collected in October 2017 than in March 2018. There were also fewer symptoms of bacterial canker observed. Eleven *Phytophthora* and eight *Pythium* isolates were obtained using the soil baiting technique.

Conclusion and Discussion

Climatic conditions and area were found to strongly influence the ring nematode densities and the occurrence of bacterial canker symptoms, respectively.

07. *Survey of stem cankers and dieback symptoms of young apple trees and possible inoculum sources. (L Mostert, M Havenga and G Gatsi)*

Objectives and Rationale

Recently, a higher occurrence of canker development on 1-year-old apple trees shortly after establishment was observed in apple orchards in the Western Cape Province of South Africa. Knowledge regarding latent infections of canker or wood rot pathogens in certified nursery trees in South Africa is lacking. This study aimed to assess the phytosanitary status of nursery trees in relation to canker and wood rot pathogens and to investigate propagation material as possible inoculum sources.

Methods

Thirteen 1-year-old apple orchards showing canker or dieback symptoms were sampled from three apple producing areas in the Western Cape. Certified nursery apple trees were collected from four nurseries as well as scion and rootstock mother plant material, which are used during propagation of apple trees. The propagation material sampled include cankers and pruning wounds from apple scion mother blocks, 1-year-old scion shoots, rootstock layer blocks, and diseased 1-year-old rootstock shoots. Isolations were made from the discolouration observed in the vascular tissue of the plant parts and from asymptomatic material. Causal fungal species involved in the infection of the apple plant material were identified. Pathogenicity trials were done with 39 species inoculated onto two-year-old branches of 14-year-old Golden Delicious trees. Lesions lengths were measured and fungi re-isolated after 5 months.

Key Results

Similar canker and wood rot fungi were isolated from 1-year-old diseased apple trees, nursery apple trees and from the propagation material. A total of 44 fungal species associated with canker or wood rot symptoms reported on fruit trees or other woody hosts were identified in this study. *Didymosphaeria rubi-ulmifolii s.l.* was the dominant fungal specie causing latent infection in the certified nursery apple trees and was also found causing dieback in 1-year-old apple trees. Other canker and wood rot pathogens isolated belonged to the Basidiomycetes, Botryosphaeriaceae and Diatrypaceae. It also included species in the genera *Didymella*, *Didymosphaeria*, *Phaeoacremonium*, *Diaporthe*, *Cadophora*, *Coniochaeta*, *Cytospora* and *Truncatella angustata*. Sixty-five percent of certified nursery apple trees were infected with canker and wood rot pathogens. The bud unions and pruning wounds on the rootstock were most infected in the nursery trees, suggesting that aerial spores are also sources of inoculum. Basidiomycete and Ascomycete fruiting structures were found on the scion mother block trees, 1-year-old apple trees, and the 1-year-old nursery rootstock shoots which can contribute to aerial inoculum. Propagation material is also a source of inoculum with scion shoots used for budding and rooted rootstock cuttings from layer blocks having respective 5% and 21% latent infections of canker and wood rot pathogens. *Neofusicoccum viticlavatum, D. foeniculina* and *D. perniciosa* caused the longest lesions in the pathogenicity trial, while all the other species caused lesions that were significantly longer than the control.

07. *Survey of stem cankers and dieback symptoms of young apple trees and possible inoculum sources. (L Mostert, M Havenga and G Gatsi)*

Conclusion and Discussion / Recommendation

This study confirmed the presence of canker and wood rot pathogens in apple propagation material as well as certified nursery apple trees. Management should focus on i) the sanitation of orchards and nursery fields of dead shoots and branches; ii) the production of cleaner propagation material and iii) improved wound protection of nursery trees.

Crop Protection Integrated Pest Management

01. *Sequencing the genome and transcriptome of false codling moth, Thaumatotibia leucotreta, for pest management. (J Terblanche and M Karsten)*

Objectives and Rationale

The false codling moth (FCM), *Thaumatotibia leucotreta* (Meyrick), is a polyphagous pest attacking many crops of economic importance. The development of novel control methods for FCM is an urgent priority for several fruit kinds to maintain current and emerging market access. Here we aim to develop a new genomic and transcriptomic toolkit for FCM in order to support novel population control methods and better understand the rapid evolution of, and constraints on, pesticide resistance and environmental stress adaptation and potential interactions between these.

Methods

False codling moth adults were obtained from XSIT (Citrusdal) as starting material. Laboratory rearing of moths to create full-sib families for the transcriptome applications has been started. We reached out to multiple commercial genome sequencing companies to obtain quotes as well as more information with regards to bioinformatics support. Several different DNA extraction techniques have been performed and tested to ensure sufficient amounts of high quality DNA for whole genome sequencing.

Key Results

A commercial company has been chosen and a feasible time line worked out for sequencing of the false codling moth genome. To attain sufficient amounts of DNA for genome sequencing, several moth's DNA had to be pooled and DNA for shotgun sequencing and for mate-pair genome sequencing has been effectively extracted and is ready for collection. Laboratory rearing of full-sib families has started with the rearing process being optimised.

Conclusion and Discussion

The laboratory rearing of moths has started and DNA is ready to be collected by MACROGEN for whole genome sequencing. This project is on track for completion

02. *Exploration of orchard sanitation and the potential of parasitic wasps for the biological control of fruit flies in South Africa. (P Addison and B Stead)*

Objectives and Rationale

The objectives of this project are to i) identify (morphologically and molecularly) the diversity of parasitic wasp species in South Africa and their relative importance in controlling fruit flies; ii) search for biocontrol agents in the area of origin of fruit flies (rest of afrotropical region) in view of future introductions; iii) highlight the trophic associations between fruit flies and their parasitoids (utilizing a DNA metabarcoding approach), and iv) perform initial testing of augmentoria, which could greatly assist with orchard sanitation.

Methods

Subsequent to extensive surveys, all samples will be subject to DNA extraction, PCR amplification and sequencing the mitochondrial Cytochrome Oxydase 1 to construct a DNA barcode database using conventional molecular methods. A 2 step PCR and an illumina sequencing technology will be applied to fresh samples collected in the field in order to assign each parasitoid wasp to its specific insect host, and the wasp species specifically associated with fruit flies will be identified. Lastly, an augmentorium (orchard sanitation method) will be tested to optimize and adapt the technique according to optimal size of netting to match size of local parasitoids, and optimal time for fruit collecting.

Key Results

The first surveys have taken place and parasitoids have been obtained from modified augmentoria. These first samples have been sorted into morphospecies and are currently being processed at the DNA laboratory in France.

02. *Exploration of orchard sanitation and the potential of parasitic wasps for the biological control of fruit flies in South Africa. (P Addison and B Stead)*

Conclusion and Discussion

No conclusions can be provided at this stage of the project.

03. *Determining the contribution of wild honey bees (pollination ecosystem service) to commercial deciduous fruit production. (R Veldtman and M Allsopp)*

Objectives and Rationale

Deciduous fruit orchards found in landscapes with a high percentage of semi-natural areas may receive a pollination service from wild honey bees. If their contribution is significant, it would have implications for industry recommended hive stocking rates. We aim to investigate the contribution of wild versus managed honey bees as pollinators in a deciduous fruit crop under different landscape contexts in the Western Cape. Seeing as field observations alone cannot determine if observed honey bees are wild or managed, we propose to determine this ratio by manipulating introduced honey bee hives.

Methods

By using hive boxes that can regulate the foraging of the colony, counting foraging bees when the colonies are closed compared to when they are open, we can determine the percentage of honey bees from introduced versus wild colonies. We will use early flowering plums as our study crop. This experimental approach is novel and no device has been developed to allow for the easy separation of returning honey bee foragers from outgoing foragers, without disruption.

Key Results

None as yet. The first device failed to adequately separate the incoming from the outgoing foragers, while the second device succeeded in this purpose but only at the cost of causing unacceptable levels of disruption around the entrance of the colony. A third improved device is currently in pre-field testing.

Conclusion and Discussion

At this stage no milestones have been achieved due to a hive device still being tested. Orchard experiments will now be done in the 2019 field season.

04. *False codling moth population genetics: gene flow in agricultural environments. (J Terblanche, M Karsten and E Huisamen)*

Objectives and Rationale

The false codling moth (FCM), *Thaumatotibia leucotreta* (Meyrick), is a polyphagous pest attacking many crops of economic importance, and is listed as a quarantine pest for most of our export markets. Here we aim to investigate the gene flow of FCM in orchards and non-orchards across South Africa to identify potential movement pathways and possible host races. In addition, the possibility of refugia will be explored in the Western Cape Province and kinship analyses will be used to track moths and provide estimates of dispersal.

Methods

Microsatellite markers will be developed using the genome of false codling moth. This project's methods dovetail and overlap with our other project entitled "*Sequencing the genome and transcriptome of false codling moth, Thaumatotibia leucotreta, for pest management*" and progress on that project compliments this one too. Developing microsatellites from the whole genome provides us the opportunity to develop markers that better represent FCM genetic diversity and therefore provide better coverage and reliability.

Key Results

A student has been identified and registered for a PhD in February 2018 (Mrs Erika Huisamen). The student has been busy with background reading to be incorporated into her PhD proposal and developing her project presentation to the Department of Conservation Ecology and Entomology. In conjunction with proposal writing, the student has identified areas for trap setting and fruit collections and has been learning important laboratory techniques, including DNA extractions.

Conclusion and Discussion

No conclusions can be made at this stage.

05. *Using biological control against two sporadic pests in vineyards and orchards. (P Addison and B Dlamini)*

Objectives and Rationale

Due to the sporadic nature of katydids in vineyards, no chemical pesticides have been registered for this pest and current chemical control measures are mostly ineffective. However, previous research has identified possible biological control agents, including entomopathogenic fungi (EPFs) and parasitic wasps, which can be incorporated into an IPM program. Katydids seem limited to the Cape Winelands region but further research will be required to determine their distribution. *Phlyctinus callosus* (Schönherr) (Coleoptera: Curculionidae) or banded fruit weevil (BFW) is a sporadic pest causing damage to fruits, leaves and roots of deciduous fruits in the Western Cape province. Trunk barriers are used to prevent the weevils from reaching leaves and fruits, but this method is labour-intensive. Entomopathogenic fungi (EPF) are effective biocontrol agents for the control of soil-borne and above ground insect pests.

Methods and results

Consultants and farmers were contacted to assess katydid populations. During site visits, katydid densities were recorded and katydids were collected for bioassays. Insects were temporarily kept in a laboratory colony in between bioassays. Twelve entomopathogenic nematode (EPN) species were evaluated at a concentration of 200 infective juveniles per katydid nymph.

Different EPF isolates were screened at 1 x 10^6 conidia ml^{-1} for virulence against different life stages (larvae, pupae and adults) of the BFW. The results indicated that Broadband (*Beauveria bassiana*) (96.7 %) and Meta 69 (*Metarhizium anisopliae*) (92.5 %) resulted in *P. callosus* larval mortality significantly higher ($p < 0.05$) than EcoBb (*B. bassiana*) (58.3 %), with no difference between each other. In the case of pupae, Broadband (91.7 %) resulted in mortality significantly higher ($p < 0.05$) than EcoBb (67.5 %) and Meta 69 (65.8 %). Broadband (90 %) resulted in adult BFW mortality, which differs significantly from EcoBb (69.2 %) and Meta 69 (65 %). Broadband (91.7 %) gave significantly higher ($p < 0.05$) control of BFW adults than EcoBb (65 %), Meta 69 (59.5 %) and *M. anisopliae* isolate EA iso 2 (64.2 %) when the commercial EPF virulence was compared to local EPF isolates.

Conclusion and Discussion

The distribution of katydids, primarily in the Cape Winelands Region of the Western Cape, were confirmed and mapped. Katydid densities were inconsistent throughout the season. Similar to last year, survivorship of katydids in a laboratory colony were poor. Four EPN species had promising results (average 48H mortality in brackets): *Heterorhabditis zealandica** (100%), *H. indica* (95%), *Steinernema jeffreyense* (94%), and *S. yirgalemense* (91%). Statistical analysis of data is still pending.

The results indicated that all the EPF isolates tested were effective against the immature and adult stages of the BFW, showing clear differences among the EPF isolates tested. Broadband can effectively control BFW under laboratory conditions, the conducting of large-scale field trials are recommended to demonstrate the potential use of this biocontrol agent within integrated pest management programmes.

06. *The effects of biotic and abiotic factors on the distribution of economically important weevils in the deciduous fruit industry. (P Addison and M Magagula)*

Objectives and Rationale

It is proposed that an in depth analysis be undertaken to determine which abiotic and biotic factors play a role in causing damaging population levels in commercial orchards/vineyards. The objectives of this project will include: 1) determination of the influence of soil type on weevil distribution, 2) determining the influence of orchard floor management practices (e.g., cover crops), 3) establishing the relative abundance of economically important weevil species and user-friendly keys for the identification of the species involved. The aim of this study will be to yield valuable information in developing improved weevil management related to both soil texture and cover crop variability (cultural control methods), as well as prioritising the species that should be targeted for management purposes.

Methods

Farms with a history of weevil infestations will be selected in two-three regions (e.g. Ceres, Elgin and a coastal region). Monitoring will take place once per month, using weevil bands (double-sided cardboard bands) and plant (buds, leaves, stems and fruit) damage assessments. Collection of geographic and biological attributes will include: soil, slope, location, orchard design (nr. trees/vines/ha, row spacing, irrigation, fertilisation etc.), cover crop assessment (type, estimation of % cover, ratio between broad leaf and grass species). Weevil species (if occurring as mixed populations of various species) will be analysed using rank abundance curves which assess both species richness and evenness to determine level of dominance.

Coupled with results from damage assessments, the data will indicate which species are of more economic concern for growers.

06. *The effects of biotic and abiotic factors on the distribution of economically important weevils in the deciduous fruit industry. (P Addison and M Magagula)*

Key Results

Field sites were established in Grabouw, Ceres and Stellenbosch (one orchard and one vineyard block each). Seasonal monitoring has been completed, using cardboard bands and fruit damage assessments have taken place in all sites, indicating high damage levels (above 50%). Final assessments show that *P. callosus* appears to be the dominant weevil species in apples, while in the vineyards *E. occutus* and *E. setifer* were the second and third dominant species after *P. callosus*. An easy identification key for the identification of common weevils attacking both grapevines and apples has been compiled. One poster was presented at the recent ESSA/ZSSA conference in Pretoria during July 2017.

Conclusion and Discussion

P. callosus (Banded fruit weevil) is the dominant weevil species, followed by *E. occutus* and *E. setifer*. A taxonomic identification key has been developed and will be adapted for non-experts. Field work has been completed and currently data analysis is being conducted. The student is due to graduate in March 2019.

07. *Maintaining and rearing of insect cultures. (D Stenekamp and T Asia)*

Objectives and Rationale

The objective of this project is to establish and maintain different insect species in a laboratory environment to assist researchers and currently enrolled post-graduate students in developing IPM technologies. These studies are all current and cannot be completed without the rearing of these insect species.

Methods

The following species were reared in the laboratory in 2017/2018: codling moth (*Cydia pomonella),* Trichogramma wasp, Mediterranean fruit fly (*Ceratitis capitata*), banded fruit weevil (*Phlyctinus callosus*), wax moth larvae (*Galleria mellonella*) and *Lobesia vanillana*. All of these insects were reared on different artificial mediums except the banded fruit weevil which was reared on carrots.

Key Results

An average of 15 000 codling moths and 1 000 Mediterranean fruit flies were reared weekly. A total of 951 banded fruit weevil larvae and 250 adults were reared. An average of 200-250 Lobesia moths were reared weekly.

Conclusion and Discussion

A medium-scale, multi-rearing system was successfully maintained. Not only was there an increasing demand for rearing and maintaining a variety of insects, but we could supply the students with adequate material.

08 . *Integrated management of the control of false codling moth, Thaumatotibia leucotreta, on stone fruit and table grapes. (P Addison and V Steyn)*

Objectives and Rationale

False codling moth (FCM), which is a priority pest on stone fruit, has recently become a problem on table grapes, posing phytosanitary restrictions in terms of export fruit, as well as direct crop damage. This project aims to investigate the use of biological control and mating disruption as alternate control methods for FCM.

Methods

Soil surveys were conducted in the Western Cape, so as to establish what pathogens (nematodes and fungi) are present. Newly collected and known species/strains were tested in bioassays against FCM eggs, larvae and pupae. Mating disruption experiments were executed in stone fruit and table grape blocks to determine the level of disruption for six doses (0,1/3FD,2/3FD,1FD,4/3FD,8/3FD) and for five densities of Isomate™.

Key Results

Soil survey
• Entomopathogenic fungi – nematodes isolated from soils
Bio-assays
• EPN collected (*H. indica, H. bacteriophora, H. zealandica*) from soil
• EPN caused mortality in eggs (first record,30-70%), larvae (70-100%) and pupae (8-27%)
• EPNs caused high mortality and persisted 4 weeks after application in field trials
• EPF caused larval mortality (20-77%), strains require identification

08. *Integrated management of the control of false codling moth, Thaumatotibia leucotreta, on stone fruit and table grapes. (P Addison and V Steyn)*

Key Results

Mating disruption experiments
- Field work complete total of 94 releases
- Mating disruption works against FCM in stone fruit and table grapes
- 0.33xField dose to 1xField dose=83% disruption, 1.33-2.66xField dose=96% disruption
- 800 dispensers/ha optimal dose
- 36 Clusters of dispensers similar to disruption from 800 single dispensers

Conclusion and Discussion

It is evident that the alternate control methods tested to date against FCM work well and should form part of an integrated control program against FCM. Control of FCM entering orchards from neighbouring areas may become important to consider.

09. *Pest and disease monitoring in orchards under shade net. (M Addison)*

Objectives and Rationale

The use of shade netting in apple orchards is becoming common place. The effects on the pest and disease complex in covered orchards are poorly understood. This study is aimed at determining the effects of shade netting on the pest and disease complex. In addition, aspects such as soil health and orchard floor management practices will be assessed where possible.

Methods

Orchard A23 on Oak Valley Estate in Elgin was selected for the purpose. The orchard is fully enclosed with 20% white shade cloth. The orchard is 2.45ha in extent and is planted to Granny Smith on a range of rootstocks (CG222, M7, M9, M109). The orchard was planted in 2012 and extended in 2013. The orchard is contiguous and an untreated (trees without nets) area is available for comparative purposes. Standard pest and disease monitoring protocols will be followed in the orchard. Pre harvest fruit damage assessments will be carried out by inspecting 10 fruit per tree on 25 trees per block. In addition, on farm monitoring data will be collected. Additional soil sampling will be conducted where possible according to standard protocols.

Key Results

Pest monitoring data indicates the orchard remains codling moth free, woolly apple aphid and banded fruit weevil appear to be an increasing problem. A geometrid moth, *Cleora tulbaghata* has been "captured" in the orchard and causes extensive leaf and shoot damage. Fruit damage assessments indicate that woolly apple aphid and banded fruit weevil are problematic in the orchard despite routine control measures being applied. Soil sampling to determine the nematode populations and the status of soil health indicate that the soils remain disturbed and unbalanced. In addition, root lesion nematode species are increasing both in the tree and work row.

Conclusion and Discussion

Pest and disease monitoring should continue in the orchard. The project should be extended to assess the effects of shade netting on orchard floor management including cover crops in additional orchards.

10 . *Control of false codling moth, Thaumatotibia leucotreta, on stone fruit with mating disruption. (D Stenekamp and T Asia)*

Objectives and Rationale

False codling moth, *Thaumatotibia leucotreta* (Meyrick) (FCM), has an adverse economic impact on the export of stone fruit as stone fruit might be subject to phytosanitary regulations regarding FCM. It is important due to the possible economic impact to control this pest using an integrated pest management approach and the current best option is using mating disruption.
The performance of FCM under oriental fruit moth *Grapholita molesta* (Busck) (OFM) mating disruption (MD) was monitored in stone fruit orchards. Oriental fruit moth and FCM are both key pests on stone fruit and share the same pheromone components, but the two acetates in the MD are used in different, non-overlapping ratios. It is noteworthy that no FCM mating disruption was registered on stone fruit until the end of 2016. The growers now have a choice between OFM and FCM mating disruption per orchard as to using both is expensive.
The objective was to examine if OFM MD would be an effective mating disruptant for FCM.

Methods

Sterile FCM moths were centrally released in three plum orchards under Cidetrak® OFM MD, three plum orchards under no MD and three plum orchards under FCM MD. Six central releases were done in each orchard. Eight FCM traps were placed in each orchard and wild and sterile FCM catches were recorded weekly. A sample of each week's sterile FCM moths was used for laboratory flight cylinder tests to verify the quality of the released moths.

10. *Control of false codling moth, Thaumatotibia leucotreta, on stone fruit with mating disruption. (D Stenekamp and T Asia)*

Key Results

More FCM moths were caught in the traps in the non MD orchards than in the OFM MD orchards. More sterile moths were caught in the OFM MD orchards than the FCM orchards. Very low numbers, if any, of the sterile and wild moths were caught in the FCM MD orchard. The FCM damage in the orchards decreased from 2016/2017 to 2017/2018.

Conclusion and Discussion

False codling moth is a quarantine pest and therefore there is a zero tolerance for fruit damage. OFM MD may have an effect on FCM under low populations, but under high moth populations it is not sufficient to disrupt FCM.

11. *Investigating biological control agents for the management of Ceratitis capitate (Wiedemann). (P Addison and M James)*

Objectives and Rationale

Persistent crop damage and loss caused by fruit flies (Diptera: Tephritidae) forces the reliance on chemical control methods by the fruit industry. However, social, environmental and economic consequences associated with such controls are forcing the exploration of alternative, more sustainable options. This study investigates the use of entomopathogenic nematodes (EPNs), entomopathogenic fungi (EPF) and parasitoid wasps, as biological control agents against one of the most widespread and dominant fruit flies in South Africa, the Mediterranean fruit fly or Medfly (*Ceratitis capitata* (Wiedemann)).

Methods

Different methods were used in order to (i) isolate and identify local EPNs and EPF from deciduous fruit orchard soils; (ii) evaluate the pathogenicity of local EPN and EPF isolates against the third larval stage of Medfly under controlled laboratory conditions, and the most virulent of each in a more natural (sand) environment; (iii) estimate the lethal concentration/dose needed to cause 50% *C. capitata* mortality (LD50) using selected EPN isolates; and (iv) survey for and identify fruit fly parasitoid species occurring in fruit-producing areas of the Western Cape, Mpumalanga and Limpopo Provinces.

Key Results

Soil sampling yielded many local entomopathogenic isolates, including EPNs with new bacterial associations and an EPF, *Metarhizium robertsii* (MJ06), which was trapped using Medfly larvae as bait. Initial EPN screenings (100 IJs / 50 µl) showed all tested EPNs to be highly pathogenic against the third instar Medfly larvae, while the lower concentration (50 IJs / 50 µl) highlighted *H. noenieputensis* as the most virulent EPN species. This species, as well as *S. yirgalemense,* which is currently in the process of being mass cultured and formulated for commercial use, was further tested in sand bioassays. *Heterorhabditis noenieputensis* caused significantly greater mortality (94-100%) and most Medfly infected as larvae pupated and then died within the puparium. *Steinernema yirgalemense* also offered good control, with 58-79% of exposed larvae dying as adults. The LD50 of *H. noenieputensis* was 37 IJs / insect, which was 14 times more effective than those of *S. yirgalemense.*

Local EPF isolates and commercial products tested against third instar larvae, using the dipping method, were pathogenic and caused visible fungal infection (mycosis) of 57-74%. A replicate experiment with reduced humidity, also reduced overall mycosis, with the highest mycosis of 55% caused by the local isolate, MJ06. Third instar Medfly larvae added to sand, sprayed with the non-commercial EPF, caused most exposed larvae to die and mycose as adults (62-86%). Parasitoid wasps were obtained during fruit sampling, but difficulties with low DNA extraction, amplification and limited available barcodes of local fruit fly parasitoids, restricted their species identification. The use of sentinel traps - setting out apples infested with Medfly eggs and larvae as well as exposed Medfly pupae - did not trap any wasps during this study, but provides a simple and inexpensive method to be used in future studies.

Conclusion and Discussion / Recommendation

This study highlights an EPN (H. noenieputensis SF669) and EPF (M. robertsii MJ06), virulent against the soil-life stages of Medfly, which should be the focus of future studies as potential biocontrol agents. Moreover, this study provides valuable groundwork for the future incorporation of local biological control agents, into an IPM system, to sustainably and effectively manage the Mediterranean fruit fly.

Crop Protection Precision Agriculture

01. *Replacing or modifying the Unrath model for optimal spraying in high density orchards, by using the principles of the MABO-dosing model. (A McLeod and P Rebel)*

Objectives and Rationale

In modern high density orchards in South Africa, the currently used pesticide dosing model together with axial fans without turrets are likely not optimal. The MABO dosing model has been developed for modern orchards in Germany and Austria. Spray deposition must be correlated with biological efficacy, i.e. pest and disease control. No biological efficacy model is available for any disease on apple. The objectives of the study are to (i) evaluate the efficacy of the MABO dosing model in high density orchards in South Africa, (ii) develop a spray drift sampling and quantification protocol and (iii) develop a biological efficacy model.

Methods

Evaluation of the MABO dosing model were done using orchard trials along with fluorescent pigment sprays, photomicrography and digital image analyses. The biological efficacy model was evaluated using apple seedlings sprayed with mancozeb, spray deposition quantification and *Venturia inaequalis* inoculations. Pathogen infections were quantified using infrared thermal photography, image analyses and qPCR analyses.

Key Results

Four spray trials evaluated the MABO dosing model within orchards with different canopy size and tree densities. In two of the trials, the adverse effect of wind on the outcome of spray deposition was illustrated, even though the wind velocity was still within the considered safe range for spraying. Final orchard spray trials were done at two volumetric airflow fan rates. Varying tractor speed as required by the MABO model resulted in a better fit of the spray machine air profile to the target canopy, which was more pronounced in the narrower 3.5m than in the 4m inter row width orchards. Thermal infrared imaging and qPCR protocols were optimized and used towards determining the biological efficacy deposition benchmarks for apple scab.

Conclusion and discussion

The MABO model has potential for pesticide application in high density orchards in South Africa. Thermal infrared imaging can be used for apple scab disease severity quantification.

02. *Integration of GIS and spatial analysis with monitoring data of major pests for the purposes of area-wide management. (P Addison and F Bekker)*

Objectives and Rationale

To incorporate fruit fly monitoring data from Fruit Fly Africa and XSIT into a geo-database together with corresponding environmental variables in order to spatially analyse the monitoring data. Variation in the spatial patterns of Mediterranean Fruit fly (Medfly) were investigated and the most influential variables that explain these spatial patters will be determined. During the past year, exploratory factors that might explain the spatial distribution of Medfly in the Western Cape were investigated and data analyses conducted.

Methods

Incorporate monitoring data into a Geographic Information System (Data management procedure). Optimized hotspot analysis (ArcGIS 10.5.1) to investigate spatial patterns. This analysis identifies statistically significant spatial data clusters of high values (hot spots) and low values (cold spots).
Classification and regression tree algorithms. This type of analysis is used to model the likelihood of occurrence of a certain event. In the case of this study, to model the likelihood of an increase in trap catches. This analysis also identifies the most important variables that explain the data.

Key Results

RF (Random Forest) proved to handle the increase in complexity when the WB and EGVV datasets were combined quite well. For most of the models the combined model accuracies were similar to the individual regions' model accuracies

Conclusion and Discussion

The combined RF models provided good model accuracies and gave similar results to the region-specific models, however, when environmental variables do not share overlapping ranges, as was the case for EGVV and the WB, the dominant factors driving *C. capitata* hot-and cold spots may not be sufficiently accurate to explain these hot-and cold spots. Therefore, it is recommended to only use combined models for explaining *C. capitata* hot-and cold spots in regions that share more similar geography (overlapping ranges), and separate region-specific models where environmental factors have different value ranges (less overlap).

03. *Evaluating an ascospore release forecasting model and orchard disease monitoring methods for improving apple scab management. (A McLeod and D de Villiers)*

Objectives and Rationale

Apple scab caused by *Venturia inaequalis* is a disease of major economic importance. Although disease management is effective in most years, substantial losses can occur. This is likely due to our inability to identify severe primary infection events, since the currently used disease prediction model (iLeaf) only uses weather parameters, and not ascospore quantities. The RIMpro forecasting model can improve predictions since it takes both parameters into account. An important factor that determines the severity of primary scab infections is the potential ascospore dosage (PAD), which is determined by scab severity in fall. The three objectives of the study were to (i) establish a method for determining the biofix (first ascospore release of the season), which is required as an input parameter for running RIMpro, (ii) validate the RIMpro model in South Africa and (ii) to evaluate different grower based PAD methods.

Methods

The biofix was determined in nine orchards over two seasons (2016/17 and 2017/18) using scabbed leaves overwintered in plastic mesh bags or Triloff traps. The RIMpro model was validated in three to five commercial orchards in three seasons (2015/16 to 2017/18), and in the last two seasons also in an experimental ARC orchard. Trap trees and Rotorod spore samplers were used to determine the severity of scab infections and ascospore release respectively, during infection events. A qPCR method was developed for quantifying ascospores from Rotorod samplers. Three grower based PAD methods were evaluated in seven orchards over two seasons; a MacHardy leaf counting method, a European percentage infected shoots method using 25 trees, and a modified European method using 60 trees.

Key Results

The biofix could only be identified in the ARC experimental orchard in the two assessed seasons using leaves overwintered in plastic mesh bags. The RIMpro model only indicated one to four infection events per season, whereas the iLeaf model indicated many more infection events. The RIMpro model was very accurate in the 2015/16 season in commercial orchards based on trap tree data and ascospore quantifications. RIMpro was not accurate in predicting trap tree infections and ascospore release patterns in the 2016/17 season in commercial orchards. In the 2017/18 season RIMpro was accurate in prediction the two most severe infection events, based on trap tree infections. Ascospore release patterns in the 2017/18 season could not be determined since *V. inaequalis* DNA quantities on spore samplers were too low to accurately quantify. The presence of low ascospore inoculum was also supported by low disease severities on trap trees in all of the orchards in the 2017/18 season. In the experimental ARC orchard, RIMpro was inaccurate in predicting trap tree infections and ascospore release.

Evaluation of three grower based PAD methods showed that there was a good correlation between the methods. However, the MacHardy leaf counting method revealed larger differences in PAD between some orchards than the European methods.

Conclusion and Discussion / Recommendation

The RIMpro model has potential for predicting severe apple scab infection events. It is unknown why the model was inaccurate in commercial orchards in the 2016/17 season. The latter along with the fact that the three evaluated seasons were very dry and not conducive to scab development, are reasons why RIMpro requires further evaluation under South African conditions. The ARC experimental orchard, due to high annual scab incidences, likely involves asexual reproduction, which explains the inaccuracy of RIMpro in the orchard. The inability to detect the biofix in commercial orchards and low ascospore quantities on Rotorod samplers in the 2016/17 and 2017/18 seasons in the commercial orchards suggest that ascospore inoculum levels were low, irrespective of high fall scab levels.

Postharvest Quality Management

04. *The effect of DPA on fruit quality in pome fruit. (A Botes)*

Objectives and Rationale

Previously, the South African apple and pear industry relied on diphenylamine (DPA) for controlling superficial scald disorder; however, increasing consumer concerns and reduction in maximum residue levels (MRLs) resulted in the industry rather using alternative control strategies. Since DPA is not used on fruit exported to the EU, it may lead to other fruit quality problems. The past few seasons a lot of internal browning issues occurred. The aim of this project is to determine the effect of DPA on fruit quality. These results may lead to a re-evaluation of the current recommended CA regimes for South African pome fruit.

Methods

Optimum harvested ‘Cripps’ Pink’ apples from three sites from two production areas were subjected to five postharvest treatments. Fruit quality evaluations were done after three storage periods.

04. *The effect of DPA on fruit quality in pome fruit. (A Botes)*

Key Results

Fruit from the three sites in Grabouw had diffuse browning after 3 months storage in all the treatments. In two of the sites, the DPA+RA and RA stored fruit tended to have the lowest percentage of diffuse browning after 6 and 9 months. In all the sites, the DPA+RA and RA fruit had soft scald after 6 months followed by 14 day shelf-life. In two of the sites, all the treatments had soft scald after 9 months followed by 7 day shelf-life. Fruit from the three sites in Ceres had diffuse browning after 3 months storage which increased during the longer storage periods. Soft scald was found on RA and DPA+HCA stored fruit in all the sites at various storage periods.

Conclusion and Discussion

The application of DPA did not prohibit the development of internal browning, specifically diffuse browning. The determination of antioxidants and cell membrane integrity might give more insight into this. The trial included variables that we knew would induce browning such as farms with a historic internal browning problem and storing of apples at -0.5°C instead of the recommended 1°C. High CO_2 levels (2.5%) did not cause internal browning related to CO_2 damage. This season a standard recommended treatment was included to see if no diffuse browning can be achieved.

05. *Quantifying the effect of bag perforations on forced-air cooling cycles and post storage quality of apples. (D Viljoen)*

Objectives and Rationale

The pome industry is under pressure to reduce the forced-air cooling cycle of commercial pallets after packing and prior to shipment. It is likely that the forced-air cycles can be shortened if perforated liner bags are used.
Objectives:

1) To quantify the improvement in cooling rates/shorter forced-air cooling cycles which can be achieved with apples in perforated bags.

2) To determine the ability of liner bags, perforated to the extent that it makes a significant contribution (>20% - 40%) to forced-air cooling (FAC) rates, while maintaining post storage quality during simulated export, on selected pome fruit cultivars.

3) To test the best bag treatment on commercially cooled pallets of fruit.

Methods

Top Red apples were packed in MK9 open display apples cartons and Cripps' Pink and Golden Delicious apples were packed in MK4 apple cartons after commercial room opening. Fruit were allowed to warm up to ± 14 °C before being subjected to forced-air cooling. Fruit quality was evaluated after 4 and 9 weeks RA cold storage.

Key Results

High lenticel spot incidence occurred on Golden Delicious apples packed without a bag and in perforated bags.

Conclusion and Discussion

Packing fruit in bags with small perforations did not cool as efficiently as large perforations. With Reds and Cripps' Pink apples, the shorter cooling time did not have a significant negative effect on fruit quality. Golden Delicious apples exhibited significantly more lenticel damage when packed and forced air cooled in perforated bags or without a bag.

06 . *The use of Harvista™ (pre-harvest 1-MCP) application to control superficial scald on Packham's Triumph pears. (D Viljoen)*

Objectives and Rationale

The postharvest application of SmartFresh℠ has been investigated for superficial scald control on Packham's Triumph pears and although this product shows good control of superficial and senescent scald on Packham's Triumph pears, fruit may experience ripening issues, especially if the product is applied shortly after harvest. DCA storage may also control superficial scald development, however, not enough rooms are available and alternatives are urgently sought. Therefore the aim of this trial was to evaluate the use of pre-harvest Harvista™ sprays (1-MCP) to control superficial scald on Packham's Triumph pears during extended storage.

Methods

Harvista™ was applied to Packham's Triumph pears at release (early optimum), optimum (7 days after release) and post optimum (7 days after optimum). Fruit were harvested ± 3 days after spray application and stored for 3, 5 and 7 months at -0.5° C in RA. Fruit were evaluated after cold storage and a 7 day simulated shelf life at 20° C.

06. *The use of Harvista™ (pre-harvest 1-MCP) application to control superficial scald on Packham's Triumph pears. (D Viljoen)*

Key Results

Regardless of concentration, harvest time and storage duration, Harvista™ treated fruit were significantly firmer after shelf life compared to untreated fruit. Superficial scald occurred only on fruit stored for 5 and 7 months. Shelf life results show reduced levels of superficial scald on Harvista™ treated fruit.

Conclusion and Discussion

Harvista™ retarded ripening of fruit and reduced the incidence of superficial scald. However, it did not completely control this disorder. Future work should include CA/DCA storage to determine if there is a synergistic effect with pre harvest Harvista™ sprays.

07. *The maximum delay in SmartFresh℠ application from harvest to room filling for fruit destined for the FEMA programme. (B Pienaar)*

Objectives and Rationale

The volume of Forelle Early Market Access (FEMA) fruit has increased drastically since 2013. An unexpected outcome from the increased volumes was the sometimes limited availability of SmartFresh℠ treatment rooms, and the rate of filling of these rooms within the 7 day protocol.

The aim of this study was therefore to determine the maximum delay in SmartFresh℠ application from harvest to room filling for fruit destined for the FEMA programme, without softening of the fruit and the expression of mealiness and to determine if treatment efficacy is compromised by mixed maturities (2014 – 2016). The aim of the extension of this trial was to determine if FEMA fruit subjected to a delayed SmartFresh℠ application (14 days after harvest) can be stored up to 12 weeks, without ripening of the fruit and the expression of mealiness (2017 – 2018).

07. *The maximum delay in SmartFresh℠ application from harvest to room filling for fruit destined for the FEMA programme. (B Pienaar)*

Methods

2014 - 2016

Forelle pears from two populations sourced from the Vyeboom area were treated 7, 9, 14 and 21 days after harvest with SmartFresh℠ and stored for 6 weeks at -0.5°C. Post storage quality of fruit was evaluated at the end of the cold storage period and after a simulated shelf-life of 7 days at 20°C.

2017 - 2018

Forelle pears from two populations sourced from the Vyeboom area were treated 7 and 14 days after harvest with SmartFresh℠ and stored for 5, 8 and 12 weeks at -0.5°C. Post storage quality of fruit was evaluated at the end of the cold storage period and after a simulated shelf-life of 7 days at 20°C.

Key Results

2014

In one of the populations, pears subjected to a SmartFresh℠ application 9, 14 and 21 days after harvest were just as effective in maintaining fruit quality compared to a 7 day after harvest application. The other population however, exhibited reduced efficacy in the form of mealiness expression, when fruit were treated 21 days after harvest and stored for 6 weeks.

2015

Applying SmartFresh℠ up to 21 days after harvest proved to be effective in maintaining fruit quality and prevent fruit from developing mealiness.

2016

The same orchards were used as in the 2014 season and similar results were obtained.

2017

No mealiness was detected in fruit treated with SmartFresh℠ even up to 12 weeks cold storage.

2018

Mealiness was detected in fruit subjected to SmartFresh℠ 14 days after harvest after 7 days shelf life.

Conclusion and Recommendation

It is recommended to apply SmartFresh℠ within 7 days after harvest. Should an orchard be subjected to SmartFresh℠ later than 7 days after harvest, it should not be stored for an extended period of time. Such fruit should be packed and shipped immediately, especially if it was harvested towards the end of the FEMA harvest window. Forelle pears destined for the FEMA program should never be subjected to SmartFresh℠ later than 14 days.

It is also recommended to keep the shelf life of FEMA Forelle subjected to SmartFresh℠ between 7 and 14 days after harvest, shorter than 7 days to prevent mealiness development.

Stone Fruit Projects

01. *Develop a storage protocol for plums harvested from week 5 onwards for 6 weeks in bins. (H Viljoen)*

Objectives and Rationale

Moisture loss (shrivel) and decay is a problem for late season plums cultivar cold stored in bins for up to 6 weeks or longer. The objective of this trial is to develop a protocol for plums stored in bins with focus on reducing moisture loss and controlling shrivel, without negative effects such as decay.

Methods

Angeleno plums were harvested and packed in bins and then subjected to a SmartFresh^{SM} treatment. Bins were placed in cold rooms either with or without humidity control. Sub samples were weighed and placed with other fruit in the bins for 6 weeks cold storage at -0.5 °C. The cold room without humidity control had an average RH of 80.1%, while the cold room with humidity control had an average RH of 97.8%. Plums were then reweighed to determine mass loss. Fruit from these bins were weighed and packed as for commercial export and cold stored for another 3 weeks simulating shipping and distribution. Fruit were weighed again after cold storage and shelf life. Fruit quality was also assessed after cold storage and after a shelf life period.

Key Results

Humidity control during prolonged bin storage reduced mass loss and shrivel significantly, compared to plums cold stored without humidity control. Moisture loss, measured as the mass loss percentage of fruit during cold storage, was significantly higher in fruit drenched with Fludioxonil and cold stored in bins, compared to plums in bins that did not receive the drench. However, the risk of decay is too high if there is high decay potential, so the fungicide application is recommended.

Conclusion and Discussion

Humidity control during prolonged bin storage is crucial to reduce mass loss of fruit via moisture loss, and to reduce shrivel levels. Decay levels occurred at low levels (≤ 1%) after bin storage with no significant differences between treatments. However, due to a very dry season the decay potential might have been very low, and the risk potential might change with changing seasons.

02. *Application of postharvest edible coatings to alleviate shrivel in plums and nectarines. (O Fawole and S Riva)*

Objectives and Rationale

Some cultivars of plums and nectarines are prone to shrivelling as a result of moisture loss, and often must be repacked upon arrival at the export destination, thus having a detrimental effect on the income generated by stakeholders in the industry. Edible coatings, a new strategy used to extend shelf-life and to improve food quality of whole fruits and fresh-cut fruits, have been applied to many products. The objective of this study is to investigate the potential edible coating application as a postharvest solution for nectarines and plums.

Methods

This research used the most susceptible cultivars – August Red for nectarines; African delight for plums. Treatments were performed by dipping for 2 minutes in various coatings (A-F). Fruits were packed and stored at -0.5°C for 35 days to simulate shipping conditions. Thereafter, fruit were moved to 20°C. Fruit quality assessment took place at harvest, and then at weekly intervals throughout the cold storage period, and five-day intervals during shelf-life.

Key Results

Based on the data collected, it was established that coating D had the most potential in being a successful coating for stone fruit. In both cultivars of plum and nectarine, coating D showed the most consistent results. Changes related to postharvest ripening such as acidity losses, softening and ethylene production were reduced in fruit coated with coating D. It was evident in the scanning electron microscope that, when coated, stomata were completely covered, giving evidence to the theory that coatings reduce respiration rates by limiting oxygen intake and water expulsion.

Conclusion and Discussion

Performance of the investigated edible coatings varied, but present themselves as a postharvest solution that has the potential to maintain quality and extend shelf-life of plums and nectarines. An in-depth data analysis and other investigations are ongoing.

03. *Identify and test improved packaging as well as humidity control in cold stores to reduce moisture loss and shrivel in nectarines. (H Viljoen)*

Objectives and Rationale

To improve the current packaging of nectarines to reduce shrivel without negative effects on general quality and determine the effect of improved humidity control in cold stores on moisture loss and shrivel.

Methods

August Red nectarines were sourced from a commercial pack house, repacked into different packaging liner types and then accumulated in two cold rooms, one with and one without humidity control. The cold room without humidity control had an average relative humidity (RH) of 82.6%, while the cold room with humidity control had an average RH of 95.6%. Fruit was weighed at repacking and again after cold storage and subsequent shelf life. Fruit quality was also assessed after cold storage as well as after a shelf life period.

Key Results

It was evident that fruit packed without wrappers or perforated bags lost more moisture and developed more shrivel compared to those packed in liners. Moisture loss was exhibited as shrivel after the cold storage and the shelf life periods. However, shrivel levels did not increase with an increase in moisture loss, as one would expect. After cold storage period the shrivel levels of 6.1% were significantly lower for nectarines held in the cold room with higher relative humidity, compared to fruit accumulated in the standard cold room with lower humidity, which exhibited 10.4% shrivel. This effect was negated over the shelf life period. No substantial negative effects of these treatments were evident in terms of internal quality. However, after shelf life, the fruit packed without wrappers and standard perforated wrappers, tended to have slightly higher pulpiness, compared to the other treatments.

Conclusion and Discussion

August Red nectarines packed in 72 x 4 mm perforated bags, irrespective of cold storage humidity during a simulated seven day accumulation period, exhibited the best fruit quality at the end of cold storage and a subsequent shelf life, across all examination parameters.

04. *Identify and test improved packaging as well as humidity control in cold stores to reduce moisture loss and shrivel in plums. (H Viljoen)*

Objectives and Rationale

Improving the current packaging of plums to control shrivel without negative effects on general quality and to determine the effect of improved humidity control in cold stores on moisture loss and shrivel.

Methods

Laetitia and African Delight plums were sourced from commercial pack houses, repacked into different packaging liner types and accumulated in two cold rooms, one with and one without humidity control. The cold room without humidity control had an average RH of 74.2% and 89.9%, for Laetitia and African Delight, respectively, while the cold room with humidity control had an average RH of 94.9% and 95.6% for Laetitia and African Delight, respectively. Fruit was weighed at repacking and again after cold storage and shelf life. Fruit quality was also assessed after cold storage and after shelf life.

Key Results

Laetitia

Laetitia plums packed without perforated bags and accumulated at a lower humidity in the cold room, had higher moisture loss than those accumulated at a higher humidity. After shelf life it was clear that the mass loss due to moisture loss was a good indication of the shrivel levels, with levels increasing with increased mass loss. Flesh firmness was best maintained by accumulating Laetitia at a higher humidity, with no clear trends forming relative to packaging types.
No internal quality problems occurred after cold storage. However, IB after shelf life was higher in fruit packed in standard perforated wrappers and 36 x 4 mm perforated bags. Skin cracks were not evident.

African Delight

African Delight plums packed without wrappers or bags showed significantly higher mass loss, compared to fruit packed in perforated bags. Humidity also played a role, with higher humidity during accumulation reducing the mass loss of fruit. Fruit packed with perforated bags with high number of perforations and accumulated at a lower humidity had greater moisture loss than those packed in perforated bags with less perforations and accumulated at a higher humidity. There were no clear trend that the mass loss due to moisture loss was a good indication of shrivel levels after cold storage. Flesh firmness did not differ significantly between treatments with no clear trends evident. No internal quality problems occurred.

04. *Identify and test improved packaging as well as humidity control in cold stores to reduce moisture loss and shrivel in plums. (H Viljoen)*

Conclusion and Discussion

Laetitia

72 x 4 mm perforated bags and non-perforated wrappers maintained fruit quality the best, at the end of cold storage plus shelf life, across all parameters. Accumulation at higher humidities of 95% was best.

African Delight

Perforated bags with a 18 x 4 mm hole configuration reduced mass loss the most, followed closely by 36 x 4 mm perforated bags. The latter, in combination with high humidity in the cold room during accumulation, kept shrivel levels to a minimum.

05. *Develop optimum ripening protocols for nectarines and plums arriving too green (skin colour) or too firm in market. (H Viljoen)*

Objectives and Rationale

Develop protocols to ripen firm, poorly coloured nectarines and plums, to an acceptable eating quality and skin colour in the market place.

Methods

Nectarines were cold stored with and without pre-ripening, before onset of cold storage. Plums on the other hand were subjected to treatments with or without ethylene after cold storage. Nectarines and plums were subjected at end of cold storage to different ripening temperatures for various durations, based on the rate of quality deterioration. The ripening patterns were monitored and the effect of the various treatments on fruit quality assessed.

Key Results

Nectarines:

Regal Pearl nectarines pre-ripened before cold storage exhibited the best internal quality. The post cold storage ripening temperature of 20 °C was generally the best option in terms of fruit quality for pre ripened and non-pre ripened fruit.

Pre-ripening shortened the ripening process of nectarines after cold storage by 3 – 7 days, compared to non pre-ripening. August Red nectarines pre-ripened before cold storage did not have the same positive effect than on Regal Pearl nectarines. Similarly, the ripening temperature of 20 °C resulted in the best quality [T2 & T5], irrespective of pre ripening.

Plums:

Songold: Ethylene treatment and higher post storage holding temperature resulted in accelerated ripening, measured by flesh firmness. Gel breakdown occurred in all treatments, with the levels increasing with shelf life. It is suggested that SmartFresh℠ needs to be included in the trial to provide firmer fruit, with less colour development and limiting internal disorders.

African Delight: Ethylene treatment had an effect on the 15 °C and 20 °C treatments, accelerating the reduction in flesh firmness, compared to the same temperature treatments without ethylene applications. The use of 25°C as ripening temperature seems to be the best temperature option for colour development, with no shrivel and moderate levels of OR, however, committed monitoring is necessary.

Conclusion and Discussion

The research is based on results generated for specific populations, with each population being unique. Arrival quality will determine if ripening procedures are possible. A commercial recommendation will follow subsequent to supportive data of the early findings.

06. *Revision of temperature tolerance at loading for plums. (A de Kock)*

Objectives and Rationale

The effect of temperature during the accumulation phase, prior to loading of plums onto ships for export was tested. Temperatures selected were -0.5 °C, because this is the recommended pulp temperature at loading, 2 °C which is 0.5 °C higher than the current maximum temperature of 1.5 °C; and 3 °C. A temperature of 4.0 °C was also tested in 2015. Accumulation periods of 3, 7 and 10 days were used. The objective was to determine if maximum temperature at loading of plums can be adjusted upwards without a negative effect on post storage quality.

Methods

Various plum cultivars not cooled before packing were obtained from a commercial pack house. Each cultivar was divided into 9 treatments. The variables were accumulation periods of 3, 7 and 10 days and temperatures of -0.5 °C, 2 °C and 3 °C. After the accumulation periods, the plums were cold stored according to the recommended cold storage protocols.

06. *Revision of temperature tolerance at loading for plums. (A de Kock)*

Methods

The plums were evaluated for flesh firmness, decay, shrivel and internal disorders after cold storage, and after 5 days shelf life at 10 °C. This was followed up by semi commercial trials.

Key Results

Cultivars differed in the extent to which fruit quality was affected by higher temperatures during accumulation before loading onto ships for export to overseas destinations. Quality of plums accumulated at -0.5° C and 2.0° C was similar. In most cases, accumulation at 3.0 °C had no negative effect on fruit quality compared to -0.5 °C and 2.0 °C. Exceptions were Sunkiss in 2016 that were softer when accumulated at 3.0 °C compared to -0.5 °C and 2.0 °C, and Songold in 2017, which developed more GB before shelf life if accumulated at 3.0 °C. In a semi commercial trial in 2018 on Ruby Star plums fruit was marginally softer but shrivel was reduced. However, the slightly softer fruit was not regarded as a problem.

Conclusion and Discussion / Recommendation

The recommendation is that the temperature tolerance at loading for plums can be adjusted from 2.0 °C (maximum temperature 1.5 °C) to 3.5 °C (Maximum loading temperature 3.0 °C). There is a warning that a maximum temperature tolerance for Songold plums with flesh firmness below 6 Kg (Non SmartFresh℠ treated) should not be exceeded.

07. *Evaluation of the 8mm penetrometer plunger to determine harvest maturity on nectarines. (A de Kock)*

Objectives and Rationale

Flesh firmness as an important harvest maturity parameter is currently determined on nectarines with a penetrometer fitted with an 11 mm plunger. In late cultivars that are harvested relatively firm the use of the 11 mm plunger proved to be problematic since firmness readings are highly variable. The aim of this trial was to determine if 8 mm plungers can be used to provide accurate flesh firmness readings for nectarines.

Methods

Four nectarine cultivars were harvested at regular intervals starting 4 to 7 days prior to the expected commercial harvest date in 2016 and 2017. In 2018, three additional cultivars were added. In total there were three harvest maturities for each cultivar. At each harvest the flesh firmness was determined with penetrometers fitted with plungers of 11 mm and 8 mm in diameter. In 2016 and 2017, standard deviations were determined for flesh firmness at each of the harvest maturities to determine the variability in the firmness readings. In 2018, a regression analysis for flesh firmness with the two plungers was done. After harvest the fruit were cold stored for 4 weeks at -0.5 °C and evaluated before and after a shelf life of 5 days at 10°C, for flesh firmness, decay, shrivel and internal quality.

Key Results

Generally, the standard deviation in flesh firmness at harvest was higher when the 11 mm plunger was used compared to the 8 mm plunger. This indicates that the variation in flesh firmness for fruit harvested at specific sizes or skin colour will be less when the 8 mm plunger is used. For Alpine, August Red and September Bright nectarines, the fruit from the first harvests generally developed less internal problems and decay compared to fruit from the last harvest. The 8 mm plunger as a tool to determine flesh firmness at harvest could potentially allow producers to harvest early without incurring rejections due to variation in flesh firmness at harvest. Summerfire (non-melting type) did not soften over the harvesting period and remained firmer than the maximum firmness level set by DAFF.

Conclusion and Discussion / Recommendation

Flesh firmness was determined accurately with the 8 mm plunger and variation between readings was less compared to the 11 mm plunger. A conversion factor of 1.8 is suggested to covert firmness readings from the 11 to the 8 mm plunger. On firm fruit, the 8mm plunger could be more accurate as fruit will not crack, as often occurs when the 11 mm plunger is used.

If there is a need to change to the 8mm plunger, DAFF regulations should be changed accordingly.

Postharvest Physiological Defects

01. *Fuji browning types explored via x-ray CT in collaboration with existing trial. (E Crouch and K Chigwaya)*

Objectives and Rationale

'Fuji' internal browning is reported annually and in some seasons, unacceptably high. The purpose of this study was to determine the most prevalent browning types and microstructural differences.

Methods

Fruit were stored in regular atmosphere (RA) for 6 months at -0.5 °C, controlled atmosphere (CA, 1.5% O_2 and 0.5% CO_2) for 6 months at -0.5 °C and delayed CA 3 weeks RA and 5 months CA at -0.5 °C plus 4 weeks RA at -0.5 °C plus 7 days ripening. A sample of fruit was subjected to 50% CO_2 for 3 days after harvest at ambient temperature to determine the incidence, type and intensity of browning and define internal browning caused by high CO_2 concentration. Twenty fruit of each browning type and 20 fruit without browning were chosen for X-Ray CT scanning. Micro-CT was done on the whole fruit to determine tissue density on different regions of the fruit and Nano-CT was done on cylindrical samples to determine porosity, connectivity and sphericity of affected and unaffected tissue.
Fruit with internal browning were sourced from a commercial packhouse and X-Ray CT scanned to determine micro-structural differences associated with those browning types.

Key results

Light core browning was significantly higher in fruit from the RA, and delayed CA storage treatment after 6 months cold storage and shelf-life. Brown apple tissue had a significantly lower porosity and number of pores/mm^3 as compared to apple tissue without browning. The browning type sourced from a commercial packhouse was different from CO_2 damage in terms of microstructural parameters such as porosity, this tissue was more dried out.

Conclusion

CA storage was more effective in reducing light internal core browning incidence resembling core-flush as compared to RA and delayed CA storage. The lower porosity in brown tissues coupled with low connectivity amongst the pores may have impaired the movement of respiratory gases within the fruit leading to the accumulation of CO_2 within these tissues and onset of anaerobic respiration.

This may indicate that any factors influencing porosity may influence browning development.

02. *To assess Internal Browning development potential from high watercore incidence FEMA Forelle. (D Viljoen)*

Objectives and Rationale

The 2016 season exhibited high incidence of watercore in Forelle fruit destined for the FEMA program. PPECB inspectors are rating this disorder as internal breakdown (IB) which has a 2% tolerance compared to 10% for watercore. This trial needs to determine the risks of watercore incidence on fruit quality and will assess whether the disorder diminishes over time, or develops into internal browning.

Methods

Two orchards were subjected to flooding 3 days before harvest to induce watercore. Fruit were harvested from both flooded and non-flooded trees, subjected to SmartFresh^{SM} according to the FEMA protocol and evaluated after 6, 12 and 20 weeks cold storage.

Forelle pears were harvested from 3 FEMA blocks and subjected to a FEMA rate SmartFresh^{SM} application within 7 days after harvest. Fruit were evaluated after 5, 8 and 12 weeks cold storage. Fruit samples were subjected to 50% CO_2 for 3 days after harvest and assessed for watercore and internal browning (IB) incidence. Data were correlated with post storage data to develop a prediction test for IB development.

Key Results

No watercore or internal browning were detected at harvest or during post storage evaluations. The CO_2 prediction test yielded almost no IB fruit.

Conclusion and Discussion

No watercore or IB were detected in the 2018 season even though the orchards had a history of watercore and were harvested at a late stage. This renders answers to the objectives as inconclusive. This disorder, like others, is a seasonal occurrence and cannot be predicted

03. *Postharvest 'Forelle' (Pyrus communis L.) mealiness development, detected at harvest by CT-x ray scanning and semi-commercial colour pre-sorting influenced by canopy position at harvest as well as pollination. (E Crouch, R Cronje, W Fourie, T Muziri and L Schoeman)*

Objectives and Rationale

The objective of this trial was to determine if 'Forelle' canopy position is linked to mealiness by evaluating environmental factors such as irradiance, fruit surface temperature (FST), relative humidity and maturity indices. This study further aimed to establish whether canopy position influences the microstructure and porosity of fruit situated in the outside, middle and inside canopy using X-ray computed tomography (CT).

Methods

Light irradiation and FST were measured for five fruit positions in the six weeks prior to harvest. Fruit were harvested at optimum maturity (±6.2 kg). Maturity indices and mealiness incidence were determined after 8 weeks of cold storage at -0.5 °C and 7 days of ripening at 20 °C. After ripening X-ray CT was used to visualise and quantify microstructural differences between fruit from different canopy positions.

Key Results

Outside canopy fruit, which were directly exposed to high levels of irradiance, had a higher FST and were more susceptible to mealiness. X-ray CT found that inside canopy fruit had a significantly lower level of porosity (0.77±0.48%) and thus mealiness compared to middle (2.91±1.01%) and outside canopy fruit (3.64±1.33%). Mealy pears are characterised by large cells and a high porosity due to the presence of large intercellular airspaces.

Conclusion and Discussion

Large temperature fluctuations, experienced by outer canopy fruit, result in negative changes in fruit metabolism which eventually leads to deterioration of cellular components during ripening. Exposure of fruit to high irradiance levels, coupled with high fruit surface temperatures, are some of the determining factors in 'Forelle' mealiness development. X-ray CT demonstrated that inside canopy fruit had a significantly lower porosity and mealiness score than outside canopy fruit.

04. *Identification of factors involved in the expression of internal browning in Fuji apples and the development of a strategy to reduce risk of incidence. (D Viljoen)*

Objectives and Rationale

In 2015, unacceptable levels of internal browning (IB) (up to 80%) reported for shipments of Fuji apples to the Far East lead to many claims. The objective of this trial is to investigate factors that result in IB expression in Fuji apples; to develop a predictive test for the risk of IB expression and to develop an industry protocol that will reduce the risk of IB expression.

Methods

Eight Fuji orchards, with a history of IB were selected in the Koue Bokkeveld and EGVV areas. Fruit were harvested at optimum and 10 to 14 days after optimum, taken to CA storage facilities immediately after harvest and again 3 weeks after harvest and evaluated after ± 6 months CA cold storage and 4 weeks RA.

As a means of predicting IB, fruit were subjected to 50% CO_2 for 3 days after harvest at ambient temperature and evaluated daily for IB to compare to IB expression after 6 months cold storage.

Key Results

No orchards exhibited more than 1% IB after end of 6 months storage and shelf life. When taken in combination with core flush and CO_2 damage, RA fruit generally had the highest incidence of these disorders, compared to the CA and 3wk CA storage regimes.

High incidence of IB developed during the CO_2 prediction test (≤ 85.0 %).

Conclusion and Discussion

Generally fruit from orchards used in this trial did not develop high levels of IB. Fruit stored in RA exhibited higher IB incidence compared to fruit stored in one of the CA regimes.

05. *Harvest and storage condition plus duration influencing internal browning and fruit quality of 'Rosy Glow' (E Crouch and J Doe)*

Objectives and Rationale

'Rosy Glow' is regarded prone to internal flesh browning. This study investigated tree age, harvest maturity, storage temperature, 1-methylcyclopropene (1-MCP) treatment and storage duration in CA as factors influencing 'Rosy Glow' internal browning.

Methods

Fruit were harvested at <40% and >50% starch breakdown (SB) for the harvest maturity trial (Trial 1) and <40% SB for the storage duration, temperature, 1-MCP (Trial 2) and tree age trial (Trial 3). Trial 1 and 3 fruit were stored for 7 months in CA (1% CO_2 and 1.5% O_2) plus 6 weeks in air at -0.5 °C and 7 days at 20 °C and evaluated after each period. Trial 2 fruit treated with or without 1-MCP, were stored at -0.5 °C or 2 °C and evaluated after 3, 5 and 7 months in CA plus 6 weeks in RA and 7 day shelf-life periods. Fruit numbers used in the trial were increased in the second season in order to decrease variability. The results therefore mainly focused mainly on the second season although both seasons are taken into consideration.

Key Results

Diffuse (DB), radial (RB), and combination (CB) as well as CO_2 browning were observed in both seasons. Optimum harvested fruit (<40%) were less susceptible to DB and RB. 1-MCP treated fruit had a lower internal browning incidence and no tree age effect was observed (4th and 7th leaf). DB and RB were first observed after 5 months in CA plus 6 weeks RA at - 0.5 °C and increased with storage time and was highest after the shelf-life period. A weak (60%) correlation was observed with background colour and browning incidence after storage and shelf-life.

Conclusion and Discussion

Diffuse browning was the main type of browning present. Postharvest maturity (>50% SB) played a significant role in 'Rosy Glow' browning development. Fruit quality was better retained at -0.5 °C than at 2 °C in the second season, while 1-MCP treated fruit quality was better maintained than control fruit over time. A large orchard influence was observed on 'Rosy Glow' browning. Ripening rates over time for various orchards and factors influencing ripening rate requires further investigation.

Postharvest Storage Techniques

01. *To investigate different step down cooling regimes, utilised in conjunction with SmartFresh℠, to reduce the risk of internal browning of Cripps' Pink apples and provide year round supply of good quality fruit. (H Tayler, D Viljoen and E Crouch)*

Objectives and Rationale

Internal browning (IB) of 'Cripps' Pink' apples is a worldwide tendency. It has been a very important internal defect in the past, costing the South African industry millions of Rands in revenue. The types of browning in this cultivar have been verified, and current storage regimes adapted according to the knowledge of the risk factors involved for shorter-term controlled atmosphere (CA) storage (up to 5 months). However, long-term CA storage (7-9 months) is still a risk for developing diffuse browning in particular. Certain cooling strategies in conjunction with SmartFresh℠ technology are currently being utilised in other Southern Hemisphere countries with good success for long-term storage. This study will test the most successful protocol currently used in Australia. The objective of this study therefore was to investigate different step down cooling regimes, utilised in conjunction with 1-MCP (SmartFresh℠), to reduce the risk of internal browning of 'Cripps' Pink' apples and provide longer supply of good quality fruit.

Methods

'Cripps' Pink' apples were sourced in Elgin and Ceres areas from internal browning risk orchards (5 populations/ orchards per area) and subjected to the Australian step down cooling regimes and compared to South African regimes after 9 months in CA (1% CO_2 and 1.5% O_2) + 4 weeks regular atmosphere (RA) and a 7 day shelf life period.

Key Results

The 2017-2018 season proved to not be a high potential internal browning year, but trial results indicated success thus far for storing 'Cripps' Pink' apples for up to 9 months CA at 1.0 °C in a low risk year, which could enable marketing of year round supply of good quality fruit. An unidentified peel disorder was found during shelf-life in all treatments. The incidence was high in populations harvested over-maturely. Attention will be given to understanding what caused this disorder, if the occurrence of the disorder is repeated in the 2018 stored fruit.

Conclusion and Discussion

This trial has to be repeated to confirm 2017 results before any commercial recommendations can be made.

02. *Optimisation of RLOS protocol for superficial scald prevention on Packham's Triumph pears. (A Botes)*

Objectives and Rationale

Repeated low oxygen stress (RLOS) can prevent superficial scald incidence on Packham's Triumph during long term storage. In certain seasons the alcohol build-up during the stress periods in the pear is higher than the prescribed maximum levels of 100-150 ppm which can lead to off-tastes. The aim of this project is to optimize the RLOS protocol to control superficial scald on South African 'Packham's Triumph' pears.

Methods

Three treatments (RLOS+ULO, RLOS+CA and RA) were applied to optimum harvested Packham's Triumph. A minimum of one stress and a maximum of 9 stress periods where applied over the storage period of 10 months. Fruit quality evaluations were done after each shelf-life period.

Key Results

RLOS+ULO and RLOS+CA was effective in preventing superficial scald on optimum Packham's Triumph up to 10 months with 7 day shelf-life, irrespective of the number of stress periods that was applied. These treatments resulted in fruit with a high firmness. The alcohol concentration in the fruit stored under RLOS+ULO was higher than the recommended maximum levels after the stress periods but still there were no off-tastes detected after shelf-life.

Conclusion and Discussion

One stress period of 10 days at the beginning of the storage period was effective to prevent superficial scald development over long term storage (10 months). High alcohol concentrations in fruit after RLOS+ULO storage did not result in off-tastes whether fruit was stored in bags or not.

03. *Determine optimum storage conditions for Abate Fetel pears. (A Botes)*

Objectives and Rationale

Abate Fetel plantings in the South African pear production areas have increased significantly over recent years from 540 ha in 2009 to 810 ha in 2015 and subsequently also the export volumes. The aim of this project is to identify the optimum storage conditions for Abate Fetel pears in order to maintain the best fruit quality. The objective is to evaluate the effect of different storage regimes on the quality of Abate Fetel pears from two production areas to extend the storage life to 6 months.

Methods

Abate Fetel were obtained from two production areas, Grabouw and Ceres. Fruit were harvested at two maturities (optimum and post-optimum) and six treatments (1.5% O_2 + 0.5% CO_2, 1.5% O_2 + 0.5% CO_2 + 1-MCP, 6% O_2 + 0.5% CO_2, 6% O_2 + 0.5% CO_2 + 1-MCP, RA and RA + 1-MCP) were applied at two temperatures (-0.5°C and 1°C). Fruit quality evaluations were done after each shelf-life period.

Key Results

Optimum harvested Abate Fetel from Grabouw was successfully stored under CA for 6 months at -0.5°C and 1°C without physiological disorders when Smartfresh™ was used. Optimum and post-optimum harvested Abate Fetel from Ceres was stored under CA for 6 months at -0.5°C without physiological disorders when Smartfresh™ was applied. Fruit treated with SF and stored under CA at 1°C decreased more in firmness than fruit stored at -0.5°C, but not that significantly. The firmness results were not consistent over production areas and maturities. Fruit treated with Smartfresh™ had a greener skin colour with a higher firmness than none treated fruit.

Conclusion and Discussion

Smartfresh™ was effective to prevent the development of superficial scald and soft scald on Abate Fetel when fruit was stored at -0.5°C. Storage under CA with Smartfresh™ at 1°C gave inconsistent results with regard to superficial scald prevention. This season DCA-CF with SF just before packing is incorporated as an additional treatment.

Postharvest Decay: Pome Fruit Projects

01. *Purification of antimicrobial lipopeptides produced by Bacillus spp. for biological control of postharvest phytopathogens in the perishable fruit industry. (R Pott, D Baloyi and G Teke)*

Objectives and Rationale

The research outlined in this proposal is focused on the separation and purification of lipopeptides produced in *Bacillus* fermentations. The work investigates acid precipitation, solvent extraction, adsorption and aqueous two phase extraction for product recovery and purification.

Conclusion and Discussion

The results of this project thus far are very encouraging. All Milestones have been met for this portion of the project, and several milestones for the next section of the work are already underway. The work has tied well with parallel projects in plant sciences, showing good anti-fungal efficacy from the crude extracts.

02. *Lipopeptides for the biological control of postharvest phytopathogens. (R Pott, G Teke, D Baloyi, J Marais and S Magwebu) – funded by the Postharvest Innovation (PHI) Programme*

Objectives and Rationale

This project aims to scale-up a technology that has previously been demonstrated at laboratory scale. This is accomplished by first producing large enough quantities of product, using traditional bioreactor configurations (as well as a novel bioreactor design). This product is then used to determine the efficacy against phytopathogens in *in vivo* and *in vitro* tests. Toxicology tests will be conducted, in order to verify that the product exhibits no risk to human consumers.

Conclusion and Discussion

The project is mostly on track, with some concern around toxicology testing. However, we have extended beyond the initial project brief with regards reactor development, through the design of a novel bioreactor.

03. *Lipopeptides Fengycin and Iturin A as postharvest fungicide on pome fruit. (C Lennox, J Meitz-Hopkins and J Marais)*

Objectives and Rationale

Cyclolipopeptides produced by the biocontrol agent *Bacillus amyloliquefaciens* such as fengycin and iturin A have been identified as potential biological fungicides. The aim of this study is to evaluate the efficacy of CLPs on fruit infected with *Botrytis cinerea* (causing grey mould on pears) and *Penicillium expansum* (causing blue mould on apples).

Conclusion and Discussion

All milestones scheduled to this stage have been met.

04. *The development of an integrated management strategy for Bull's Eye rot of apples. (C Lennox, J Meitz-Hopkins and A Russouw)*

Objectives and Rationale

Neofabraea vagabunda infection on apples (c.o. Bull's Eye Rot of apples; syn. *N. alba*) can result in devastating fruit decay in storage. The objectives were to identify the causal pathogen species, and to test efficacy of pre-and postharvest fungicides to control the disease.

Methods

Isolates were obtained from bull's eye rot symptomatic fruit and identified with species-specific PCR. Pathogenicity testing of *Neofabraea* sp., was conducted on cv. Cripps' Pink, Golden Delicious and Fuji. A pilot trial was set up to test pyraclostrobin efficacy at the recommended dose in the orchard applied shortly before harvest. Fungicides containing the active ingredients fludioxonil or pyrimethanil were evaluated as a drench application on artificially inoculated apple cv. Cripps' Pink and Fuji.

Key Results

A total of 112 *N. vagabunda* isolates have been collected from a Western Cape packhouse in 2017. The cultivars Fuji and Cripps' Pink showed similar levels of susceptibility to bull's eye rot, while Golden Delicious was less susceptible to decay caused by *N. vagabunda*. No bull's eye rot incidence has been detected to date in the trial orchard. Drench application of fludioxonil achieved the best bull's eye rot inhibition on both Fuji and Cripps' Pink.

04. *The development of an integrated management strategy for Bull's Eye rot of apples. (C Lennox, J Meitz-Hopkins and A Russouw)*

Conclusion and Discussion

All milestones scheduled to this stage have been met. Fuji and Cripps' Pink were more susceptible than Golden Delicious. Fludioxonil applied as a drench can achieve good levels of control.

05. *Development of a fungicide sensitivity monitoring service for SA pome fruit pathogens. (C Lennox, J Meitz-Hopkins and B Cloete)*

Objectives and Rationale

The objective was to verify protocols for monitoring of fungicide sensitivity of apple scab, caused by *Venturia inaequalis*, and pear gray mould, caused by *Botrytis cinerea*, from apple and pear growing regions in SA. The project aimed develop a more rapid and cost effective fungicide sensitivity monitoring service for the pome fruit industry.

Methods

Pear gray mould and apple scab isolates were collected from unexposed fruit (50 each). *Botrytis cinerea* fungicide baseline sensitivity was evaluated using mycelial growth tests for anilinopyrimidine (AP), benzimidazole, dicarboximide, phenylpyrrole class fungicides. Another set of 165 *B. cinerea* isolates collected from packhouses was tested at discriminatory doses of the fungicides.

For *V. inaequalis,* the active ingredients of four fungicide classes, namely anilinopyrimidine, guanidine, sterol demethylation inhibitor (DMI), and ethylene-bis dithiocarbamates (EBDC) were tested. The concentration to inhibit 50% mycelial growth (EC_{50}) was determined for each isolate from the baseline populations and sanitation trial orchards and the means calculated. *Botrytis cinerea* fungicide sensitivity was also tested using a microtiter plate reader for the fungicides fludioxonil, iprodione and pyrimethanil. The microtiter method was also optimised for *V. inaequalis* isolates and tested using mancozeb and azoxystrobin (a QoI fungicide). Possible molecular mechanism for AP and DMI fungicide resistance were investigated in *V. inaequalis* isolates.

Key Results

Mean baseline sensitivities to benzimidazole, phenyl pyrrole, dicarboximide and anilinopyrimidine group fungicides were evaluated for a population of previously unexposed isolates from the Ceres region in the Western Cape (WC). The concentration that inhibited 50% mycelial growth *in vitro* was EC_{50}(benomyl)= 0.08 mg/L, EC_{50}(fludioxonil)= 0.005 mg/L, EC_{50}(iprodione)= 0.24 mg/L, and EC_{50}(pyrimethanil)= 0.21 mg/L. The mean EC_{50} of the *V. inaequalis* baseline population from Greyton for sensitivity towards the DMI group fungicide flusilazole was 0.22 mg/L, and 87% of the tested isolates were categorised as sensitive. Baseline sensitivity to cyprodinil (an AP fungicide) was 0.88 mg/L and 0.08 mg/L for the guanidine group fungicide dodine. The EBDC fungicide mancozeb was highly effective when tested in a glasshouse inoculation experiment. Even at mancozeb concentrations as low as 0.00015 mg/L over 70% of leaf infections could be prevented. Using the microtiter method, an EC_{50} of approximately 1 mg/L was estimated for mancozeb. Resistance frequencies of *B. cinerea* isolates from WC packhouses were 29.3% for pyrimethanil, 6.7 % for benomyl, 2.4% for iprodione, and 0.6% were fludioxonil resistant. A large proportion (>10%) of 40 tested *V. inaequalis* isolates contained an insertion in the promoter region of the CYP51A1 gene, potentially contributing to DMI resistance development. The point mutations detected in the cystathione lyase gene of *V. inaequalis* isolates from cyprodinil exposed populations, could be partially responsible for AP resistance. Strobilurin resistance conferring mutations were identified in the tested population from Elgin.

Conclusion and Discussion

Baseline sensitivity of the tested *B. cinerea* and *V. inaequalis* populations show similar ranges as previously reported from the USA, although some fungicide groups such as the AP (cyprodinil, pyrimethanil) appeared to be slightly less effective with mean EC_{50} values of approximately 3-times higher than the ones from literature. This has also been observed in a parallel study on another apple pathogen, thus cross-resistance to other fungicides is expected from this fungicide group.

06. *Pre and postharvest monitoring of Alternaria spp. in orchards with historically high incidence of dry core rot. (S Ferreira and I Wilson)*

Objectives and Rationale

Since no method to quantify the presence of *Alternaria* spp. within the seed cavity exist, the aim of this study was to develop and test a method to detect and quantify the accumulation of *Alternaria* spp on blossoms and in the seed cavity of susceptible Top Red apples. The developed method was subsequently used to firstly determine whether blossom distance from the orchard floor has an influence in the inoculum levels of *Alternaria* spp., and secondly to monitor the accumulation of *Alternaria spp*. fungal species in the seed cavity of susceptible cultivars during production and storage.

06. *Pre and postharvest monitoring of Alternaria spp. in orchards with historically high incidence of dry core rot. (S Ferreira and I Wilson)*

Methods

We quantified *Alternaria* spp. and specifically *Alternaria alternata* on blossoms located at different distances from the orchard floor and in the extracted seed cavity of fruit at different maturities or stored for different periods in industry simulated cold storage conditions. The fungal inoculum was quantified based on the amount of DNA present using quantitative real- time PCR.

Key Results

We could accurately quantify the *Alternaria* spp. inoculum levels on blossoms and in the seed cavity. There is an inoculum gradient from the orchard floor to the top of the tree with higher inoculum present in blossoms closest to the floor, indicating the importance of the orchard floor as inoculum source. There was also a gradual build-up of *Alternaria* spp. in the seed cavity up to two months in storage, after which there was a gradual decline. The decline could potentially be attributed to the methodology used will be adapted in future analysis. In all samples analysed there were no significant difference observed between total *Alternaria* spp present and *Alternaria alternata*, indicating that the predominance of *Alternaria alternata*.

Conclusion and Discussion

The aim of the project was to develop methods to detect and quantify the most prominent *Alternaria* spp. on blossoms and in the seed cavity of Top Red apples. In this regard the project was successful and could accurately quantify the *Alternaria* spp. inoculum levels on blossoms and in the seed cavity. Furthermore, we could show that there is an inoculum gradient from the orchard floor to the top of the tree with higher inoculum present in blossoms closest to the floor. There was also a gradual build-up of inoculum within the seed cavity which was highest two months into storage, after which it declined. The decrease in inoculum after two months can be attributed to the experimental layout inadvertently out-selecting fruit with higher inoculum levels and the method will be adapted for future studies.

The project has greatly advanced our ability to detect and quantify Alternaria spp. within Top Red production, providing tools to greatly reduce the economic impact of DCR.

Postharvest Decay: Stone Fruit Projects

01. *Factors that influence the retention of fungicide residues on plums. (A de Kock)*

Objectives and Rationale

Export countries regulate traces of chemicals legally tolerated on fruit. Maximum residue limits (MRLs) dictate the permissible residues. Non-compliance results in rejection of fruit upon arrival at export destinations, with concomitant financial loss. Variation in residues on fruit subjected to postharvest fungicide application is sometimes experienced. To assist growers and packers, this study was initiated to determine the effect of cultivar, fungicide exposure time, fruit maturity, fruit temperature and fungicide solution temperature on residue retention, following postharvest fungicide dip applications.

Methods

Songold and Laetitia plums, each sampled at two harvest maturities were dipped in fungicide solutions with Fludioxonil the active ingredient. The variables included for testing, on the basis of resultant residue levels achieved, were: exposure time, fruit pulp temperature and fungicide solution temperature.

Key Results

The plum cultivars reflected significantly different residue levels following postharvest fungicide dip applications, with Songold at 2.8 ppm and Laetitia at 2.3 ppm. Exposure times of 10 and 30 seconds, gave significantly lower residues (2.1 ppm) compared to 3 and 4 minutes (2.9 ppm). Songold data suggested that dipping cold fruit (3 °C) with a flesh firmness of 6 kg, may lead to significantly lower Fludioxonil residues than less mature fruit (7.6 kg), or warm fruit (22 °C) irrespective of maturity. Lowest residues occurred for advanced maturity cold Songold plums dipped in a warm solution (40°C). Laetitia showed contrasting results, with less mature fruit (7.9 kg) exhibiting significantly lower residues than advanced maturity (6.1 kg). All residues in this research were within the 5.0 ppm Fludioxonil MRL applied for plums.

Conclusion and Discussion

Dichotomies between Songold and Laetitia suggest that harvest maturity of plums, under a multitude of different temperature conditions, will impact on residue levels. Monitoring residues with special reference to cultivar, fruit maturity, fruit and fungicide temperature will provide useful management information.

Postharvest Packaging/Logistics

01. *Logistical considerations and limitations of refrigerated containers used in the pome and stone fruit export markets. (L Goedhals-Gerber, T Adams and C Neethling)*

Objectives and Rationale

The South African fruit industry uses ten different container companies to conduct exports. Although all the different companies' containers have the same external dimensions, their internal dimensions differ. The majority of containers used by the fruit industry are leased from third party operators for one-way shipping. Therefore, it is difficult to predict the type or model of high cube container that will arrive for loading.

In order to optimize the packaging to suit the different containers, the diverse dimensions and variability place a significant constraint on the design. Developing new packaging solutions for the fruit industry and not taking the above-mentioned constraints into consideration will complicate the process and result in wasting useful resources.

The maximum useable volume inside a container will depend on the red-line within the container, the internal dimensions of the containers, the refrigeration unit specifications of the containers, the pallet dimensions and the type of packaging the industry uses for pome and stone fruit.

Methods

This research performed a detailed survey of high cube refrigerated containers to identify the usage distributions applicable to the South African export market. The research involved the collection of both primary and secondary research data. Specifically, the research highlighted the number of containers in use by type and specification.

Key Results

The key results have not yet been identified.

Conclusion and Discussion

All milestones scheduled to this stage have been met. Surveys have been collected and the findings of the surveys are currently being analysed.

02. *Implementation of Next-generation Packaging Systems in High Cube Refrigerated Containers for Efficient Cooling and improved Volume Usage. (T Berry and A Tiamiyu)*

Objectives and Rationale

Shipping costs can be greatly reduced by using a packaging system that improves space utilisation of high cube refrigerated containers. The introduction of a new packaging system provides a unique opportunity to utilise the refrigeration system of containers more effectively. This will enhance improved fruit quality preservation, reduce fuel consumption of the refrigeration unit and enable improved application of various temperature treatments (e.g. intermittent warming and ambient loading). Additionally, optimising the proposed packaging for increased cooling efficiency is also critical, as higher fruit packing densities will further increase strain on an already limited refrigeration system. Before an optimal packaging system can be developed, it is necessary to first identify relevant design guidelines. For instance, the impact of gaps between pallet stacks must be known in order to determine an optimal loading strategy. Furthermore, the optimal air flow (ventilation) for the respective packaging system should be determined. Together, this new knowledge will enable future packaging systems to be matched with the optimal working point of refrigerated units.

Methods

A previously developed CFD model is being further extended and validated to investigate conceptual packaging design scenarios. Using literature review and survey information from past and current collaborating projects, the CFD model will be applied to evaluate a refrigerated container when loaded with standard pome and stone fruit packaging systems as a base line for remaining objectives (WP1). Refrigerated container performance will be assessed using a range of pallet stacks with varying airflow resistances to identify an optimal air permeability (ventilation) specification (WP2). Next, the model will be used to evaluate the effect of various gaps between pallet stacks and the potential use of slip sheets on container performance (WP3). Finally, the combination of results obtained from the present study and inputs from collaborating projects will be used to develop novel packaging solutions, which will then be assessed for cold chain performance (WP4).

Key Results

A qualified mechanical engineering student (from Nigeria), with experience in fluid dynamics was identified in January 2018. The student (Adewale Nuryan Tiamiyu) joined our team in July and is now familiarising himself with the existing CFD model and the research problem. A pilot survey of the main packaging systems used in stone and pome fruit handling, respectively, has been performed. Additionally, a detailed mathematical investigation regarding how a refrigerated container can be better loaded has been performed. These data will be tested later in the study, using the CFD model.

02. *Implementation of Next-generation Packaging Systems in High Cube Refrigerated Containers for Efficient Cooling and improved Volume Usage. (T Berry and A Tiamiyu)*

Discussion and Conclusion

Although work on this project was scheduled to start in January 2018, no students with the necessary skills/experience was identified locally. It was, thus, necessary to admit an international student with the required academic background and skills, who arrived in July 2018. The model-development and validation milestones (target: July 2018), which require about 6 months of work have thus not been completed. However, work has been progressing rapidly and we expect to be back on target by the end of the year. Milestones relating to the pome/stone packaging survey and container specifications (related project; Prof Leila Goedhals-Gerber) are on target. Additionally, numerous novel packaging solutions have been generated in anticipation of the upcoming simulation work.

Postharvest Fundamental Understanding

01. *Profiling sugar metabolism and accumulation in plums as related to maturity, cultivar difference and postharvest storage regimes. (O Fawole and T Majoni)*

Objectives and Rationale

During the ripening process, fruits are transformed into palatable products for consumers. However, sugar accumulation patterns and concentrations differ among plum fruit cultivars, especially in fruit with different ripening behaviour (either climacteric or non-climacteric), due to differences in ethylene production in specific cultivars. Sorbitol, a sugar alcohol, is present in some fruit belonging to the Rosaceae family, especially in plums, but its concentration varies strongly between cultivars. For instance, the suppressed-climacteric cultivars are known to display an altered sugar metabolism with the enhanced production of sorbitol (Kim et al., 2015). Such cultivars would be desirable in niche health markets, as sorbitol is an ideal replacement for sugar for patients suffering from obesity, diabetes, cardiovascular diseases (Dai et al., 2015; Lee, 2015). In fleshy fruit during maturation and ripening, sorbitol can either be accumulated or be converted into other sugars, thus affecting the sweetness of the fruit, which is a key attribute of fruit quality.

Postharvest handling including storage regimes can also influence the sugar accumulation hence sensory attributes in fruit. With recent technological developments, it is now possible to perform metabolic profiles using large numbers of samples. The objectives of this study are to;

1) To establish metabolomic techniques for sugar analysis in plum fruit;

2) To investigate and provide an extensive picture of the developmental dynamics of sugar metabolism in plum fruit of different cultivars

3) To study the effect of storage regimes on the dynamics of sugar accumulation and composition in plum fruits

Methods

Twelve plum cultivars were investigated in this study. Fruit quality assessment took place at harvest, physio-chemical properties such as firmness, colour, total soluble solids and acidity, physiological responses were assessed. Sugar analysis was carried out using an optimised gas chromatographic method.

Key Results

The plums cultivars analysed in this study were found to be significantly different for all the characters tested. Expression of the climacteric nature of the investigated cultivars was not significantly different at harvest, although some cultivars had higher ethylene production and respiration rate than the other. Generally, fructose was the predominant sugar and significantly higher than other sugars in most of the cultivars. The proportions of the sugars varied markedly amongst the cultivars, the order mostly being Fr>Su>Sor>Glu for most cultivars. The cultivars were classified into three pairs based on sugars concentrations. Class 1 was characterised by high sucrose, sorbitol, and total sugar concentrations and % sorbitol level; class 3 was characterised by high levels of fructose and glucose they contained while class 2 consisting Angelino, Lamoon and Ruby Sun, had intermediate levels of all the sugars. Linear regression distinguished TSS as a promising predictor of sorbitol content at commercial harvest, in all the investigated plum cultivars grown under the same condition.

Conclusion and Discussion

The results of this research show large variability among the investigated cultivars at commercial harvest. Our results suggest that the investigated plum cultivars are not only different based on firmness and colour attributes but were clustered based on concentrations of individual sugars at harvest. Better understanding of metabolism and accumulation of these sugars during growth and postharvest handling, and its implications on sensory properties is thus required.

02. *Postharvest moisture loss studies in Japanese plums (Prunus salicina Lindl). (E Lötze and I Kritzinger)*

Objectives and Rationale

A comparison of cuticle ultrastructure, chemical composition, and epidermal / hypodermal ultrastructure between Japanese plum cultivars is required to investigate whether these factors contribute to fruit moisture loss and shrivel. Understanding why some cultivars are more prone to post-harvest moisture loss is the first step to preventing or reducing this problem and lowering consignment rejection and financial loss in overseas markets.

Methods

'African Delight™', 'Laetitia' and 'Songold' plums were sampled from three weeks before their anticipated commercial harvest dates, until their commercial harvest date. Additional fruit were packed in commercial packaging materials and cold stored for analysis thereafter, as well as after shelf life. To compare cuticular membrane composition between 'Laetitia' and 'Songold', four replicates of 15 randomly selected fruit were collected on each sampling date. Two peel disks per fruit were excised for isolation of the cuticular membranes, waxes, and cutin. The wax and cutin samples were analysed using GC-MS, to determine the composition and relative abundance of wax and cutin monomers, respectively. On each of the aforementioned sampling dates, 10 fruit per cultivar were sampled for microscopy analysis. Fruit sections were placed in formaldehyde until further use. To visualise cell structure, sections were cut from the pedicel end of the fruit and stained with a 0.01% Toluidine Blue solution. Three fruit were randomly selected for microscopy, with three sections taken per fruit. Cuticle thickness, cell size, cell shape, and intercellular spaces will be visualised.

Key Results

Sample collection for the microscopy studies has been completed but due to technical problems with the light microscope, the imaging has been delayed. This will be completed by December 2018. Sample collection and analyses are completed for the wax and cutin composition trial. Clear differences in wax composition were noted between cultivars, which might explain the difference in susceptibility to moisture loss. Differences in moisture loss as well as cuticular composition were also noted between seasons. Interpretation of these results are currently being finalised.

Conclusion and Discussion

Cuticular wax composition is known to affect fruit peel permeability, as certain compounds are better at 'blocking' water movement through the cuticle. Characterising these compositional differences between 'Laetitia' and 'Songold' cuticular waxes and cutin will provide insight into their differences in moisture loss susceptibility. However, the hypodermal cells might also play a role in maintaining the structure of the fruit peel after moisture loss. Intercellular spaces and cell wall thickness might determine the level of deformation that can occur in the cuticular membrane.

Postharvest Market Access

01. *Confronting Climate Change Initiative (A Blignaut)*

Objectives and Rationale

The agricultural sector is a large source of greenhouse gases through activities such as land-use change, agrochemical application and fossil fuel use. Africa has been identified as one of the most vulnerable regions in the world due to a low capacity to respond to climate change. The CCC carbon emissions calculator not only provides the fruit and wine industry with a method to calculate and report on their carbon emissions but also ensures the continued monitoring of emissions which provides opportunities to raise awareness on appropriate mitigation and adaptation techniques within the agricultural sector.
The overall objective of the Initiative is to assist the fruit and wine industries in enhancing their competitive position, to proactively protect market access, to proactively respond to the challenges of climate change and to enhance the sustainability of individual businesses and the industry as a whole.

Methods

Carbon emissions and consumption data on farm, packhouse, coldstore and winery level is collected through submission by the producer via an on-line data entry interface. The carbon footprint is calculated in the background and a PDF report is generated for the user. Training through workshops as well as telephonic and email support is offered to users. Communication takes place via email, websites and social media. Data quality is managed through a benchmarking process of sense-checking of the data.

01. *Confronting Climate Change Initiative (A Blignaut)*

Key Results

The user numbers, number of completed carbon footprints as well as the number of data points within the benchmark reports continues to grow year-on-year. The coverage within industry of table grapes and wine cellars has significantly increased over the last three years. There is evidence of a declining carbon footprint trend in most commodities.

Progress has been made with Grain-SA in a joint project with CCC:

• **Wintergrain regions: Phase 1 & 2:** snapshot regional carbon footprint and sequestration under different management regimes. Successfully completed.

• **Wintergrain regions: Phase 3:** A proposal has been submitted to allow for a pilot phase to roll out an excel based carbon calculator to a limited number of producers.

• **Maize Trust: Phase 1:** The funding proposal to the Maize Trust has been approved and will follow a similar approach to Phase 1 of the Wintergrain region.

This is considered as the very successful first steps towards potentially rolling out this carbon calculator tool in the grain sector.

Conclusion and Discussion

The CCC project continues to be an important resource to both industry and the producer to measure and manage inputs and to determine carbon emissions. The CCC project remains strategically important and allows for:

1) Better managed & more sustainable businesses

2) Enhanced industry competitiveness

3) Regulatory and Standards readiness & compliance

The project will continue throughout Phase 4: Year 2 with focus of broadening the reach of the project to other commodities and growing its commercial potential.

Return on Investment

01. *Developing a research information system for two South African agricultural industries: Learning about the impact of funded research. (N Boshoff and H Esterhuyse)*

Objectives and Rationale

Contemporary funders have a need to understand the potential impact of the research that they support already before project completion. The current study is therefore aimed at impact monitoring and will combine, in a research information and management system (called RIS-Agric), select insights from three approaches for assessing the broader impacts of research (SIAMPI, IOM and ASIRPA). The deliverable is a set of impact-oriented monitoring tools for funders.

Methods

The first phase studied four completed research projects (two each from Winetech and Hortgro) through the lens of the SIAMPI approach. It involved 18 in-depth interviews and document analyses. The impact notions of funders were investigated by surveying individuals on the funders' decision-making committees (43 Winetech and 23 Hortgro responses were received).

Key Results

The most prominent productive interactions were 'direct' interactions, compared to 'indirect' and 'material' interactions. The visualisation of impact pathways (theories of change) highlighted the importance of project stage-specific networks in impact creation. The study also generated a framework to systematically investigate the impact notions of funders.

Conclusion and Discussion

The SIAMPI analysis showed that it is indeed possible to identify (and capture) the research-stakeholder interactions of funded research. It also demonstrated that impact creation is network-oriented and that any impact monitoring system cannot ignore relevant research–stakeholder interactions. Information about direct interactions are seldom captured by funders, which need to be addressed in RIS-Agric. The question remains whether the interactions identified in the four projects are also associated with impacts that the funders value. The survey results, once analysed, will provide the answer.

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