2016 17

annual report

HORTGRO

Growing Fruit IQ

science

contents

1. CHAIRMAN'S REPORT

1. CHAIRMAN'S REPORT

The year 2017 heralded an exciting new chapter in Hortgro Science history, the offices at Welgevallen were occupied and a roof wetting luncheon was held on February 22, 2017.

Professor Danie Brink, Dean of the Faculty of AgriSciences, Stellenbosch University addressed the guests, management and Advisory Council members, and officially opened the new office complex.

This facility is the physical embodiment of research collaboration, bringing research stakeholders closer together. The location, as well as the tenants of the building, all enhance and stimulate the research environment necessary for success; this is a potential hub of research excellence.

It would be amiss of me not to register a special word of thanks to Theresa Sonnenberg for the monumental effort she made in ensuring a relatively hassle-free move from the old offices in Dorp Street.

A key role of the Advisory Council is to guide Hortgro Science management in various strategic initiatives, one of which is human capacity as well as succession planning. Over the years we have become complacent and simply accepted the individuals that manage our research and development efforts, they are world-class and difficult to replace. I am confident and comfortable with the effort made to date in ensuring that this objective is successfully managed and achieved and pleased to report that the process is underway to ensure the transition to new leadership within Hortgro Science. Professor Wiehann Steyn was promoted to Assistant General Manager Hortgro Science as of October 1, 2017, a worthy understudy to our current General Manager, Hugh Campbell.

With a total of 116 research projects running in the 2016/17 financial year, 75 focused on pome fruit and 57 on stone requires dedicated, committed management, as well as processes in place to ensure money invested provides the necessary return and provides the levy payer with additional tools and systems to remain internationally competitive. This responsibility rests on the shoulders of Hortgro Science together with the Peer Review and Technical Advisory Committees. Thanks to every one of the individuals that give of their time in this process.

The individuals that manage our research and development efforts are world-class.

Finally, if you have managed to get this far through my report, I urge you to make the effort to keep up to date with what's happening at Hortgro Science by visiting their website www.hortgro-science.co.za. The Advisory Council together with Hortgro have made communication one of our key strategic objectives and I am proud of the effort and progress made to date.

As we face a challenging 2018, with the water prospects even more daunting in 2019, I would like to ensure you that the Council, together with Management, recognise and accept the responsibility we have in ensuring that our Growers remain competitive and successful, and will direct our efforts to address these challenges.

Stephen Rabe

2. GENERAL MANAGER'S REPORT

2. GENERAL MANAGER'S REPORT

Hortgro Science's primary objective is to keep South African pome and stone fruit growers internationally competitive and economically sustainable.

Our focus is on research and development which translates into generating new knowledge, technologies or practices that are required to mitigate, avoid or overcome threats and risks and to exploit opportunities. This sounds very noble and ambitious – but what does it translate into?

The ideal is to have developed a tool or technology that will address a problem before the problem manifests. So, for example, one would like to have water saving technologies in place before a drought arrives or a mechanism to control a pest before it has actually become an economic problem. Researchers are trained to think ahead, to anticipate problems within their specific area of expertise. Mostly, researchers are required to solve problems that have already manifested and often one is stuck with something that still has not been solved because it is more complex than initially anticipated – the problem can be managed but not solved (e.g. bitterpit or internal browning). If one reviews where funding is being spent then it is evident that 37% of the available funds for research are being spent on post-harvest projects followed by 21% on crop protection, 19% on crop production, 17% on breeding and 6% on market alignment. This, to an extent, is a reflection of the research challenges that currently face the industry.

This annual report is a collection of the range of activities that have been put in place to support and address the research portion of what Hortgro is mandated to do on behalf of its growers. It has been designed to give you a birds-eye view of what is happening. Theresa Sonnenberg and Esté Beerwinkel, along with our programme managers, have crafted the annual report into themes and have included an executive summary of each project at the back of the report for those who would like more detail of what projects are being funded. More detailed reports are also available on request.

The Hortgro Science Advisory Council under the chairmanship of Stephen Rabe provides strategic direction along a couple of key focus areas which include: future vision, long term research, communications, funding and operational excellence. The strategic objectives are translated into an operational implementation action plan which is reviewed quarterly at

the Advisory Council meetings. The 'orchard of the future' programme leads a lot of the research and is one of the key focus areas under the future vision programme along with the cultivar acquisition strategy, risk assessment and addressing industry bottlenecks like rootstocks and nursery tree quality. Human capacity development and the creation of the next generation of researchers remains a key driver of the long term research programme or focus area. We are currently funding 49 post graduate students, 50% who are Black. The drive to upgrade the industry's controlled atmosphere capabilities has been partly met by the SA Apple and Pear Producers' Association agreeing to fund additional facilities to underpin long term storage research.

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 2016/17 year less funding was leveraged from government sources. The Post-Harvest Innovation (PHI) fund which was funded through the Department of Science and Technology (DST) reached the end of its cycle and the Technology and 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 by 50% this past year. New research proposals have been submitted to THRIP. 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.

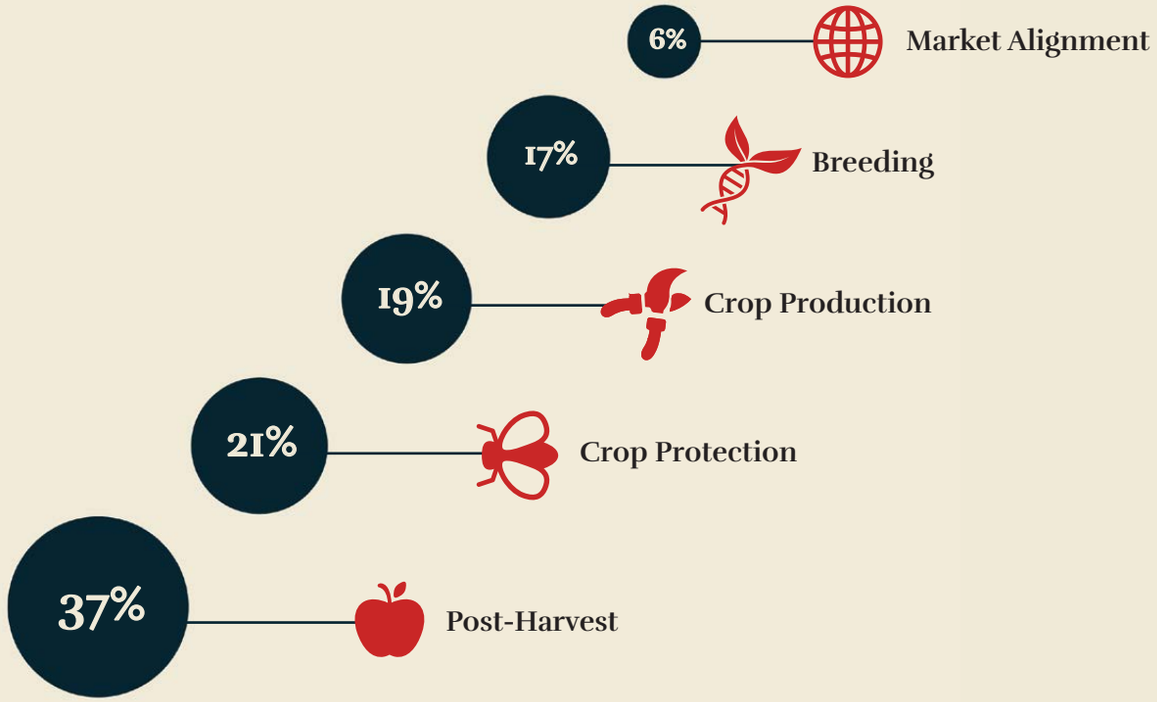
One of the greatest challenges of any research organisation is to ensure that they are focusing on the right stuff and secondly, that the results of research are effectively communicated to the end users of the technology. Hortgro Science makes use of multiple workgroups and review committees (30+) made up of over 200 individuals whose main function is to identify research priorities and then review the progress and output of the research. It is therefore a collective exercise. We are greatly indebted to our small pool of researchers and the larger pool of technical people who assist us in these endeavours. Our small communications team in conjunction with our programme managers and the relevant researchers published 81 popular articles during the 2016/17 year along with eight events which were attended by a cumulative 2,180 people.

A lot of information is contained within this annual report. Thank you to the Hortgro Science team that coordinate and drive the process. It is a great and mostly happy team working with a large group of extremely committed and competent individuals and serves a great industry. Well done to Theresa for putting this annual report together and to Esté for doing the design and layout. I invite you to read on.

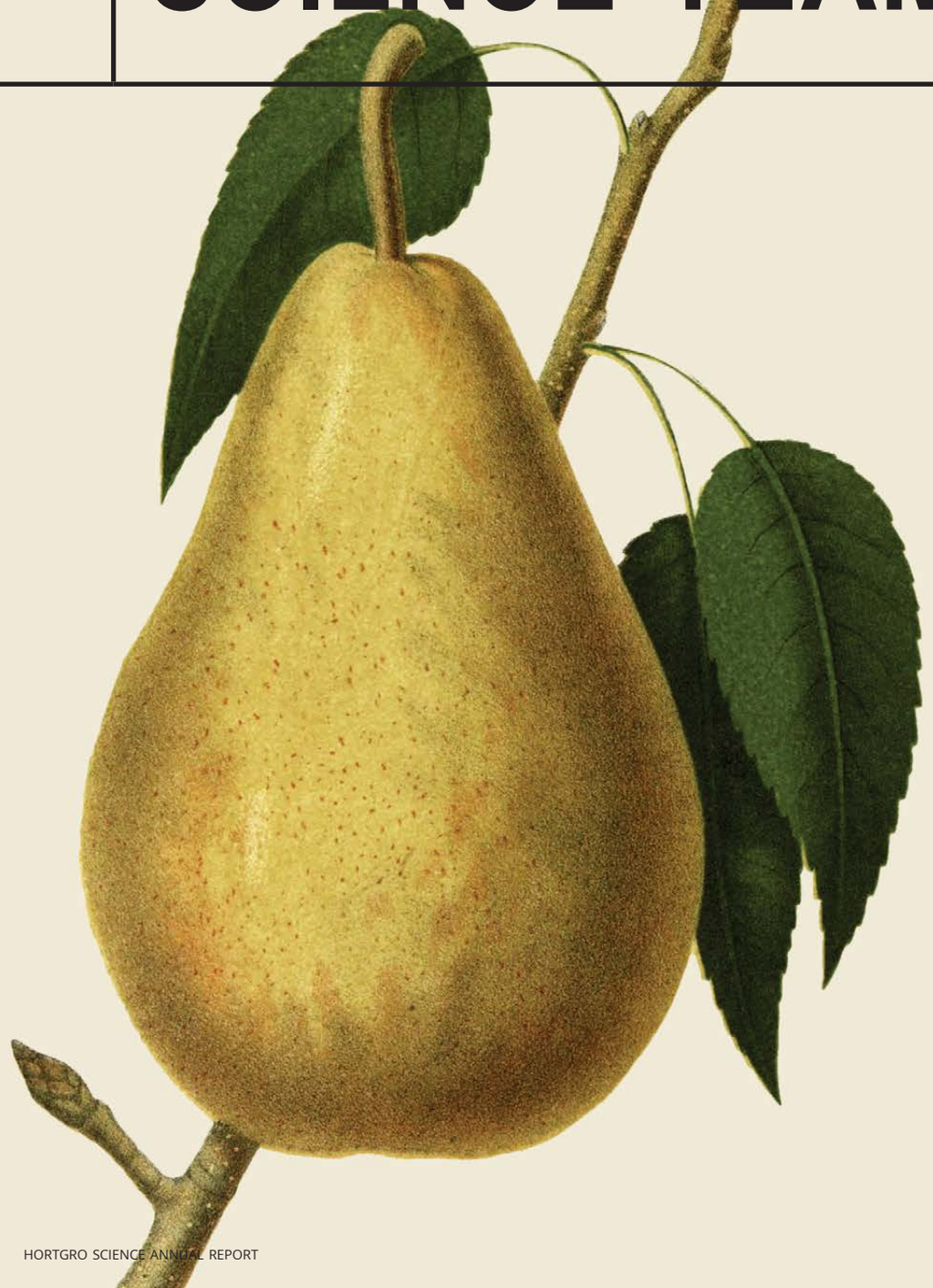
Hugh Campbell

HUMAN CAPACITY DEVELOPMENT AND THE CREATION OF THE NEXT GENERATION OF RESEARCHERS REMAINS A KEY DRIVER OF THE LONG TERM RESEARCH PROGRAMME OR FOCUS AREA.

Where funding is being spent:



3. THE HORTGRO SCIENCE TEAM



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Matthew Addison Crop Protection Programme Manager	mfa@sun.ac.za 021 870 2953
Dr Xolani Siboza Regional Fruit Production Researcher	xolani@hortgro.co.za 081 796 5822
Dr Daleen Stenekamp Applied Researcher in Crop Protection positioned at Stellenbosch Unversity	daleen@hortgro.co.za 021 882 9164
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Thea van Zyl Events Coordinator	thea@hortgro.co.za 021 870 2900
Elise-Marie Steenkamp Group Communications Manager	elise-marie@hortgro.co.za 021 870 2950

Staff seconded to Stellenbosch University
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

4. BREEDING PROGRAMME

4. BREEDING PROGRAMME

The deciduous fruit Breeding and Evaluation programme is partly funded by industry and pays particular attention to adaptability to warm winters and resistance to pests and diseases. It also focuses on yield and fruit quality, in the case of scion cultivars, and the ease of propagation and orchard performance, in the case of rootstocks.

The Agricultural Research Council (ARC), collaborating industry associations and Culdevco, annually review progress. Fruit from promising Phase 2 selections and semi commercial trials are displayed at periodic Fruit Exhibitions held at the Infruitec campus.

The Breeding and Evaluation research projects at the ARC include pears, apricot, plum, peach and nectarine for both the winter and summer rainfall areas of South Africa. The traditional stages of the programmes includes: maintaining and improving genebanks, performing controlled crosses, selecting the most promising seedlings (Phase 1) and evaluating them in evaluation trials (Phase 2). Appropriate genetic studies underpin this research. The ARC introduced reskilling of existing staff and continued with training of students in conjunction with Stellenbosch University. Links with Departments of Genetics, Horticultural Sciences, Plant Pathology and the Institute of Wine Biotechnology are of great value to the Crop Development Division. Thembeka Nyawo and Lawrence Kwalimba (both funded by Hortgro Science) completed their MScs in Genetics and Trevor Koopman obtained his PhD.

ARC reduced the orchard sizes by removing the trees that have been 'living beyond their means' to reduce farm cost and to prioritise the trees to receive irrigation from very limited water sources due to the lingering drought. The extreme drought experienced in the Western Cape will probably be a challenge in the coming years. Marker-assisted breeding, allowing for more informed choice of parents and earlier discarding of undesirable seedlings, should play a bigger part in reducing farm plantings, but funds are needed to develop relevant technology.

The ARC Crop Development team is grateful for the continuous support received from ARC, SAAPPA, SASPA and Hortgro Science to continue with the deciduous Breeding and Evaluation programme.

Louisa Blomerus

Researchers and students

Cultivar Development Research Team Leader

1. Ms Louisa Blomerus

Researchers

2. Mr Werner Pieterse
3. Mr Taaibos Human
4. Ms Ester Lotz
5. Dr Khashief Soeker
6. Mr Irwin Meintjes
7. Mr Ken Tobutt
8. Mr Sonwabo Booi

Students

9. Mr Solomon Ntladi (PhD Student)
10. Mr Lawrence Kwalimba (MSc Student)
11. Ms Thembeka Nyawo (MSc Student)
12. Mr Khethani Mhelembe (PhD Student)

Stone fruit

Breeding Projects List

Abstracts for the stone fruit section of this theme can be found on pages 107 – 114.

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 Projects List

CURRENT PROJECTS

- *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)

COMPLETED PROJECTS

- *Evaluation of newly bred stone fruit rootstock hybrids for the first and second economy.* (S Booi) – *see Rootstocks and Nursery Tree Quality*

FARM PLANTINGS CAN BE REDUCED BY MARKER-ASSISTED BREEDING, AS IT WOULD PROVIDE A MORE INFORMED CHOICE OF PARENTS AND EARLIER DISCARDING OF UNDESIRABLE SEEDLINGS.

Pome fruit

Breeding Projects List

Abstracts for the pome fruit section of this theme can be found on pages 102 – 107.

CURRENT PROJECTS

- *Breeding of pear cultivars.* (JP Human and S Ntladi)
- *Molecular breeding in apple.* (K Tobutt and K Mhelembe)
- *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*

Evaluation Projects List

CURRENT PROJECTS

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

5. CROP PRODUCTION PROGRAMME

5. CROP PRODUCTION PROGRAMME

The research within the Crop Production Programme addresses current problems experienced by fruit growers, 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.

Wiehann Steyn

Dormancy

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. There is great anticipation regarding the new project of Dr Esmé Louw on the impact of insufficient winter chill on apple fruit quality. The results of this study may provide pointers on how tree maturity variation can be reduced by various technologies including rootstock choice.

— Expertise

- Dormancy Workgroup

Researchers and students

Crop Production Programme Leader
1. Prof Wiehann Steyn

Researchers
2. Dr Esmé Louw
3. Ms Laura Allderman
4. Dr Xolani Siboza

Students
5. Dr Janine Colling (Postdoctoral Research Fellow)
6. Ms Micheline Inamahoro (PhD student)
7. Mr Andrew van Lingen (MSc Student)

Projects List

Abstracts for this theme can be found on pages 114 – 119.

NEW PROJECTS

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

CURRENT PROJECTS

- *Physiological dynamics of dormancy in apple buds grown in areas with insufficient cold.* (E Louw, J Colling and M Inamahoro)
- *Investigating the effects of different autumn temperatures on endodormancy progression.* (E Louw and L Allderman)
- *Evaluate rest breaking programmes for warm winter regions.* (X Siboza)

COMPLETED PROJECTS

- *Using the shoot assay to screen combinations and sequential application of existing and possible new rest breaking agents in apples.* (E Louw and L Allderman)

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

Rootstocks and Nursery Tree Quality

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

Crop Production Programme Leader
1. Prof Wiehann Steyn

Researchers
2. Dr Xolani Siboza
3. Mr Carlo Costa
4. Dr Iwan Labuschagne
5. Mr Sonwabo Booi
6. Dr Piet Stassen
7. Prof Stephanie Midgley
8. Mr Abraham Vermeulen

Projects List

Abstracts for this theme can be found on pages 119 – 130.

NEW 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.* (X Siboza and I Labuschagne)
- *Evaluation of pear rootstocks for the South African industry – Cheeky in Wolseley.* (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.* (P Stassen and I Labuschagne)

CURRENT PROJECTS

- *Evaluation of plum rootstocks.* (P Stassen)
- *Evaluation of apricot rootstocks.* (P Stassen)
- *Evaluation of peach rootstocks.* (P Stassen)
- *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 replant rootstock trials for determining a screening technique.* (A Vermeulen)
- *Evaluation of newly bred stone fruit rootstock hybrids for the first and second economy.* (S Booi) – also Stone Fruit Breeding and Evaluation
- *Screening of apple rootstocks for resistance to woolly apple aphid.* (C Costa) – *also Integrated Pest Management*

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- *Apple rootstock evaluation in the Witzenberg valley.* (X Siboza)
- *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 Growing Season Climate*
- *Establishing quantitative relationships between water relations, growth, yield and quality of high performing commercial apple orchards.* (S Midgley and S Zirebwa) — *also Irrigation and Nutrition*

Publications List

These are popular publications applicable to the Rootstocks and Nursery Tree Quality theme.

- **SAFJ October/November 2016**
  McDonald D. *Spanish lessons for South African fruit growers*
- **SAFJ December 2016 /January 2017**
  Hugo HJ. *Susceptibility of commercial stone fruit rootstocks to ring nematode (Criconemoides xenoplax)*
- **SAFJ February/March 2017**
  Weten om te groein: HORTGRO EU visit 2016
- **SAFJ April/May 2017**
  McDonald D. *Langkloof seminar tackles climate change*
- **SAFJ June/July 2017**
  Stassen P, Malan A. *Host status and sensitivity of commercial stone fruit rootstocks to ring nematodes*

Events List

These are events applicable to the Rootstocks and Nursery Tree Quality theme.

- **Hortgro Science Technical Symposium, June 2017**
  "Those who adapt best will survive, says Dutch nurseryman" – Mr Han Fleuren (Director Fleuren Boomkwekerij, Netherlands).
- **Hortgro Science Technical Symposium, June 2017**
  Pome Fruit Field Day – Ceres
- **Langkloof Seminar and Orchard Walk, Louterwater, December 2016**
- **Pome Fruit Field Day, Grabouw, March 2017**

Growing Season Climate

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

Crop Production Programme Leader
1. Prof Wiehann Steyn

Researchers
2. Prof Karen Theron
3. Prof Stephanie Midgley

Students
4. Mr Giverson Mupambi (PhD Student)
5. Ms Nazreen van Rensburg (MSc student)
6. Mr Prince Barasu (MSc Student)
7. Mr Brian Makeredza (PhD Student)

Projects List

Abstracts for this theme can be found on pages 130 – 132.

NEW PROJECTS

- *Effect of nets on growth, yield and fruit quality as well economic feasibility in plums* (K Theron and N van Rensburg)

COMPLETED PROJECTS

- *Tree water relations and sunburn in pome fruit* (W Steyn and G Mupambi)

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

- *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*

Publications List

These are popular publications applicable to the Growing Season Climate theme.

- **SAFJ April/May 2017**
  McDonald D. *Langkloof seminar tackles climate change*

- **SAFJ June/July 2017**
  Steyn W. *Growing Fruit IQ – The net gain*

Events List

These are events applicable to the Growing Season Climate theme.

- **Hortgro Science Technical Symposium, June 2017**
  “Nuts and bolts of installing and managing under shade nets” – Mr Michael Zoth (Competence Center Obstbau Bodensee Bavendorf, Germany).

- **Hortgro Science Technical Symposium, June 2017**
  Pome Fruit Field Day – Ceres

- **Langkloof Seminar and Orchard Walk, Louterwater, December 2016**

Reproductive Biology

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

Researchers and students

Crop Production Programme Leader
1. Prof Wiehann Steyn

Researchers
2. Dr Xolani Siboza
3. Dr Nicky Taylor

Student
4. Ms Suzann Oosthuizen
(MSc Student)

Projects List

Abstracts for this theme can be found on pages 132 – 136.

COMPLETED PROJECTS

- *Evaluate the use of NAA and Ethephon to increase return bloom in apples and pears.* (X Siboza)
- *Evaluation of apple thinning programmes.* (X Siboza)
- *Chemical thinning of pears.* (X Siboza)

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

Publications List

These are popular publications applicable to the Reproductive Biology theme.

- **SAFJ April/May 2017**
  Kotze W, Steyn W, Siboza X. *Does foliar sucrose application increase fruit set in Packham's Triumph pears?*

- **SAFJ June/July 2017**
  Theron K, Steenkamp H, Lötze G, Reynolds S, Steyn W. *A new chemical thinner for plums on the horizon.*

Events List

These are events applicable to the Reproductive Biology theme.

- **Hortgro Science Technical Symposium, June 2017**
  Pome Fruit Field Day – Ceres

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 emphasised 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 List

These are popular publications applicable to the Farming Technology theme.

- ***S*AFJ October/November 2016**
  Theron K, Kirstein D, Steyn W. *Are handheld bloom thinners a viable option to thin apple trees?*

- **SAFJ October/November 2016**
  Bonthuys J. *Fruitlook – Satellites aid irrigation on fruit farms*

- **SAFJ December 2016/January 2017**
  Bonthuys J. *FruitLook offers bigger picture*

- **SAFJ February/March 2017**
  Bonthuys J. *FruitLook: Support for Farmers*

- **SAFJ June/July 2017**
  Bonthuys J. *Beyond the farm gate: FruitLook shows the big picture*

Irrigation and Nutrition

Attendees to the Hortgro Science Technical Symposium in 2015 rated water availability as the highest risk to the Orchard of the Future within the Crop Production programme. Note that this was before the current 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 for water is increasing with the rapidly growing human population. According to the 2014 minutes of this workgroup, the Crop Production water strategy involves determining how much water highly productive apple trees use (current WRC co-funded research project of Dr Sebinasi Dzikiti); funding permitting expanding this research to include stone fruit; 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 conducting research to show growers the negative effects of over-irrigation on production and quality. In 2018, Hortgro Science will be driving an awareness campaign regarding the consideration of water use productivity (yield or income per m^3 water applied) as metric of the value of water.

COMPETITION FOR WATER IS INCREASING DUE TO THE RAPIDLY GROWING HUMAN POPULATION.

Expertise

- Irrigation and Nutrition Workgroup

Researchers and students

Crop Production Programme Leader

1. Prof Wiehann Steyn

Researchers

2. Dr Sebinasi Dzikiti
3. Prof Stephanie Midgley
4. Dr Theresa Volschenk
5. Dr Eduard Hoffman
6. Dr Johan van Zyl

Students

7. Mr Solomon Zirebwa (PhD Student)
8. Ms Zanele Ntshidi (PhD Student
9. Ms Nompumelelo Mobe (PhD Student)
10. Ms Aline Stofberg (MSc Student)

Projects List

Abstracts for this theme can be found on pages 137 – 140.

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

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- *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*

Publications List

These are popular publications applicable to the Irrigation and Nutrition theme.

- **Fresh Notes 129 – 25 October 2016**
  Irrigation Guidelines during Water Shortages
- **SAFJ October/November 2016**
  Bonthuys J. Fruitlook – Satellites aid irrigation on fruit farms
- **SAFJ December 2016/January 2017**
  Bonthuys J. FruitLook offers bigger picture
- **SAFJ February/March 2017**
  FruitLook: Support for Farmers
- **SAFJ June/July 2017**
  Bonthuys J. Beyond the farm gate: FruitLook shows the big picture

Events List

These are events applicable to the Irrigation and Nutrition theme.

- **Hortgro Science Technical Symposium, June 2017**
  Stone Fruit Field Day - Montagu
- **Irrigation seminar, Simondium, 18 August 2017**
- **Irrigation seminar, Langkloof, 19 September 2017**

6. CROP PROTECTION PROGRAMME

6. CROP PROTECTION PROGRAMME

The Crop Protection research programme is multidisciplinary and involves research in nematology, plant pathology and entomology.

The programme addresses research needs on a number of levels from basic research through to highly applied research. Overall, the research programme is aimed at ensuring sustainability of the industry with respect to pest management.

Current research addresses a number of themes; these include biological control, orchard ecology, soil health and precision agriculture. Various other aspects such as taxonomy are also addressed.

> PHYTOSANITARY ISSUES AND INVASIVE PESTS ARE REGARDED AS CRITICAL.

As with the other industry research, the prioritisation and selection of research projects is determined by the Crop Protection Technical Advisory Committee and assessed by the Entomology and Pathology Peer Work Groups. The Integrated Pest Management group is also influential in overall research direction and it allows for current crop protection related issues to be addressed. The current challenges in crop protection research are many but phytosanitary issues and invasive pests are regarded as critical.

Matthew Addison

Phytosanitary

The research focus on phytosanitary threats to the industry is critical. The current research projects involve work on false codling moth, oriental fruit fly and a new fumigation method. The research will allow for the effective management of phytosanitary pests and thus allow the industry access to export markets.

Expertise

- Integrated Pest Management Group

Researchers and students

Crop Protection Programme Leader

1. Mr Matthew Addison

Researchers

2. Dr Daleen Stenekamp
3. Dr Marelize de Villiers
4. Dr Shelley Johnson
5. Dr Pia Addison
6. Dr Chris Weldon
7. Dr Aruna Manrakhan
8. Dr Corey Bazelet

Technical Assistance

9. Mr Terence Asia

Students

10. Ms Welma Pieterse (PhD Student)
11. Ms Louisa Makumbe (PhD Student)
12. Ms Renate Smit (PhD Student)

Projects List

Abstracts for this theme can be found on pages 140 – 147.

NEW PROJECTS

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

CURRENT PROJECTS

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

COMPLETED PROJECTS

- *Identification of larval samples in PPECB-inspected stone fruit (False Codling Moth in stone fruit).* (S Johnson, C Bazelet and P Addison)
- *Dispersal capacity of Bactrocera dorsalis.* (C Weldon, A Manrakhan and L Makumbe)

Events List

These are events applicable to the Phytosanitary theme.

- **Integrated Management of False Codling Moth on Stone Fruit Workshop, Stellenbosch, October 2016**

Nematology

The research programme on nematodes continues to be highly productive and relevant. The research projects below include plant parasitic nematodes and entomopathogenic nematodes. A number of projects also involve research on entomopathogenic fungi. The use of both fungi and nematodes in conjunction as biological control agents against a range of insects is an exciting prospect. The research will allow for enhanced biological control of orchard pests and better integrated management in orchards in the future.

Expertise

- Integrated Pest Management Group
- Soil Health Workgroup

Researchers and students

Programme Leader

1. Mr Matthew Addison

Researchers

2. Dr Antoinette Malan
3. Dr Nomakholwe Stokwe
4. Dr André de Klerk
5. Dr Rinus Knoetze
6. Ms Sheila Storey
7. Ms Lené van der Walt
8. Dr Pia Addison

Students

9. Ms Caro Kapp (PhD Student)
10. Mr Bonginkhosi Dlamini (PhD Student)
11. Ms Deidré Odendaal (PhD Student)
12. Ms Maryna Odendaal (MSc student)
13. Ms Letodi Mathulwe (MSc Student)

Projects List

Abstracts for this theme can be found on pages 147 – 155.

NEW 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)

CURRENT PROJECTS

- *Incorporating entomopathogenic nematodes and fungi in an integrated pest management system for the control of codling moth.* (A Malan and D Odendaal)
- *Ring nematode (Criconemoides xenoplax) distribution, characterisation and culture methods.* (A Malan and M Odendaal)
- *Control and management of lesion nematodes in apple rooted layers and nurseries.* (A de Klerk)
- *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*
- *A survey to determine the Pratylenchus spp. present in South African apple orchards.* (L van der Walt)
- *Entomopathogens from local agricultural soil and their potential to control the banded fruit weevil (BFW), Phlyctinus callosus (Schoenherr) (Coleoptera: Curculionidae).* (P Addison, A Malan and B Dlamini)

COMPLETED PROJECTS

- *Bioprospecting of agriculture and natural ecosystems for entomopathogenic nematodes. (A Malan and D Odendaal)*

Publications List

These are popular publications applicable to the Nematology theme.

- **SAFJ October/November 2016**
  McDonald D. Insect-killing fungi could soon be added to growers' toolbox
- **SAFJ December 2016/January 2017**
  McDonald D. SA-India collaboration to take biological pest control to next level
- **SAFJ December 2016/January 2017**
  Hugo HJ. Susceptibility of commercial stone fruit rootstocks to ring nematode (Criconemoides xenoplax)

Soil Health

Soil health is emerging as a major research theme and is regarded as a fundamental part of sustainable agriculture. The current research projects are aimed at the use of cover crops in orchards to enhance sustainability and resilience. The development of methods to assess and measure soil health in orchards forms a vital component if soils are to be managed in a sustainable fashion.

Expertise

- Integrated Pest Management Group
- Soil Health Workgroup

Researchers and students

Crop Protection Programme Leader
1. Mr Matthew Addison

Researchers
2. Dr André Meyer
3. Dr Johan Fourie
4. Ms Sheila Storey

Students
5. Ms Caro Kapp (PhD Student)

Projects List

Abstracts for this theme can be found on pages 156 – 157.

CURRENT 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)
- *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 List

These are popular publications applicable to the Soil Health theme.

- **SAFJ October/November 2016**
  McDonald D. Insect-killing fungi could soon be added to growers' toolbox

- **SAFJ February/March 2017**
  Bonthuys J. Soil: The true wealth of farmers

Plant Pathology

The plant pathology research addresses a number of important issues, namely apple replant disease, the role of stress factors in bacterial diseases, and base line surveys to determine which fungi are infecting trees.

Expertise

- Integrated Pest Management Group

Researchers and students

Crop Protection Programme Leader

1. Mr Matthew Addison

Researchers

2. Prof Teresa Coutinho
3. Prof Adele McLeod
4. Dr Lizel Mostert
5. Mr Abraham Vermeulen

Students

6. Ms Rhona van der Merwe (MSc Student)
7. Ms Khumbuzile Bophela (PhD Student)
8. Ms Khwathelani Takalani (MSc Student)
9. Mr Makomborero Nyoni (PhD Student)
10. Ms Minette Havenga (MSc Student)
11. Mr Greg Gatsi (BSc Honours Student)

Projects List

Abstracts for this theme can be found on pages 158 – 162.

NEW PROJECTS

- *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 K Takalani)

CURRENT PROJECTS

- *Management of apple replant disease using phosphonates.* (A McLeod and M Nyoni)

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

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

Publications List

These are popular publications applicable to the Plant Pathology theme.

- **SAFJ February/March 2017**
  USDA Expert: There's a Plan B to handle apple replant disease

- **SAFJ February/March 2017**
  Duvenhage E. Apple replant disease under spotlight

- **SAFJ August/September 2017**
  Ferreira S. The hunt for Botrytis cinerea (Post-Harvest Innovation Programme)

Integrated Pest Management

The Integrated Pest Management (IPM) research deals with a wide spectrum of pests in a number of crops. The research will allow industry to manage pests in a more sustainable and efficient manner. For example, the current research on false codling moth (FCM) genetics will provide a better understanding of which plant hosts the moth utilises, and where the insect overwinters. The research will lead to improved management of the pest on an area wide scale.

Expertise

- Integrated Pest Management Group

Researchers and students

Crop Protection Programme Leader

1. Mr Matthew Addison

Researchers

2. Dr Daleen Stenekamp
3. Dr Pia Addison
4. Prof John Terblanche
5. Mr Carlo Costa

Technical Assistance

6. Mr Terence Asia

Students

7. Dr Minette Karsten (Postdoctoral Research Fellow)
8. Mr Bonginkhosi Dlamini (PhD Student)
9. Mr Meshack Magagula (MSc Student)
10. Mr Vernon Steyn (PhD student)
11. Ms Monique James (MSc student)

Projects List

Abstracts for this theme can be found on pages 163 – 169.

NEW PROJECTS

- *False codling moth population genetics: gene flow in agricultural environments.* (J Terblanche and M Karsten)
- *The effects of biotic and abiotic factors on the distribution of economically important weevils in the deciduous fruit industry.* (P Addison, B Dlamini and M Magagula)

CURRENT PROJECTS

- *Control of false codling moth, Thaumatotibia leucotreta, on stone fruit with mating disruption.* (D Stenekamp and T Asia)
- *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)
- *Investigating biological control agents for the management of Ceratitis capitate (Wiedemann).* (P Addison and M James)
- *Pest and disease monitoring in orchards under shade net.* (M Addison)

COMPLETED PROJECTS

- *Screening of apple rootstocks for resistance to woolly apple aphid.* (C Costa) – *see Rootstocks and Nursery Tree Quality*

Publications List

These are popular publications applicable to the Integrated Pest Management theme.

- **Fresh Notes 133 – 5 May 2017**
  Trapping Guidelines for Bactrocera dorsalis in South Africa
- **SAFJ October/November 2016**
  McDonald D. Insect-killing fungi could soon be added to growers' toolbox
- **SAFJ December 2016/January 2017**
  McDonald D. The 'how and why' of biological control of mites in the Ceres region
- **SAFJ December 2016/January 2017**
  Pringle KL, Heunis JM. Mites with special reference to pears.

SAFJ April/May 2017
Baard N. Area Wide IPM programmes work, analysis shows.

SAFJ April/May 2017
McDonald D. Thrips Control: Culmination of a 34-year entomology career for Dr Elleunorah Allsopp

SAFJ June/July 2017
Addison M. IPM still going strong after 30 years

Events List

These are events applicable to the Integrated Pest Management theme.

- **Hortgro Science Technical Symposium, June 2017**
  "Deciduous fruit industry signs Bee and Pollination Charter"

- **Hortgro Science Technical Symposium, June 2017**
  "IPM: Integrated Pest Management at a glance" – Mr Matthew Addison (Crop Protection Manager, Hortgro Science).

Precision Agriculture

The application of new technologies in integrated pest management represents an important step. The development and assessment of spray application methods has many benefits. Coupled to this is the use of forecasting models and decision support software to allow accurate and timely spray applications. The use of geographic information systems (GIS) in combination with machine learning has also yielded important results.

Expertise

- Integrated Pest Management Group
- Spray Application Group

Researchers and students

Crop Protection Programme Leader
1. Mr Matthew Addison

Researchers
2. Prof Adele McLeod
3. Dr Pia Addison

Students
4. Mr Francois Bekker (PhD Student)
5. Mr Philip Rebel (MSc Student)

Projects List

Abstracts for this theme can be found on pages 169 – 172.

NEW 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)

CURRENT PROJECTS

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

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

7. POST-HARVEST PROGRAMME

7. POST-HARVEST PROGRAMME

Post-harvest supports and enhances the processes throughout the supply-chain which are 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 or wholesalers and end consumers.

The Post-harvest Technical Advisory Committee (TAC) provides inputs into the gap analysis to ensure that problematic issues are incorporated for potential research projects. They then allocate priorities to the items listed. This has now been broadened to include the newly formed industry Store It Post-harvest group. 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 Hortgro Science Assistant General Manager, 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.

Richard Hurndall

Quality Management

Quality management refers to maintaining quality throughout the logistical chain to the end consumer.

Several of the pome fruit projects were directed at, and funded by, the Forelle Early Market Access (FEMA) programme. As the Forelle FEMA volumes have increased to nearly 50% of the total Forelle exports, the finding that SmartFresh^{SM} can be applied up to 14 days after harvest, and still maintain quality for 12 weeks storage, will assist with operational arrangements. The harvest profile of Cheeky was determined.

With reference to stone fruit, an increase in the temperature tolerance to 3°C for certain cultivars has been recommended. This is only the tolerance allowed, and does not refer to shipping temperatures. Guidelines are now available for optimum cooling and transport temperatures for plums and apricots from areas situated far from cooling facilities/depots.

Expertise

- Fruit Eating Quality Workgroup
- Fruit External Quality Workgroup

Researchers and students

Post-Harvest Programme Leader

1. Mr Richard Hurndall

Researchers

2. Ms Anél Botes
3. Mr Barend Pienaar
4. Mr Daniël Viljoen
5. Mr Arrie de Kock
6. Mr Handré Viljoen

Projects List

Abstracts for this theme can be found on pages 172 – 184

Pome fruit projects

NEW PROJECTS

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

CURRENT PROJECTS

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

- *Identification of factors involved and control of astringency in pears.* (D Viljoen)
- *To determine the minimum flesh firmness that FEMA fruit can be exported without becoming overripe after storage, and to determine the effect of extended storage of FEMA fruit (stock rolling).* (D Viljoen)
- *To determine the effect of sugar/ acid ratio and other maturity indices on the eating quality of Forelle pears destined for the FEMA programme as a means of improving the FEMA release criteria.* (D Viljoen)

Stone fruit projects

NEW PROJECTS

- *Develop optimum ripening protocols for nectarines and plums arriving too green (skin colour) or too firm in market.* (H Viljoen)

CURRENT PROJECTS

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

COMPLETED PROJECTS

- *Optimum cooling and transport temperatures for plums from areas situated far from cooling facilities/depots.* (A de Kock)
- *The effect of temperature from orchard to cold store on apricot quality, specific to areas far away from cold storage facilities.* (A de Kock)

Events List

These are events applicable to the Quality Management theme.

- **Hortgro Science Technical Symposium, June 2017**
  "Growing fruit with consumers in mind" – Dr Roger Harker.

Physiological Defects

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 the greater the 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

Post-Harvest Programme Leader

1. Mr Richard Hurndall

Researchers

2. Dr Elke Crouch
3. Dr Ian Crouch
4. Mr Daniël Viljoen
5. Ms Heleen Tayler
6. Mr Arrie de Kock

Students

Next page

7. Mr Kenias Chigwaya (PhD Student)

8. Mr Rudolph Cronje (MSc Student)

9. Dr Walter Fourie (Postdoctoral Research Fellow)

10. Dr Letitia Schoeman (Postdoctoral Research Fellow)

Projects List

Abstracts for this theme can be found on pages 184 – 190.

NEW 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)

CURRENT PROJECTS

- *Post-harvest 'Forelle' (Pyrus communis L.) mealiness influenced by shading the outside canopy fruit.* (E Crouch, R Cronje, W Fourie 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

- *Preliminary study to assess Internal Browning development potential from high watercore incidence FEMA Forelle*. (D Viljoen)
- *Physiological profiling on 'Rosy Glow' apples harvested at different maturities, with special reference to internal browning development potential.* (H Tayler and A de Kock)

Events List

These are events applicable to the Physiological Defects theme.

- **Hortgro Science Technical Symposium, June 2017**
  "Dealing with superficial scald" – Mr Henk Griessel (Quality Assurance Manager, Tru-Cape Fruit Marketing).
- **Fuji Browning Information Session with Dr Bart Nicolai, 5 September 2017**

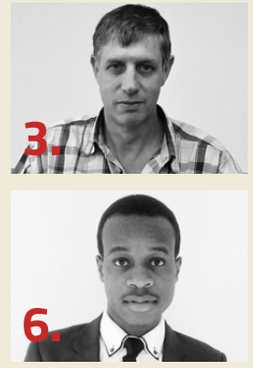
Storage Techniques

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. A new project focusses on the extended storage of Cripps' Pink in conjunction with SmartFresh^{SM} treatment.

Expertise

- CA and Post-Harvest Group
- DPA Focus Group

Researchers and students



Post-Harvest Programme Leader

1. Mr Richard Hurndall

Researchers

2. Ms Anél Botes
3. Dr Ian Crouch
4. Mr Daniël Viljoen
5. Ms Heleen Tayler

Students

6. Mr Tatenda Kawhena (MSc student)

Projects List

Abstracts for this theme can be found on pages 190 – 196.

NEW PROJECTS

- *To investigate different step down cooling regimes, utilised in conjunction with SmartFresh^{SM}, to reduce the risk of internal browning of Cripps' Pink apples and provide year round supply of good quality fruit.* (D Viljoen and H Tayler)
- *Optimisation of RLOS protocol for superficial scald prevention on Packham's Triumph pears.* (A Botes)

CURRENT PROJECTS

- *Determine optimum storage conditions for Abate Fetel pears.* (A Botes)

COMPLETED PROJECTS

- *Non-chemical storage technologies for apple and pear superficial scald prevention.* (A Botes and T Kawhena)
- *Alternatives for the use of DPA: Critical minimum DCA storage exposure periods followed by RA and CA storage to inhibit superficial scald on Packham's Triumph pears.* (A Botes)
- *Extended cold storage of Abate Fetel pears for EU market.* (D Viljoen)

Post-Harvest Decay

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.

A survey of **stone fruit** packhouse atomising systems revealed shortcomings which were addressed by a *Fresh Notes* prior to the season. The ecology of *botrytis* on plums and weeds in plum orchards was studied. Strangely, a relationship between *botrytis* levels and *monilinia* decay was found. Following on several PHI projects, an investigation into the purification and in vitro testing of a biological fungicide (antimicrobial lipopeptide) is proceeding, with possible THRIP co-funding.

Expertise

- Post-Harvest Pathology Group

Researchers and students

Post-Harvest Programme Leader

1. Mr Richard Hurndall

Researchers

2. Dr Cheryl Lennox
3. Dr Stephan Ferreira
4. Dr Ida Wilson
5. Mr Arrie de Kock
6. Prof Kim Clarke
7. Dr Julia Meitz-Hopkins

Technical Assistant

8. Ms Merle Wells

Students

9. Mr André Russouw (MSc Student)
10. Mr Benjamin Cloete (MSc Student)
11. Ms Noloxabiso Mangwana (BTech Student)
12. Ms Sebenzile Mazibuko (MSc Student)
13. Mr Willem Herbst (MSc Student)
14. Dr Vivek Rangarajan (Postdoctoral Research Fellow)

Projects List

Abstracts for this theme can be found on pages 196 – 204.

Pome fruit projects

NEW PROJECTS

- *The development of an integrated management strategy for Bull's Eye rot of apples.* (C Lennox, J Meitz-Hopkins and A Russouw)
- *Pre and post-harvest monitoring of Alternaria spp. in orchards with historically high incidence of dry core rot.* (S Ferreira and I Wilson)

CURRENT PROJECTS

- *Development of a fungicide resistance monitoring service for SA pome fruit pathogens. (C Lennox and B Cloete)*

COMPLETED PROJECTS

- *Detection and quantification of Botrytis cinerea incidence and severity in harvested pears for the development of a monitoring system to support commercial exports. (S Ferreira, I Wilson, M Wells and N Mangwana)*

Stone fruit projects

NEW PROJECTS

- *Survey and investigation on the impact of various fungicide application methods and technologies on decay control of plums in the pack-house.* (I Wilson and A de Kock)

- *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 and I Wilson)

COMPLETED PROJECTS

- *Production of antimicrobial lipopeptides by Bacillus spp for biological control of postharvest phytopathogens in the perishable fruit industry.* (K Clarke, V Rangarajan, W Herbst and S Mazibuko)

- *The prevalence of Botrytis cinerea in and on plums, and alternative host plant tissue: A preliminary investigation on the occurrence of the fungus pre-and-post harvest in order to elucidate pathogen ecology, for new decay control strategies.* (I Wilson and S Ferreira)

Packinging and Logistics

The Post-Harvest Innovation (PHI) co-funded report on the optimisation of shipping container space utilisation highlighted major potential benefits to the fruit industries. Follow-up projects to look at specific aspects have been initiated.

Expertise

- Packhouse Action Group

Researchers and students

Post-Harvest Programme Leader

1. Mr Richard Hurndall

Researchers

2. Mr Koos Bouwer
3. Mr Handré Viljoen
4. Dr Malcolm Dodd

Students

5. Ms Tessa Myburgh (BLogistics Honours Student)
6. Mr Nicholas Bridge (BLogistics Honours Student)
7. Mr Stephan Nel (BEng Honours Student)

Projects List

Abstracts for this theme can be found on pages 204 – 208.

NEW 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)

COMPLETED PROJECTS

- *The development of the industrialisation process for various ideas towards optimisation of cargo freight capacity utilisation (space, mass, packaging, refrigeration) in refrigerated shipping containers to reduce logistic costs while maintaining product quality.* (K Bouwer, M Dodd, N Bridge, T Myburgh and S Nel)

Publications List

These are popular publications applicable to the Packaging and Logistics theme.

- **Fresh Notes 130 – 24 Nov 2016**
  PAG
- **Fresh Notes 131 – 24 Nov 2016**
  PAG

- **Fresh Notes 135 – 16 August 2017**
  PAG
- **SAFJ April/May 2017**
  Hurndall R. Packhouse Action Group makes its mark

Events List

These are events applicable to the Packaging and Logistics theme.

- **Training Course - Energy Management Systems for Packhouses, August 2017**

Fundamental Understanding

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. Exposing plums to ambient conditions for 48 to 72 hours after harvest induced severe moisture loss. A 2% loss in the total mass of the fruit due to moisture loss causes shrivel manifestation. African Delight plums with concentric cracks should not be exported.

Researchers and students

Post-Harvest Programme Leader
1. Mr Richard Hurndall

Researchers
2. Prof Karen Theron
3. Dr Mariana Jooste
4. Dr Elmi Lötze
5. Mr Gustav Lötze

Students
6. Mr Kenias Chigwaya (MSc Student)
7. Ms Imke Kritzinger (PhD Student)

Projects List

Abstracts for this theme can be found on pages 208 – 211.

CURRENT PROJECTS

- *Moisture loss studies in Japanese plums (Prunus salicina Lindl).* (E Lötze and I Kritzinger)

COMPLETED PROJECTS

- *Moisture loss studies in nectarines.* (K Theron, M Jooste and K Chigwaya)
- *A study of the peel permeabilities of Japanese plums to moisture during fruit development on the tree.* (K Theron and G Lötze)

Publications List

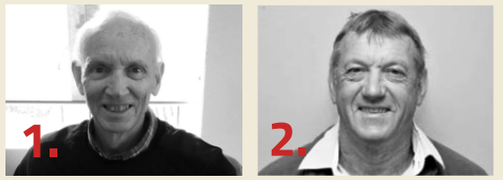
These are popular publications applicable to the Fundamental Understanding theme.

- **SAFJ August/September 2017**
  Theron K. Moisture maketh the nectarine (Post-Harvest Innovation Programme)

Technology Transfer

The stone fruit post-harvest digital application (or app), co-funded by the Post-Harvest Innovation Programme (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.

Researchers and students



Post-Harvest Programme Leader
1. Mr Richard Hurndall

Researchers
2. Mr Arrie de Kock

Projects List

Abstracts for this theme can be found on pages 211 – 213.

NEW PROJECTS

- *Expansion and updating the post-harvest digital quality management platform for mobile phone and desk-top applications (apps) to assist technology transfer for stone fruit.* (A de Kock)

- *Development of descriptive disorder charts for internal disorders and shrivel on plums for uptake in newly developed app.* (A de Kock)

COMPLETED PROJECTS

- *Development of a post-harvest digital quality management platform in the form of mobile phone and desktop applications (apps) to assist technology transfer for fruit.* (A de Kock)

Market Access

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. The development of the VapourMate treatment as a post-harvest fumigant for the phytosanitary pest, grain chinch bug, holds great promise. DPA cross-contamination is posing a potential problem to EU markets. ExperiCo and the DPA working group have done sterling work in trying to persuade the EU standing committee to retain the DPA MRL at 0,1 ppm. A decision is pending in 2019. Should the EU market become a cold steri market for plums, a solution for dual temperature varieties has been developed at single temperature in conjunction with SmartFresh^{SM}.

Researchers and students

Post-Harvest Programme Leader

1. Mr Richard Hurndall

Researchers

2. Dr Shelley Johnson
3. Mr Handré Viljoen
4. Mr Daniël Viljoen
5. Ms Anél Blignaut

Students

6. Ms Renate Smit (PhD student)

Projects List

Abstracts for this theme can be found on pages 213 – 217.

CURRENT PROJECTS

- *Confronting Climate Change* (A Blignaut)

- *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*

COMPLETED PROJECTS

- *Assessment of accumulative DPA residues throughout storage and packing facilities.* (D Viljoen)

- *Utilisation of SmartFresh^{SM} and/or pre-ripening to enable successful shipping of dual-temperature regime plums at a single temperature of 0.55°C for 24 days for cold-sterilisation purposes.* (H Viljoen)

Events List

These are events applicable to the Market Access theme.

- **Hortgro Science Technical Symposium, June 2017**
  "Choosing the right apple and peach varieties for consumers" – Prof Joan Bonany.

8. COMMUNICATIONS

8. COMMUNICATIONS

They say communication works for those that work at it. It is the language of leadership. At Hortgro it is the golden thread that runs through all our endeavours. At Hortgro Science it is the final spoke in the research wheel.

Without communicating research, one can rightly ask: Why do it?

Science communication is a specialised field that is growing exponentially. Dane McDonald was our designated science communicator until July 2017, when he left to further his career at Sanbi. This post has now been filled by the talented Esté Beerwinkel. The science communication team regularly attends workshops and seminars held at CREST (Centre for Research on Evaluation, Science and Technology) in Stellenbosch. In March 2017 Esté and Elise-Marie Steenkamp attended a SARIMA Master Class titled: *Leadership in Research & Innovation Management*.

Our overarching strategy is to simplify research, and re-package it in a visually engaging manner to create an infotainment experience for our clients. We use storytelling, video, social media, photographs and infographics as tools.

Keeping our goals in sync with Hortgro's communication strategy, we aimed to build the Hortgro brand; showcase transformation; stimulate market-related information, and improve technology transfer.

WITHOUT COMMUNICATING RESEARCH, ONE CAN RIGHTLY ASK: WHY DO IT?

2017 was a strategy year. Several surveys were sent to our clients to test our outputs. The communication department received an overwhelmingly positive feedback from our growers. Producers indicated that research information as packaged in the Fresh Notes, Timely Hints, and other technical outputs, were highly valued.

The two annual reports for Hortgro (2016) and Hortgro Science (2015/16); South African Fruit Journal, as well as the monthly electronic newsletter also got positive feedback. Our events were also well-attended (see page 93 for more on this).

In their turn producers indicated that they would prefer more one-on-one communication activities such as field days and information days. In an effort to identify growers' needs and challenges Hortgro established regional offices in Grabouw, Ceres, Free State and the Langkloof – each with their own office representative. These offices will stimulate two-way communication between Hortgro and producers on the ground. In the survey feedback producers also acknowledged that they are slow on social media uptake. Social media, however, is here to stay. It is an inevitable tool in the communication box, one that is free and powerful. A tool we use to connect with younger generations and different stakeholder groups across the board and internationally. Therefore, we encourage producers to join us on Facebook, Twitter, Instagram, YouTube and visit our Hortgro and Hortgro Science websites (see links on page 75).

This year our Facebook following grew from 477 (as reported on in our previous annual report) to 857 at the time of writing. Our Twitter following is currently at 1,115.

Technology overload is a real issue and we are sensitive for the fact that producers have little time available. In an effort to address this Hortgro tries to reduce weekly e-mail traffic to our clients by re-packing

communiques in the monthly newsletter. To stay ahead of the pack we encourage growers to read the Hortgro News and give us feedback.

For our tools to be effective we need the correct contact details of our clients. Currently the Hortgro database consists of the information we receive annually from our growers when the tree census is compiled. It remains our producers' responsibility to make sure that we have their correct contact details, and that the right people at the business receive the information they need. If you are unsure about your contact details, or want to update your profile, please contact mariette@hortgro.co.za.

In November 2016 we co-hosted with SAAPPA and AREFLH (Assembly of the European Regions producing Fruit, Vegetables and Ornamental Plants) the 9th Interpera World Pear Congress at Simondium. More than a hundred pear

SOCIAL MEDIA IS AN INEVITABLE TOOL IN THE COMMUNICATION BOX, ONE THAT IS FREE AND POWERFUL.

enthusiasts joined us for this prestigious event.
It was the first time the congress was held in Africa and gave local producers the chance to rub shoulders with our international colleagues.

Also in November 2016 Dane McDonald represented Hortgro Science at the Interpoma Congress in Italy.

The continued drought and water crisis in many of our production areas led to the Irrigation Seminar that was held in August 2017. This event was so popular that it was repeated in the Langkloof in September.

After many years of hard work a false codling moth (FCM) fact file and new protocol guidelines were put together by a Hortgro Science team to meet the requirements of the European Union. FCM is a pest of phytosanitary significance, see the link below for the guidelines and protocols, and to learn more about this pest.

Elise-Marie Steenkamp
Group Manager Communications

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 Tech Book 2015

Hortgro Science Technical Symposium Summary Report

Irrigation Seminar Summary Report

FCM Guidelines and Protocols

Visit the Hortgro Science website

Follow us on Facebook

Follow us on Twitter

Follow us on YouTube

Follow us on Instagram

9. SUPPORT STRUCTURES

9. 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

Stephen Rabe – Chair
Grant Smuts – Vice-Chair
Linde du Toit
Matthew English
Joseph Hendricks
William Myburgh
Charl Stander
Louis von Broembsen

Peer Work Groups (PWGs)

Objectives of the PWGs

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

Entomology PWG

Matthew Addison
Dr Brian Barnes
Hugh Campbell
Dr Martin Gilbert
Richard Hurndall
Welma Pieterse
Dr Ken Pringle

Soil Science PWG

Hugh Campbell
Dr Nigel Cook
Dr Eduard Hoffman
Richard Hurndall
Nelius Kapp
Dr Pieter Raath
Prof Wiehann Steyn
Dr Nicky Taylor
Dr Johan van Zyl

Horticulture PWG

Hugh Campbell
Dr Nigel Cook
Richard Hurndall
Prof Gerard Jacobs
Jakkie Stander
Dr Piet Stassen
Prof Wiehann Steyn
Dr Nicky Taylor
Prof Karen Theron

Pathology PWG

Matthew Addison
Lindi Benic
Hugh Campbell
Dr Johan Fourie
Richard Hurndall
Prof Lise Korsten
Dr Cheryl Lennox
Prof Adele McLeod
Ferdi van Zyl
Prof Altus Viljoen

Post-Harvest PWG

Hugh Campbell
Dr Paul Cronje
Dr Elke Crouch
Richard Hurndall
Prof Marius Huysamer
Prof Linus Opara
Prof Wiehann Steyn
Prof Karen Theron

Technical Advisory Committees (TACs)

Objectives of the 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 TAC

Daan Brink
Dr Nigel Cook
Peter Dall
Pierre du Plooy
Andrew Hacking
Hammies Hamman
Chris Jurisch
Nelius Kapp
Willie Kotze
Graeme Krige
Hannes Laubscher
Anton Muller
Stephen Rabe
Louis Reynolds
Mico Stander
Prof Wiehann Steyn
Christo Strydom
Tobie van Rooyen

Crop Protection TAC

Matthew Addison
Lindi Benic
Nico Ferreira
Jacques Fouche
Gustav Groenewald
Andrew Hacking
Richard Hurndall
Anton Muller
Hendrik Pohl
Dr Ken Pringle
Sheila Storey
Fanie van der Merwe
Steven Versfeld
Bekker Wessels
Martin Wohlfarter

Post-Harvest TAC

Lindi Benic
Lohan Bester
Malcolm Dodd
Elizabeth Downes
Petru du Plessis
Jacques du Preez
Nico Ferreira
Anton Gouws
Henk Griessel
Richard Hurndall
Angelique Marais
Jaco Moelich
Pieter Neethling
Bibbie Potgieter
Margaret Reinecke
Grant Smuts
Charl Stander
Adriaan Theron
Karin van Rensburg

Technology Transfer Avisory Council

Matthew Addison
Esté Beerwinkel
Keith Bradley
Hugh Campbell
Dr Nigel Cook
Dr Ian Crouch
Peter Dall
Pierre du Plooy
Linde du Toit
Richard Hurndall
Graeme Krige
Stephen Rabe
Charl Stander
Elise-Marie Steenkamp
Prof Wiehann Steyn
Christo Strydom
Marinus van der Merwe
Charl van Rooyen
Tobie van Rooyen
Thea van Zyl

APPROXIMATELY 200 INDIVIDUALS TIRELESSLY GIVE OF THEIR TIME, INTELLECT AND PASSION TO SERVE THE NEEDS OF THE INDUSTRY.

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

List of groups

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

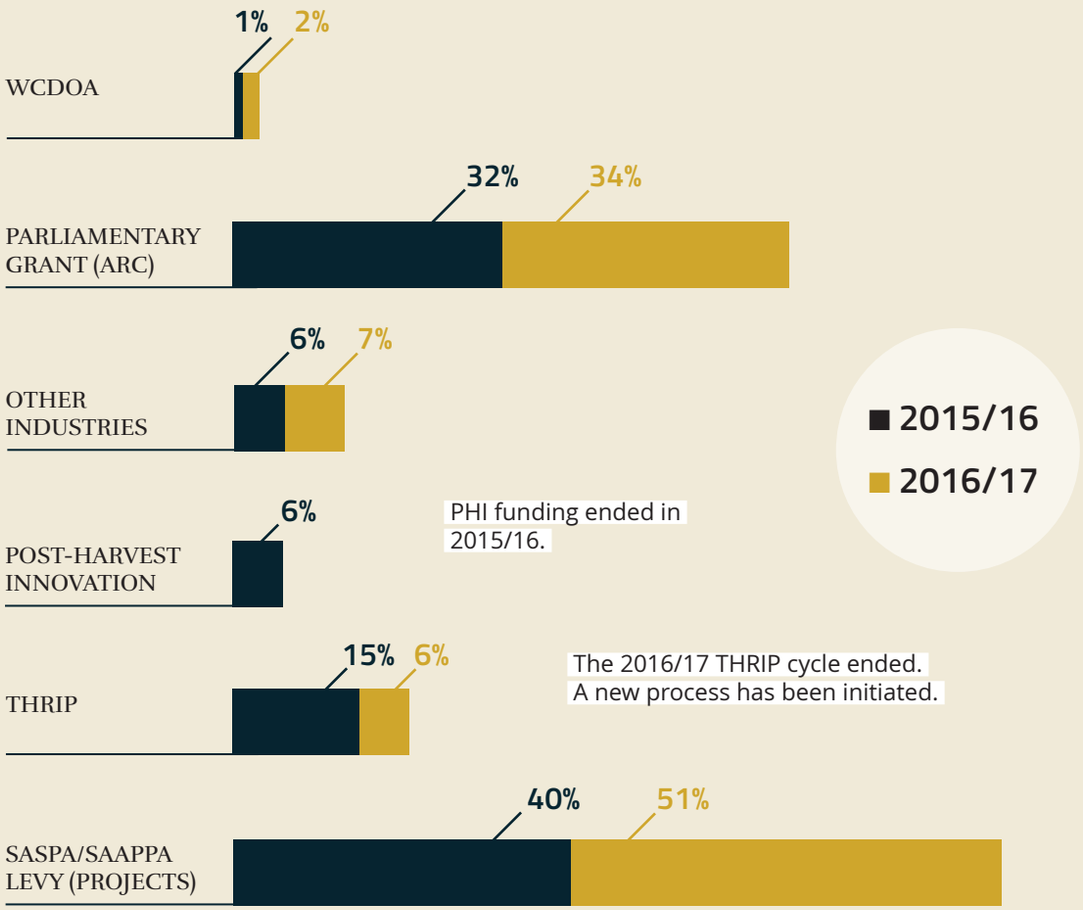
10. THE YEAR AT A GLANCE

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 2016/17 year.

Information on our funding, projects and students are captured in the graphs and tables below.

External Funding Leveraged

This graph illustrates external funds leveraged as a result of industry project funding for the years 2015/16 and 2016/17.

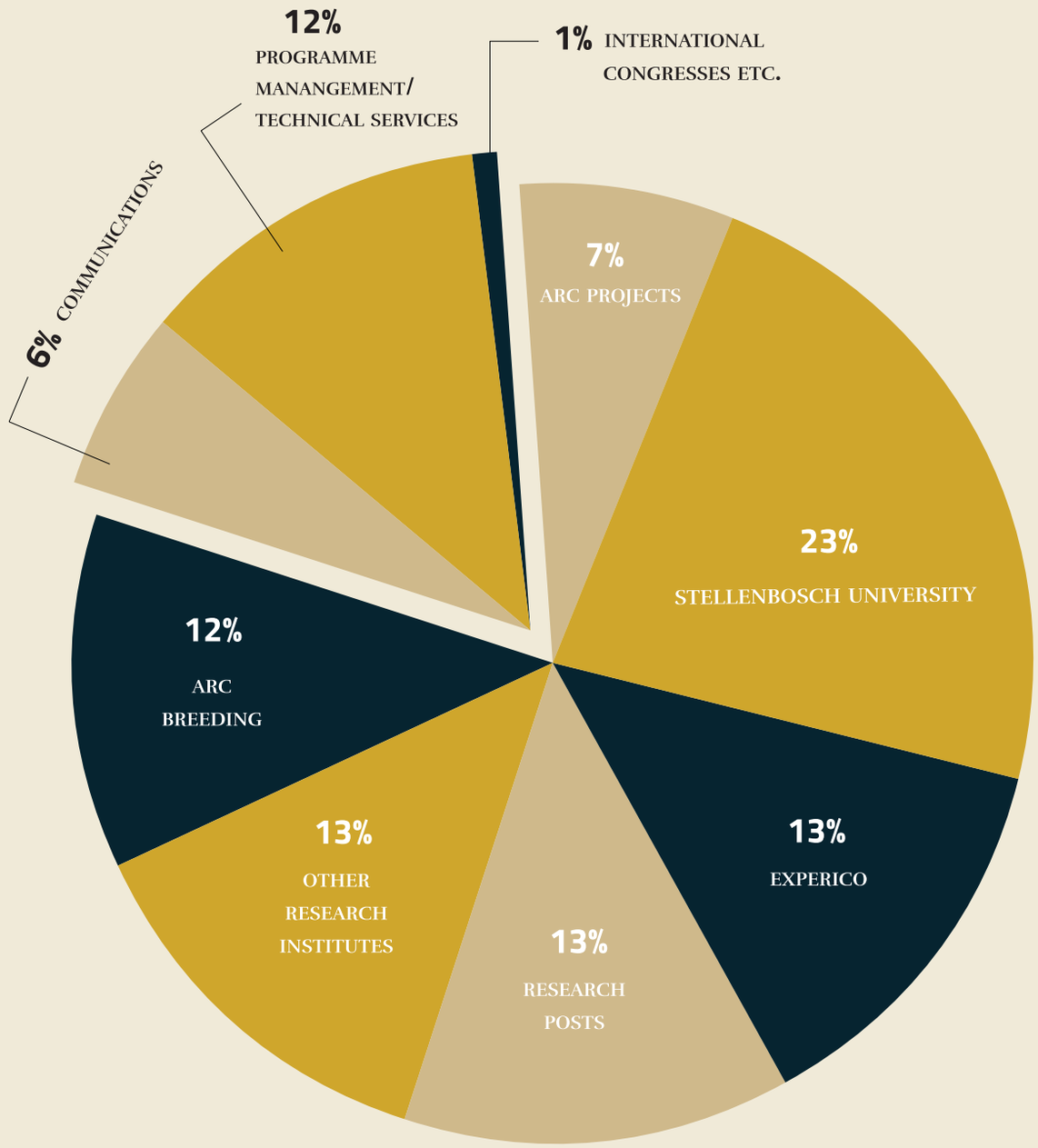


PHI funding ended in 2015/16.

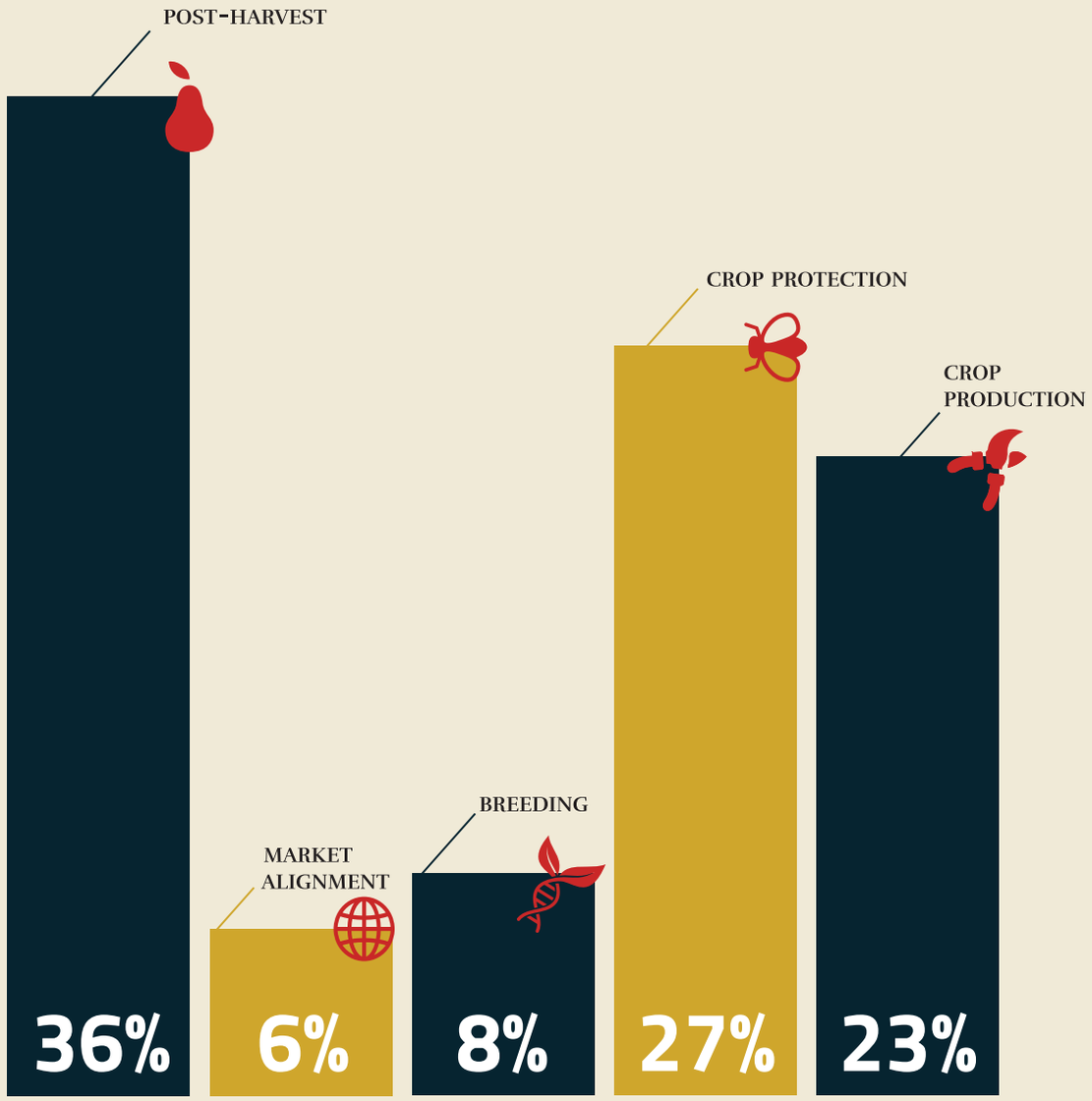
The 2016/17 THRIP cycle ended. A new process has been initiated.

Funding Allocations 2016/17

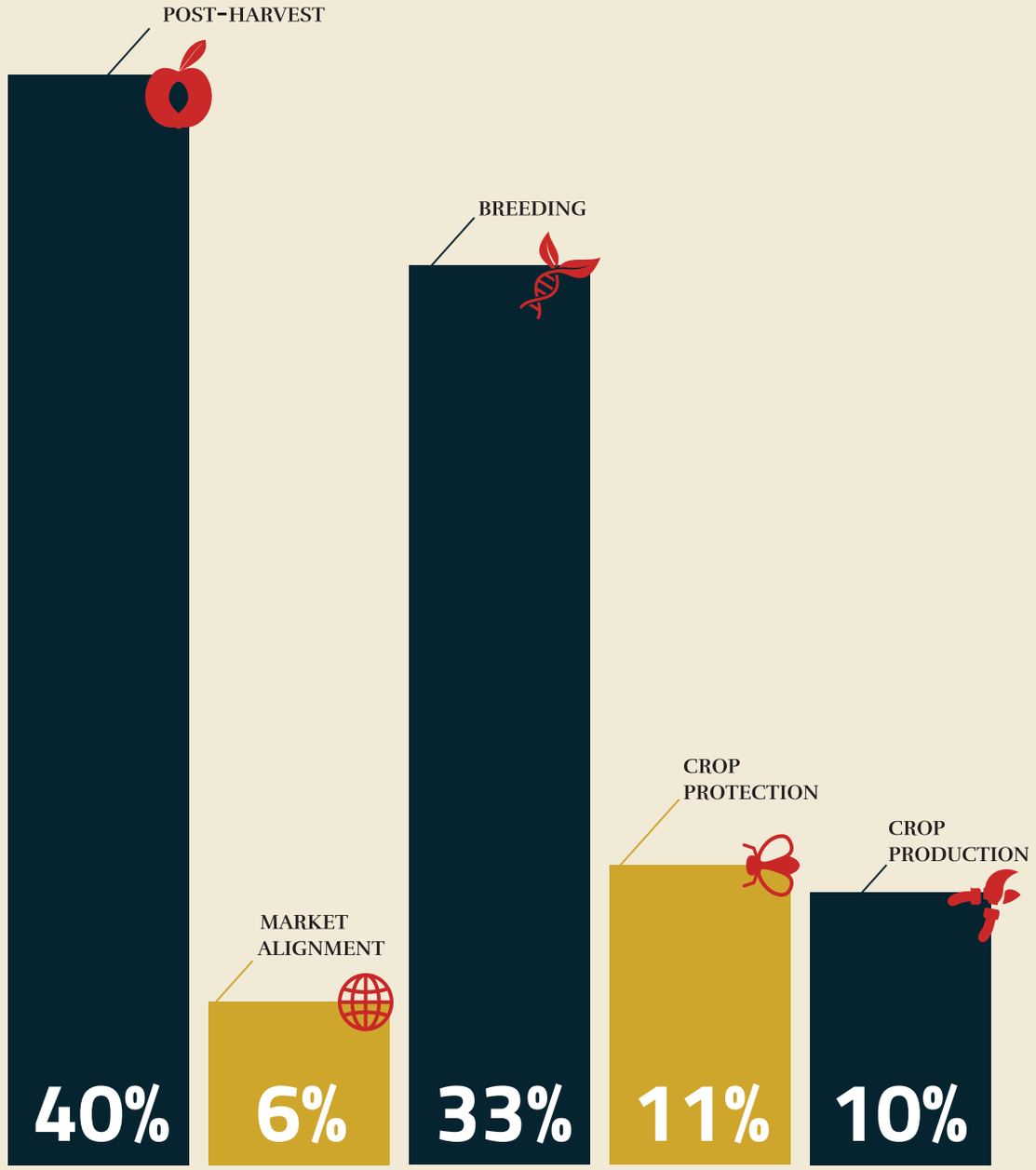
This graph illustrates the distribution of the industry's funding for research.



Investment per research focus area for 2016/17: *Pome fruit*



Investment per research focus area for 2016/17: *Stone fruit*



Summary of research projects in 2016/17

This infographic illustrates the summary of research projects in 2016/17 and includes market access projects. Please note that 16 of these projects are co-funded by SASPA and SAAPPA, and reflects in the stone and pome fruit project totals.

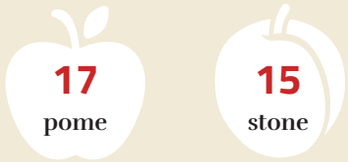
116 —— Total number of projects in 2016/17

16 —— Projects co-funded by SASPA and SAAPPA

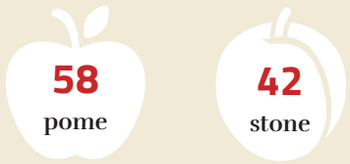
75 —— Total of pome fruit projects in 2016/17

57 —— Total of stone fruit projects in 2016/17

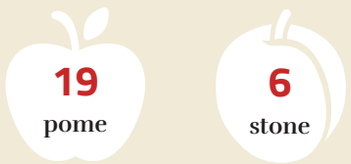
32 —— Total of new projects in 2016/17



77 —— Total projects continuing in 2016/17



23 —— Total projects completed in 2016/17

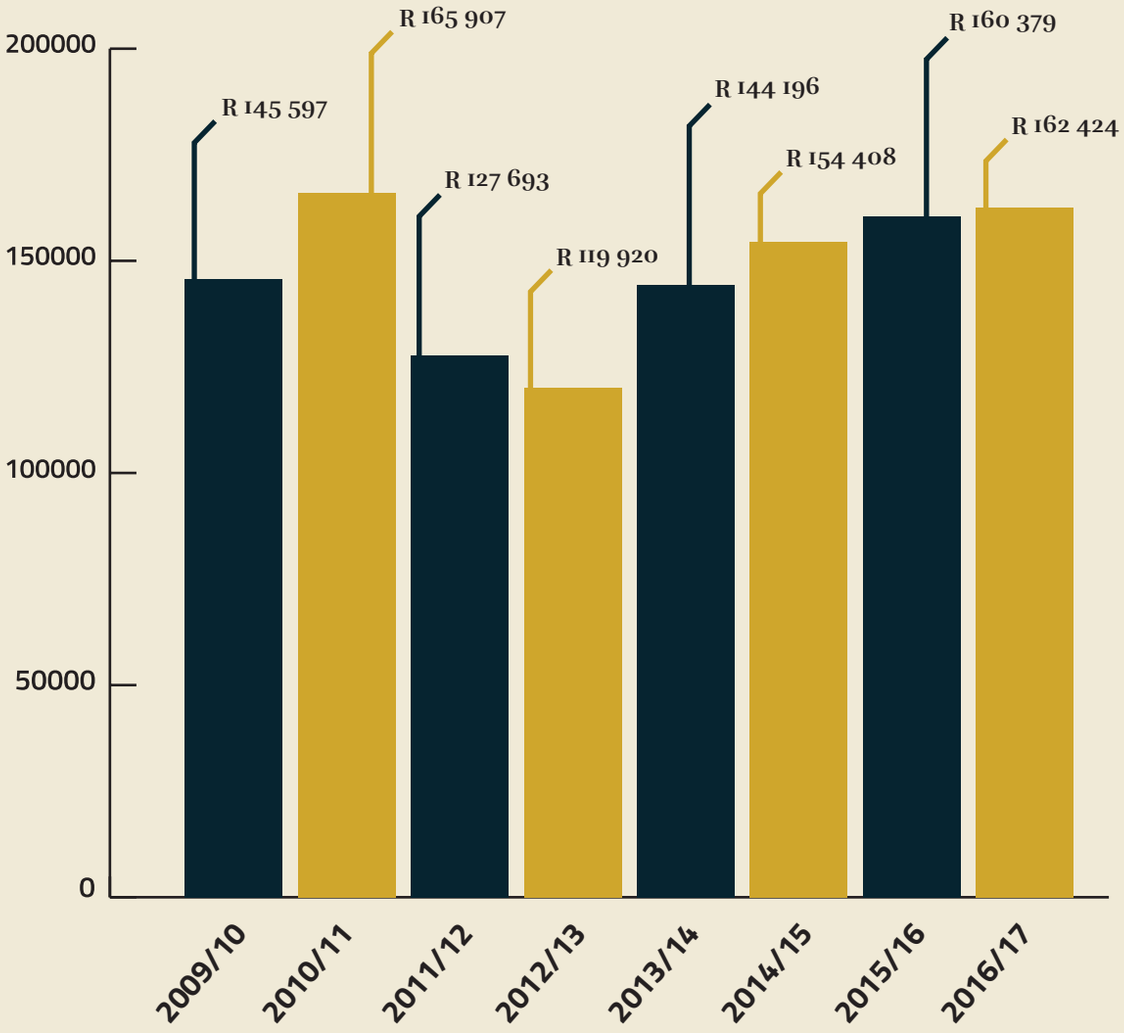


Research projects by research institutions from 2012 to 2017

Research Institute	Projects 2012/13	Projects 2013/14	Projects 2014/15	Projects 2015/16	Projects 2016/17
ARC Infruitec-Nietvoorbij	**36**	**36**	**30**	**29**	**24**
ARC Breeding	21	21	21	20	16
ARC Research Projects	15	15	9	9	8
Stellenbosch University	**38**	**39**	**34**	**33**	**36**
Dept Horticulture	15	16	14	12	12
Dept Pathology	5	5	5	5	7
Dept Entomology	18	18	14	14	16
Dept Engineering			1	1	
Dept Soil Science				1	1
Hortgro Science Technical Services	**20**	**20**	**15**	**18**	**20**
ExperiCo	**15**	**16**	**19**	**18**	**21**
CA Science	**1**	**1**	**1**		**1**
Nemlab	**1**	**1**	**1**	**2**	**2**
Blue North	**1**	**1**	**1**	**1**	**1**
University of Pretoria	**1**	**1**	**2**	**2**	**3**
Dept Zoology	1	1	1	1	1
Dept Soil Science			1	1	1
Dept Pathology					1
CSIR	**1**	**1**	**1**	**1**	**1**
Westcape Biotech			**1**	**1**	**2**
Provar					**5**
Consultants			**5**	**4**	
C Jarmain			**1**		
P Stassen			3	3	3
K Bouwer			1	1	
Total Projects	**114**	**116**	**110**	**109**	**116**

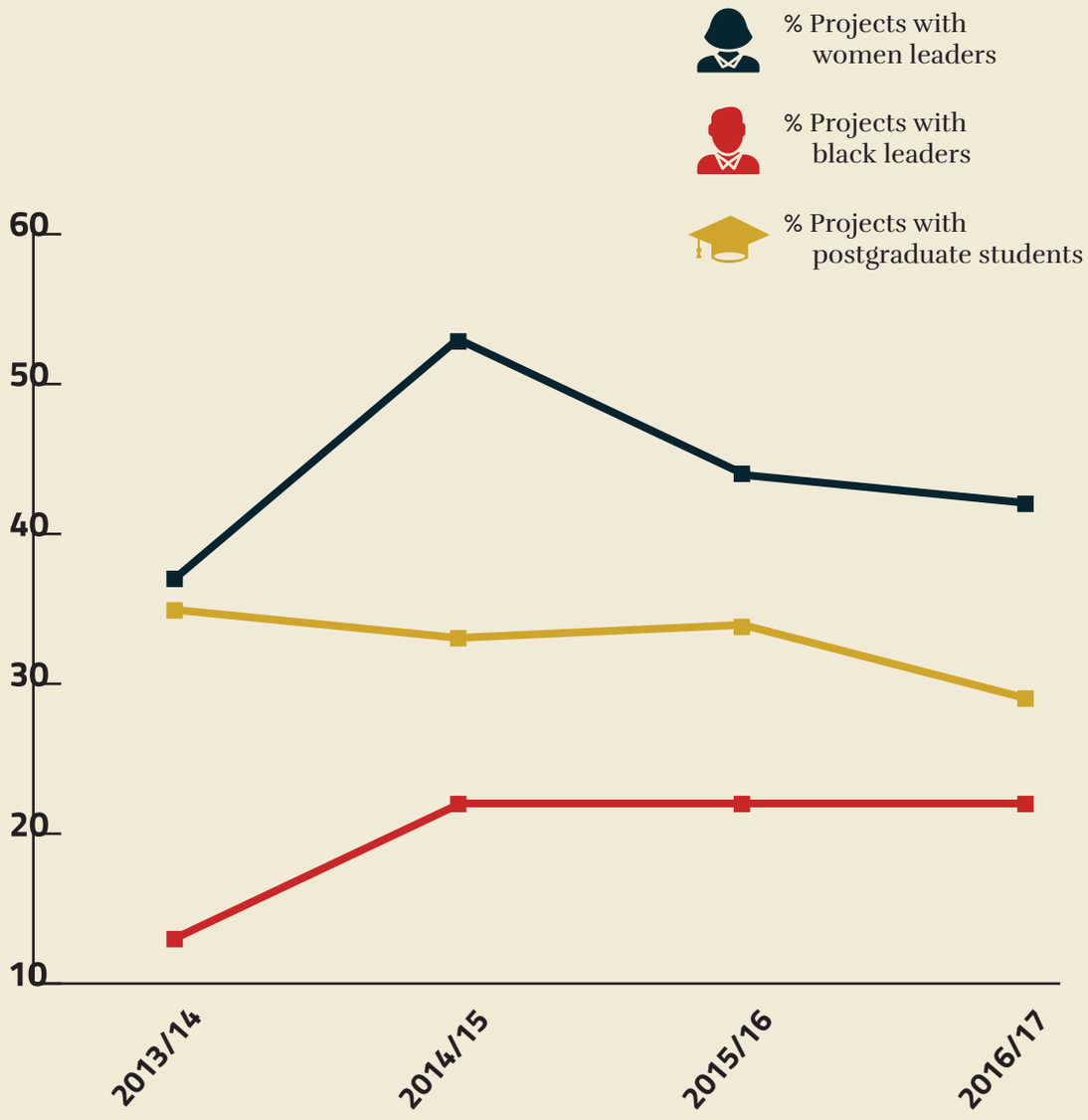
Average cost of a project per year including inflation

This graph shows the average cost of a project per year, including inflation, since 2009 til present. The average cost is influenced by the nature of the research.



Transformation in research from 2013 to 2017

This graph shows the percentage of projects with women leaders, projects with black leaders and projects with postgraduate students.



Profiles of students working on SAAPPA and SASPA projects

This table depicts the profile of the 49 postgraduate students working on projects funded by SAAPPA and SASPA. Total bursary cost to SAAPPA and SASPA is R 2 253 959.

DEGREE	BLACK MALE	BLACK FEMALE	WHITE MALE	WHITE FEMALE	TOTAL
HONOURS	1	1	1	1	**4**
MSc	4	5	6	6	**21**
PhD	7	5	2	5	**19**
POSTDOCTORAL	1		1	3	**5**

Hortgro Science events and attendence 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.

Integrated Management of False Codling Moth on Stone Fruit

October 11, 2016
Stellenbosch
103 attendees

Langkloof Seminar and Orchard Walk

December 5, 2016
Louterwater
70 attendees

Pome Fruit Field Day

March 1, 2017
Oak Valley, Grabouw
58 attendees

Hortgro Science Technical Symposium

June 5 – 9, 2017
Simondium

Attendees:

- Pome Fruit Technical Tour – 323
- Stone Fruit Technical Tour – 114
- Fruit Farming 101 – 225
- Pre-Harvest Day 1 – 362
- Pre-Harvest Day 2 – 293
- Post-Harvest Day – 184

PAG Training Course – Energy Management Systems for Packhouses

September 16 – 17, 2017
Paarl
15 attendees

Irrigation Seminar

August 18, 2017
Simondium, Groot Drakenstein
335 attendees

Irrigation Seminar

September 19, 2017
Louterwater, Langkloof
78 attendees

Fuji Browning Information Session with Dr Bart Nicolai

September 5, 2017
Stellenbosch
20 attendees

Awards

The following awards were made during the 2016/17 year. Hortgro Science would like to congratulate the award winners.

Hortgro Science – Daan Strydom Award for Best Student in Horticulture 2016

CP van der Merwe

Hortgro Science Best Semi-Scientific Article

Prof Karen Theron (co-authors: Human Steenkamp, Gustav Lötze, Schalk Reynolds and Wiehann Steyn) for *A new chemical thinner for plums on the horizon* published in the *SAFJ* Volume 16 Issue 4; June/July 2017.

Top Three Final Reports 2017

Dr Antoinette Malan for *Bioprospecting of agriculture and natural ecosystems for entomopathogenic nematodes*.

Dr Elke Crouch for *Post-harvest 'Forelle' 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.*

Dr Shelley Johnson for *CATTS as a postharvest treatment for chill-sensitive plum cultivars and associated phytosanitary insect pests.*

Overseas Tours and Sponsorships

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 4 international visits of South African researchers and research staff to international congresses and meetings during this past year. Hortgro Science also co-funded two events in South Africa that created greater exposure to our researchers, technical community and growers.

Sponsorships

IV International Symposium on Postharvest Pathology
Skukuza, South Africa
May 28 – June 3, 2017
Lanyard sponsorship

MQUIC and Ornamentals ISHS Conference
Stellenbosch, South Africa
September 3 – 6, 2017
Bronze Sponsorship

Tours and visits

ISHS CAMA Symposium
Warsaw, Poland
June 18 – 22, 2017
Attended by Mr Hurndall and Ms Anél Botes

11th International IOBC-WPRS Workshop on Pome Fruit Diseases
Jurmala, Latvia
June 28 – 3, 2017
Attended by Dr Cheryl Lennox

Phytosanitary Measures Research Group Meeting
Wageningen, Netherlands
10 – 13 July 2017
Attended by Dr Shelley Johnson

13th International Symposium on Plant Bioregulators
Chiba, Japan

Australia Visit to apple research station at Stanthorpe, Queensland, the Australian Centre for Field Robotics at Sydney University, Tatura research station and deciduous fruit production regions in Victoria, and lastly, the Department of Primary Industries and Regional Development, Manjimup, Western Australia.

August 25 – September 8, 2017
Attended by Prof Wiehann Steyn

Hortgro Science Representation on Committees and Boards

Hortgro Science represents SAAPPA and SASPA on external boards and committees as follows:

Elise-Marie Steenkamp	HortForum
Hugh Campbell	Post-Harvest Innovation (PHI) Management Committee
	Plant Improvement South Africa (Plant SA) – Combined Board DPA and VIA
	Deciduous Fruit Plant Improvement Association (DPA) – SAAPPA 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
	National Agricultural Research Forum Steering Committee
	Western Cape Agricultural Research Forum
	Confronting Climate Change – Chairman
	Crop Protection Advisory Group (CPAG)
Ken Pringle	Crop Protection Advisory Group (CPAG)
	Phytosanitary Risk Forum
Richard Hurndall	Pome Joint Marketing Forum
	Stone Joint Marketing Forum
	Project Rebirth – national fresh produce markets
	Forelle Producer Association
	SA Pink Lady Association – technical representative
	AfricaBio representative
Shelley Johnson	Phytosanitary Risk Forum
	Phytosanitary Measures Research Group
Wiehann Steyn	Water Research Commission reference group: Quantifying water use of high performing commercial apple orchards in the winter rainfall area of South Africa
	Water Research Commission reference group: Water footprint of selected vegetable and fruit crops produced in South Africa
	Western Cape Agricultural Research Forum
Xolani Siboza	South African Society for Horticultural Sciences Board member

Publications List

Here is a list of all Hortgro Science related articles publised in the *SAFJ* in 2016/17. As well as all our *Fresh Notes* for 2016/17.

SAFJ Article List

October/November 2016

- Midgley SJE, Boonzaaier J, Vermeulen M. *The benefits of using certified, virus tested, true-to-type plant material*
- Bonthuys J. *Fruitlook: Satellites aid irrigation on fruit farms*
- Theron K, Kirstein D, Steyn W. *Are handheld bloom thinners a viable option to thin apple trees?*
- McDonald D. *Insect-killing fungi could soon be added to growers' toolbox*
- McDonald D. *Spanish lessons for South African fruit growers*

December/ January 2017

- Bonthuys J. *FruitLook offers bigger picture*
- McDonald D. *SA-India collaboration to take biological pest control to next level*
- McDonald D. *The 'how and why' of biological control of mites in the Ceres region*
- Pringle KL, Heunis JM. *Mites with special reference to pears*
- Horstmann C, Van der Merwe L, Steyn L, Badenes M, Tobutt K. *Marker-assisted selection of apricot seedlings for Plum Pox Virus resistance at ARC Infruitec-Nietvoorbij*
- Hugo HJ. *Susceptibility of commercial stone fruit rootstocks to ring nematode (Criconemoides xenoplax)*

February/ March 2017

- *Hortgo Science Technical Symposium – USDA Expert: There's a Plan B to handle apple replant disease*
- Crop Production Final Report Summaries
- Weten om te groeien: Hortgro EU visit 2016
- Bonthuys J. *FruitLook: Support for Farmers*
- *Growing Fruit IQ blog: Propagating change*
- *Interpoma 2016: Knowledge & Science – key to fruit producers in the future*
- *Interpera 2016: The pear revolution*
- Duvenhage E. *Apple replant disease under spotlight*
- Bonthuys J. *Soil: The true wealth of farmers*

April/ May 2017

- Hurndall R. *Packhouse Action Group makes its mark*
- Baard N. *Area Wide IPM programmes work, analysis shows*
- Kotze W, Steyn W, Siboza X. *Does foliar sucrose application increase fruit set in Packham's Triumph pears?*
- McDonald D. *Interpoma 2016 highlights: The apple in the world*
- McDonald D. *Thrips Control: Culmination of a 34-year entomology career for Dr Elleunorah Allsopp*
- McDonald D. *Langkloof seminar tackles climate change*

June/ July 2017

- McDonald D. *Orchards of the future*
- Steyn W. *Growing Fruit IQ — The net gain*
- Theron K, Steenkamp H, Lötze G, Reynolds S, Steyn W. *A new chemical thinner for plums on the horizon*
- Addison M. *IPM still going strong after 30 years*
- Bonthuys J. *Beyond the farm gate: FruitLook shows the big picture*
- Human T. *Turkish pears in the spotlight*
- Stassen P, Malan A. *Host status and sensitivity of commercial stone fruit rootstocks to ring nematodes*
- Hurndall R. *ISHS VIII International Post-Harvest Symposium in Cartagena, Spain*

August/ September 2017

- *Hortgro Science Technical Symposium — Article Collection*
- Theron K. *Moisture maketh the nectarine (Post-Harvest Innovation Programme)*
- Ferreira S. *The hunt for Botrytis cinerea (Post-Harvest Innovation Programme)*

Fresh Notes List

- **Fresh Notes 129 – October 25, 2016** *Irrigation guidelines during water shortages*
- **Fresh Notes 130 – November 24, 2016** *Packhouse Action Group*
- **Fresh Notes 131 – November 24, 2016** *Packhouse Action Group*
- **Fresh Notes 132 – March 7, 2017** *Provar Pollinators*
- **Fresh Notes 133 – May 5, 2017** *Trapping guidelines for Bactrocera dorsalis in South Africa*
- **Fresh Notes 135 – August 16, 2017** *Packhouse Action Group*

11. PROJECT ABSTRACTS

11. PROJECT ABSTRACTS

Breeding and Evaluation

Pome Fruit

1 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

Budwood of selection P16-16, promoted by Culdevco for further commercial evaluation the previous year, was supplied to SAPO. For the 2017 season, 32 new selections were selected for harvesting in Phase 1 orchards at Drostersnes. Small fruit samples of each selection were harvested, cold stored for eight weeks and evaluated. After consulting with Culdevco, just one selection was assigned for further evaluation, all the other selections being discarded. This best selection, P17-14, harvested on Febuary 2, had blushed fruit, with good appearance and attractive colour, good texture and taste and scored 20/30. Crosses by hand yielded 14 566 seeds, comprising 22% for blush, 20% for green and 54% for future genetic studies. Seedlings from previous years were scored for early leafing and the late leafing ones were thrown away (± 3 700). The remaining mostly blush seedlings (± 12 792) for the time being, are maintained in plastic bags under the shade netting area at BD. About 2 700 non-blush seedlings will be planted at Drostersnes in an already prepared orchard (DN1). Solomon Ntladi, a PhD student, who used seedling progenies at Drostersnes for his study on mapping the blush trait, re-submitted his thesis to Stellenbosch University.

Conclusion

A PBR application was filed with DAFF for the very early blush selection, P07-3, on March 15, 2017 with suggested cultivar name of 'Cape Blush'. Thirty-two new selections were initially selected in Phase 1 seedling orchards of which, after storage evaluation, one selection, P17-14, was promoted for further commercial evaluation in conjunction with Culdevco. Clarification of the continuation project is needed so as not to jeopardise the material in the pipeline.

6 Molecular breeding in apple

K Tobutt and K Mhelembe

Objectives and Rationale

This PhD project aims to detect markers for a novel acyanic trait in apple, which will allow heterozygotes to be selected for further breeding, and to characterise and perhaps sequence the gene responsible. The grant was originally intended to top up the studentship but, with the approval of Hortgro Science, was redirected to consumables to make up for the suspension of THRIP funding for 2016/17.

Methods

The approach involves: crossing and scoring of segregations; HPLC and GCMS to characterise the phenotype; linkage analysis and mapping; and analysis of candidate genes.

Key Results

Scoring four progenies segregating for normal versus acyanic seedlings confirmed the recessive nature of the trait and also indicated the approximate location of the gene. Microsatellite primers to map the relevant region more precisely have been purchased and are being optimised and DNA has been extracted from the seedlings. Acyanic and normal samples were subject to HPLC analysis and differential peaks were detected from which the block in the anthocyanin pathway in acyanic seedlings may be deduced. Preliminary investigation of the published apple genome has identified two *MYB* transcription factors that warrant further investigation.

Conclusion and Discussion

This student project is proceeding well and is yielding novel information relevant to anthocyanin pigmentation in apple and other crops.

Planting and maintenance of existing and new germplasm of pome and stone fruit

W Pieterse, L Kwalimba and T Nyawo

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

Accessions were maintained in field genebanks at Bien Donne, Drostersnes and Elgin Research Farms, typically two or three trees per accession.

Key Results

Budwood of the replacement pear accessions still needed for the genebank, will be collected and trees propagated by a commercial nursery. Three new additions to the pear genebank, mentioned in the previous report were planted. The soil preparation, ridging and fumigation of the site for the new peach genebank, BD10B, was completed. Pollen of ten peach cultivars imported from Italy was used in crosses of the peach breeding programme. The progenies derived from these crosses, will be molecularly characterised to determine if the desirable alleles are present. Accessions with desirable alleles will be added to the genebank. MSc students Lawrence Kwalimba and Thembeka Nyawo completed the fingerprinting of the stone fruit genebanks and the molecular characterisation with respect to certain agronomic traits. Relabelling of rootstock cultivars and selections was done in both stone fruit rootstock genebanks (ZN7 and BD11).

Conclusion and Discussion

The insights gained by the fingerprinting and characterisation of the stone fruit genebanks will be of great value to ARC breeding programmes and funding for future molecular work should be sought to continue the work.

Cold storage characteristics of new cultivars and selections

E Lotz

Objectives and Rationale

Good cold storage ability is a pre-requisite for all South African export fruit cultivars.

- 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 help them and other stakeholders to decide on the future of new selections.
- To accumulate cold storage data of new selections in a database.

Methods

- Each 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 with existing data on new selections of the ARC Cultivar Development programme.
- Photographs of fruit at final evaluation are also recorded.

Key Results

- A total number of 188 fruit samples were received for cold storage from November 4, 2016 until March 22, 2017. Data and recommendations were shared with ARC cultivar development researchers.
- Feedback aimed at improving production practices (decay, insect damage and harvesting maturity) were also shared. Lower than normal rainfall experienced in the Western Cape for a second consecutive season contributed to the low incidence of post-harvest decay.

Conclusion and Discussion

Storage data and recommendations on the cold storage ability of 188 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.

5 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

A total of 19 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, three selections stored well, one was average and four were below average, while 11 did not store well. The best selection for blush, P07-3, scored 82% for consumer traits. No selections were sent for canning during the season. None of the selections evaluated this past season will be discarded, as they still have to be evaluated further. Thirteen new Phase 2 selections were planted at Elgin Experimental Farm in 2016 and these will be the last selections planted in Phase II.

Conclusion and Discussion

Since the P10 range of pears in Phase II failed to produce promising blush selections during the past season it was decided to cancel the pear orchard walk. P07-3 once again proved to be the best selection overall, but this has already been evaluated for five years and is already propagated in Phase III.

6 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 characters after storage.

Key Results

A total of 13 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, six stored well, two were below average and five had no storage potential. The best selections, after quality assessment, were: A09-4, low chill, oval, full red, 84%; 4-54-87, full red, 80%; and 4-61-35, bicolour, 79% with balanced taste and excellent flavour and texture. No selections were identified for removal after the 2017 season, as new selections need to be evaluated for a minimum of three years. Nine new selections were planted at Elgin in September 2016. Malic acid markers, developed and optimised in 2016, are currently being used to screen the most promising Phase II selections. Results are looking promising and will help with the planning of future crosses. For incompatibility, the SRB1 consensus primers were used to determine the S-genotypes of Phase II selections. Results which will be useful when recommending pollinators are available on request.

Conclusion and Discussion

Feedback from industry contacts regarding selection A09-4 was positive. This selection was fast-tracked and trees propagated for planting in a semi-commercial orchard later next 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.

Breeding and Evaluation

Stone Fruit

1 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 gene bank 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

Orchards and seedlings in shade net areas were maintained. Three crosses were made. As part of the complementary THRIP project, fingerprinting and S-allele genotyping of the gene bank accessions was completed. Apricot seedlings from progenies of crosses for the canning industry were planted at Robertson. A new site to plant seedlings of progenies of crosses for the dessert and drying industries, should be ready for planting shortly.

Conclusion and Discussion

The transition of the apricot breeding programme is progressing, with new models to develop and evaluate new cultivars and to revitalise the programme being explored. Meanwhile the programme is lagging behind as the "maintenance" period extends to months and years. It is recommended that an apricot breeder be appointed and that Industry performs Phase 1 horticultural orchard management to circumvent the challenges experienced within the ARC.

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 Phase 1 plantings and bagged seedlings were maintained. Eleven crosses made with pollen of cultivars with various desirable attributes received from Italy, yielded ~130 seedlings. Furthermore, a new seedling orchard of progenies from crosses for the canning industry was planted at Robertson with funding from the Canning Fruit Producers' Association (CFPA) and the seedlings are growing well. Budwood of crosses made for the CFPA was collected in underperforming Phase 1 seedling orchards on Bien Donné, and propagated on rootstocks to raise trees for planting at Robertson for Phase 1 evaluation. Lawrence Kwalimba concluded his MSc studies on fingerprinting and characterisation of germplasm collections. Budwood will be collected from seedlings in Phase 1 plantings of progenies of crosses for the dried fruit industry for propagation and planting at Robertson.

Conclusion and Discussion

The peach breeding programme is in a transition phase, with new models on the table to develop and evaluate new cultivars and to revitalise the programme however, the industry models have not yet been finalised and, in consequence, the programme is lagging behind. It is recommended that Industry performs Phase 1 horticultural orchard management to circumvent the challenges experienced within the ARC.

Breeding of new peach rootstocks for the first and second economy

S Booi

Objectives and Rationale

This project aims to provide the South African Stone-Fruit Industry with new, low-chill stone-fruit rootstocks (peach, plum, apricot, interspecies) resistant/tolerant to various soil conditions. The objectives for the current study were to screen selections for resistance to a combination of ring nematode (*Criconemoides xenoplax*) and root-knot (*Meloidogyne javanica*) under glasshouse conditions and to perform hand cross pollinations to raise progenies for screening the following year.

Methods

In May 2016, cuttings from 37 ARC-bred hybrids and six commercial rootstock cultivars were rooted to raise plants for resistance screening trials in 2017 under standard nursery conditions at Bien Donné Research Farm. Twelve ARC-bred stone-fruit rootstock selections, all plums, and five commercial rootstock cultivars were screened for nematode resistance in the Nematode Glasshouse at Bien Donné Research Farm, with five replicates. Hand pollinations were performed to raise new seedlings for screening in the near future.

Key Results

Of the twelve ARC-bred selections with five commercial rootstocks for resistance to a combination of ring and root-knot nematodes, ARC selections had no root-knot galls in the roots and so all were found to be resistant to root-knot nematodes. The susceptible control rootstock cultivar 'Kakamas' had root-knot galls, while 'Flordaguard' rootstock, a peach rootstock that is known to be resistant had none, which suggests that our inoculum was viable. Very low ring nematode counts were observed in the soil initially inoculated with ring nematode for all samples.

Conclusion and Discussion

The two nematode species should not be combined together on the same plant pot when screening for resistance, to avoid competition. The ring nematode resistant peach rootstock cultivar 'HBOK1' bred by retired nematologist and breeder, Dr Michael McKenry should be imported into the country for breeding purposes. More effort will be put on breeding for drought tolerance rootstocks; this will be in collaboration with SU.

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

Three crosses were made. Furthermore, budwood was collected from underperforming Phase 1 orchards on Bien Donné, to propagate trees to establish a new orchard at Robertson. Student Thembeka Nyawo submitted her MSc thesis on determining S-allele genotypes of plum cultivars in the genebanks and reference collection.

Conclusion and Discussion

New arrangements are being considered to develop and evaluate plum selections and to revitalise the programme are being considered.

Delays in finalising the industry model are detrimental to the breeding programme which is lagging behind while on hold. It is recommended that Industry undertakes Phase 1 horticultural orchard management to circumvent the challenges experienced within the ARC. The location for a new Phase 1 orchard was identified at Robertson and is being prepared for planting.

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 259 Phase 2 and Phase 3 selections at the two evaluation sites in Limpopo, and 61 peaches and 26 nectarines harvested and evaluated. Currently 18 promising selections (14 peach, 4 nectarine) should be re-evaluated in the 2017 season. Possible promotion to Phase 3 should be discussed in collaboration with Culdevco.

A further 10 newly identified selections (five peach, five nectarine) from the ARC breeding programme were planted with current reference control cultivars at the Phase 2 evaluation trial sites. Technology transfer was provided in terms of a presentation to students from Unisa on the 25 August 2016 at Bufland Farm.

Conclusion and Discussion

The Phase 2 and Phase 3 evaluations and fruit exhibitions on the co-evaluator sites should continue. Final decisions in cooperation with Culdevco need to be taken on the 18 promising selections in order to create a short list for possible releases to the summer rainfall producers. Special attention should be given to the selections already planted in Phase 3 semi-commercial blocks at the co-evaluator sites.

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 2016 to February 2017 at Bien Donné and Robertson Research Farms. No selections were planted in the 2016/17. The samples were subjected to cold storage, canning and drying trials at the Post Harvest and Wine Technology Division. Representative fruit samples were also collected to evaluate their external and internal traits and the data captured on the MS Access data base.

Key Results

Three peach and five nectarine selections scored ≥80% (cut-off point) in the cold storage evaluation. Fifteen peach selection obtained 70% or higher in the final canning evaluation. Three peach and one nectarines selection scored ≥ 70% in the final drying evaluation. At the request of Culdevco, several promising selections were given special attention regarding their horticultural traits. Four fruit exhibitions were held at ARC Infruitec-Nietvoorbij and were attended by approximately 93 people from the fruit industry. Several meetings were held with Culdevco and its clients with regard to new peach and nectarine varieties and planting guidelines.

Conclusion and Discussion

Post-harvest and horticultural evaluations as well as the fruit exhibitions will continue in 2017/18. No new selections will be planted 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 Donne and Robertson Research Farms.

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 2016 to February 2017 at Bien Donné and Robertson Research Farms as well as at a commercial farm, Uitkomst in Ceres. The fruit samples were subjected to cold storage trials at single and double temperature regimes at the Post Harvest and Wine 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

Three red skin and two yellow skin selections scored ≥80% (cut-off point) in either the single or double temperature regimes or both in the cold storage evaluation. 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. Three fruit exhibitions were held at ARC Infruitec-Nietvoorbij and were attended by a total of approximately 93 people from the fruit industry. 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 Cultivar Development Division. There was regular liaison with the deciduous fruit industry and technical support as well as technology transfer was provided.

Conclusion and Discussion

Horticultural and post-harvest evaluations as well as the fruit exhibitions will continue in 2017/18, 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 Donne and Robertson Research Farms.

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 2016 to February 2017 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

One selection, AP07-29, scored ≥80% (threshold) in the cold storage evaluation and also scored >70% (threshold) in canning evaluation.

AP02-04 scored >70% in the drying evaluation. At the request of Culdevco, several promising selections were given special attention regarding their horticultural traits. Six fruit exhibitions were held at ARC Infruitec-Nietvoorbij and were attended by approximately 93 people from the fruit industry. 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. Continuous support was given to the second economy projects in the Cultivar Development Division.

Conclusion and Discussion

Post-harvest and horticultural evaluations as well as occasional fruit exhibitions will continue in 2017/18. 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. The evaluation site at Uitkomst in Ceres was evaluated for the last time in 2016/17 season.

Crop Production

Dormancy

1 Quantifying the impact of insufficient winter chill on apple fruit quality

E Louw 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 six trees and removing the fruit from two 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 some preliminary statistical analyses were performed to quantify the variability.

Key Results

The quality parameters of the fruit differed between the two areas in terms of diameter, height, TSS and firmness with the fruit from the Koue Bokkeveld having significantly higher values. The bottom branches had a significantly higher starch conversion percentage. The sun-exposed fruit had a higher TSS than the shaded fruit.

Conclusion and Discussion

At the time of the report, the data analysis was not yet complete and no conclusions could be made. However, preliminary results give insight into the variability of 'Golden Delicious' fruit produced under different climatic conditions. The results can possibly lead to practical recommendations for farm practises such as pruning, RBA application, and harvesting and tree management.

2 Physiological dynamics of dormancy in apple buds grown in areas with insufficient cold

E Louw, J Colling and M Inamahoro

Objectives and Rationale

We investigate the physiological aspects (lipid content, oxidative stress and hormone concentration) of apple buds growing under inadequate winter chilling to gain knowledge on the changes brought about by typical South African conditions.

Methods

Dormant apple buds from two contrasting climatic regions, Elgin (insufficient chill) and Koue Bokkeveld (sufficient chill), are compared in terms of lipid content (fatty acids, phospholipids and sterols) throughout the winter period. Method development for quantification of oxidative stress (ascorbic acid and glutathione) and hormone concentrations (IAA, CK, ABA, GA) are underway.

Key Results

The following fatty acids (FA) show differences between the two areas: C16:0, C18:0, C18:1, C18:2, C18:3 and C20:0. Saturated FA show a decreasing trend during dormancy in both areas with Elgin averaging higher saturated FA and sterols at bud break. The C18:2 and C18:3 increased in both areas but the Koue Bokkeveld had significantly higher levels of C18:2 decreasing suddenly before budburst coinciding with an increase in C18:3. Results from the ABA assay show that degradation products in the contrasting areas differ. IAA, GA and CK levels are exceptionally low in the bud tissue. The oxidative stress analysis produced varying results.

Conclusion and Discussion

Insufficient winter chill changes the lipid profile of apple buds during dormancy by decreasing the amount of unsaturated FAs, sterols, phospholipids and the ratios of the C18 FAs. ABA catabolism differs between the two areas and IAA, GA and CK are very low/undetectable in the bud tissue. A project extension was approved to continue our investigations.

Investigating the effects of different autumn temperatures on endodormancy progression

E Louw and L Allderman

Note: All results, conclusion and discussion are based on an incomplete data set as the data generation and analysis was not yet complete at the time that this report was submitted.

Objectives and Rationale

We investigate the effect of different temperature scenarios on the induction (late summer/autumn) of endodormancy in apple buds to better understand the effect of temperature on dormancy progression.

Methods

'Royal Beaut' shoots from two different climatic areas were collected weekly and exposed to temperatures varying from 4 to14ºC for different time periods (one to 14 days) and then forced (25ºC, continuous light) to grow while monitoring the bud-break pattern. The effect of harsh environmental conditions were tested three times by exposing 'Cripps Pink' shoots, from both areas, to two days of either 30ºC, 4ºC or -4ºC before forcing and monitoring bud-break.

Key Results

The onset of 'Royal Beaut' endodormancy varied between climatic regions and seasons with shoots entering dormancy sooner under colder conditions. During 2016 'Royal Beaut' shoots from both climatic regions reacted to additional chill by drastically increasing their dormancy levels. This did not reoccur in 2017 in that additional chill did not cause similar deep dormancy levels. Early in the season, the 'Cripps Pink' shoots from both regions responded less to harsh conditions compared to later in the season, where 30ºC decreased and 4ºC increased dormancy levels. -4ºC had little effect in the Koue Bokkeveld but resulted in decreased dormancy levels in Elgin.

Conclusion and Discussion

Apple buds from different climatic areas show a different sensitivity to low temperatures in autumn. Large seasonal differences necessitates additional testing. Preliminary data from extreme testing conditions show that buds exposed to insufficient winter chill react differently to short-term environmental stress during the induction period.

Using the shoot assay to screen combinations and sequential application of existing and possible new rest breaking agents in apple

E Louw and L Allderman

Objectives and Rationale

The use of rest breaking agents (RBAs) is essential for successful budburst in areas with insufficient winter chill. Dormex® and mineral oil is currently the South African apple production industry standard for rest breaking. Dormex® is becoming controversial and under continuous scrutiny for its hazardous effects on man and environment. The first objective of the study was to investigate the use of growth enhancing compounds to improve the vigour of apple shoots after treatment with Dormex® and oil. Secondly, we aimed to determine the rest breaking capabilities of nitric oxide (NO) (produced chemically and enzymatically), in the presence of oil, as a safer more environmental friendly alternative to Dormex®.

Methods

The laboratory shoot assay (developed in 2014) was used to test the efficacy of a range of vigour enhancing compounds (hormones and N-containing) through visual assessment (scoring into 4 categories) and dry mass determination after exposing treated shoots to standard forcing conditions. Similar forcing conditions were used to quantify the budbreak ability of alternative RBAs that produce NO, by measuring the % budbreak (%BB), onset and duration of budbreak.

Key Results

Compared to the industry standard (Dormex® and oil), the vigour enhancing compounds that were tested did not show improved growth after 28 days post treatment. In general, all results were equal to that of Dormex® and oil. Promalin® and Maxcel® showed some potential as they always came out as the top performers, especially in 2015, and could be considered for further testing and/or field trails. No conclusive evidence could be found for improved %BB using vigour enhancers. All the NO producing rest breaking alternatives that were tested proved to be effective in delivering a %BB equal or higher to that of Dormex® and oil. However, they all showed a prolonged onset to budburst and an extended time period to completion. KNO3 was the most promising with positive results at the lowest concentration. NaNO2 was the least effective with some contradicting results and lethal activity at concentrations higher than 69g/L. The use of combinations of vigour enhancing compounds and nitric oxide producing alternatives did not deliver favourable results as all the cocktails tested lower for rest breaking and vigour assessments.

Conclusion and Discussion

The vigour enhancers, both hormonal and chemical, did not prove to increase

the vigour of the treated shoots. Our results did not support the notion that Dormex® and oil treatments have a lower vigour compared to the fully chilled samples. Nitric oxide acts as a RBA in apple buds and has a rest breaking capability equal to that of Dormex® and oil but is slow acting. The use of combined treatment should be tested on intact plants before disregarded as an ineffective RBA.

5 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. The programs under evaluation is based on prior lab work aimed at finding products or developing programs that can rely industry reliance on Dormex®.

Methods

The following treatments were applied in 'Fuji' on September 13, 2016 and on 'Rosy Glow' on September 14, 2016 with 10 replications of one tree per plot.

'Fuji' apple trees	'Rosy Glow' apple trees
3% Dormex (control)	1% Dormex + 4% Oil (control)
0.5 % Dormex + 3% Oil	4% Oil (control)
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	0.5% Lift +1.5% Oil + 1% KNO_3 + 0.5% Dormex

Key Results

The application of 0.5 % Dormex + 3% Oil + 100 mg/L Promalin enhanced the bud break percentage in 'Fuji' compared to 3% Dormex or 2% Urea + 2% KNO_3 + 0.5% Dormex + 3% Oil. The effect of Promalin on increasing bud break was also observed in 'Rosy Glow'. Bud break was increased by 1% Dormex + 4 Oil+ 100 mg/L Promalin as well as by 1% Dormex + 4% Oil compared to 4% Oil. The different rest-breaking treatments did not affect yield in both cultivars.

Conclusion and Discussion

Spraying 'Fuji' trees with 0.5% Dormex + 3% Oil + 100 mg/L Promalin resulted in a higher bud break percentage than achieved with either 3% Dormex or 2% Urea + 2% KNO_3 + 0.5% Dormex + 3% Oil. All treatments were, however, ineffective in increasing reproductive bud break as percentage of total bud break. Treatment with either 1% Dormex + 4% Oil + 100 mg/L Promalin or 1% Dormex + 4% Oil increased bud break percentage of 'Rosy Glow' apple trees compared to 4% Oil. Generally, all the rest breaks applications gave a good vegetative bud break and fruit quality in both 'Fuji' and 'Rosy Glow'.

Crop Production

Rootstocks and Nursery Tree Quality

1 Evaluation of pear rootstocks for the South African industry – Packham's Triumph in Grabouw

X Siboza and I Labuschagne

Objectives and Rationale

Pear rootstocks vary in their adaptation to various soils and climatic conditions. They also differ in 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 as well as vegetative and reproduction performance of new rootstocks under local marginal winter chilling conditions, poor soils, high temperatures and the presence of various pests and diseases. This information will then be used by the industry to advise 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 Jackal River Farm in Grabouw. The following 9 rootstocks were planted: 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 pear trees are growing very well despite translocation shock which was observed only on a few trees.

Conclusion and Discussion

It is still too early to make any conclusions.

Evaluation of pear rootstocks for the South African industry – Forelle in Wolseley

X Siboza and I Labuschagne

Objectives and Rationale

Pear rootstocks vary in their adaptation to various soils and climatic conditions. They also differ in 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 as well as vegetative and reproduction performance of new rootstocks under local marginal winter chilling conditions, poor soils, high temperatures and the presence of various pests and diseases. This information will then be used by the industry 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 Mostertshoek 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 two trees per plot. The experimental trees were spaced at 4.5 m × 1.5 m (1481 trees ha-1).

Key Results

The pear trees are growing very well despite translocation shock which was observed only on a few trees.

Conclusion and Discussion

It is still too early to make any conclusions.

Evaluation of pear rootstocks for the South African industry – Cheeky in Wolseley

X Siboza and I Labuschagne

Objectives and Rationale

Pear rootstocks vary in their adaptation to various soils and climatic conditions. They also differ in 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 as well as vegetative and reproduction performance of new rootstocks under local marginal winter chilling conditions, poor soils, high temperatures and the presence of various pests and diseases. This information will then be used by the industry 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 Mostertshoek farm in Wolsey 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 at 4.5 m × 1.5 m (1481 trees ha-1).

Key Results

The pear trees are growing very well despite translocation shock which was observed only on a few trees.

Conclusion and Discussion

It is still too early to make any conclusions.

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 (Coast Guard, Cadaman®, Kakamas seedling, Montclar®, Okinawa, Flordaguard, OSM 99-3 and Rootpack 70®) on a 79% sandy soil. The second planting with 'Snow Angel' on 12 rootstocks (Cadaman®, Okinawa, Coast Guard, Flordaguard, Kakamas seedling, Viking, OSM 99-3, Barrier 1, Earligrande, Rootpack 70®and Earliblush) on high potential red soil (45% sand). The trial layouts are randomised complete block (10) designs. Trees were planted at 4 x 1.5 m using a two-leader training system. These two sites were selected because they represent the well-drained, sandy and red soils that occur in the northern stone fruit production areas. The sandy soil is infested with moderate numbers of *Criconemoides xenoplax* (ring) and species of *Pratylenchus* (root-lesion) nematodes whilst the red soil has high numbers of ring nematodes. No pre-plant treatments for nematodes were applied.

Key Results

During the third leaf, trees on Okinawa on red soil had grown to the

largest trunk circumference, but not significantly larger compared to trees on Coast Guard, Flordaguard, OSM 99-3, Barrier and Rootpack 70. Trees on Cadaman, Kakamas seedling and Viking grew less vigorous over time. On sandy soil, trees on Rootpack 70 stayed small, whilst trees on Cadaman, Kakamas seedling, Montclair and Okinawa grew less strong. Trees on Coast Guard and on OSM 99-3 remain strong growers. Nematodes occurred at both sites and reproduction factors will be determined for selected rootstocks over the trial period. First harvest results will be analysed for reporting during 2018.

Conclusion and Discussion

No conclusions can be drawn at this early stage. Trees are growing well, and tree training was done according to plan.

5 Evaluation of plum rootstocks for the South African industry at Simondium.

P Stassen and I Labuschagne

Objectives and Rationale

The main objective for this project is the evaluation of high potential imported and local rootstocks for nematode infested sandy soil conditions and to make recommendations that can complement yield as well as fruit quality of plum cultivars whilst preventing tree die-back.

Methods

At the Simondium trial site, 'Ruby Star' on 13 rootstocks (Flordaguard, GF 677, Viking, SAPO 778, Cadaman®, Marianna, Garnem, OSK 99-6, Atlas, Guardian®, 7B-25-21, Kakamas seedling, 5A-05-34) were planted during 2015 in a complete randomised trial lay-out using 10 blocks. Trial trees and side row trees were incorporated in a commercial plum orchard. The new ARC bred rootstock selections OSK99-6 (plum), 7B-25-21 (plum) and 5A-05-34 (plum) 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. This specific site was selected because of the high-risk factors that occur, i.e., sandy soil, fluctuating water tables and the presence of *Criconemoides xenoplax* (ring) and species of *Pratylenchus* (root-lesion) nematodes. These factors can predispose trees to die-back.

Key Results

Trees have been planted and grown successfully, but will only be harvested during early 2018. Trunk diameters were measured after plant and one year later.

Conclusion and Discussion

No conclusions can be drawn at this early stage of the trial. Trees are growing well, and no tree die-back occurred thus far.

6 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 layouts are randomised complete block designs with different rootstocks planted in 10 blocks of single tree plots.

Key Results

On 90% sandy soil, high pH (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. 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), 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. On soils with about 60% sand (about 30% clay) and high numbers of ring nematodes, trees on the rootstocks, SAPO 778 (cuttings and seedling) as well as trees on Viking or Atlas performed well.

Conclusion and Discussion

Several rootstocks are available to deal with the different soil conditions that occur in our plum producing regions.

7 Evaluation of apricot rootstocks

P Stassen

Objectives and Rationale

The aim of this project is to identify suitable, rootstocks for apricot trees, using a 'Royal' interstem. Breakage at the bud union is an important aspect when selecting rootstocks for apricots. Currently only apricot seedlings (Royal and Soldonne) are compatible with apricot scion cultivars.

Methods

A trial using a randomised block design was planted in McGregor (Thornvilla) during 2013. 'Rustic' trees on Atlas, Viking, Cadaman, GF 677, SAPO 778, Guardian and Tsukuba 4 with a 'Royal' interstem were evaluated against trees on Royal seedling.

Key Results

Four years after planting, trees 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 nematodes are present in this soil. The cultivar 'Rustic' was highly recommended, but unfortunately it did not set-fruit under commercial conditions. It was decided to work this orchard over to 'Bulida' during January 2017 and new growth reach an average of 40 cm at the end of March. The owners however decided to remove this orchard during July 2017.

Conclusion and Discussion

Over a four-year period, trees grew excellently and no incompatibility occured. It is clear that rootstocks available to peaches and plums can be used for apricots, when Royal seedling does not satisfy soil conditions, by using a Royal interstem.

8 Evaluation of peach rootstocks

P Stassen

Objectives and Rationale

The main objective for this project is: To evaluate high potential imported and local peach rootstocks on different soil types.

Methods

Five trials have been planted in different climatic conditions, soil textures, containing various numbers and types of nematodes. All trial layouts are randomised complete blocks designs.

Key Results

'Alpine' performs excellently in medium potential (17.7% silt and clay), calcareous soil with high numbers of ring nematodes on the rootstocks Atlas, Garnem, Cadaman and Felinem. The nectarine 'Artic Star' performs 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 and Cadaman grow extremely strong in these soils and need more summer pruning. 'Summer Sun' peach trees on high potential replant soil (52% silt and clay) perform well on the rootstocks Atlas and Viking. 'Cascade' peach trees on Felinem and Garnem perform well on high potential soil where GF 677 are more prone to infection with fungal diseases. 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.

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.

9 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 from 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, and G228) were grouped together in two adjacent, but separate plantings. G202, a dwarfing rootstock, was planted together with the more vigorous rootstocks. Trees were planted during spring 2013 using randomised complete block designs for both plantings. We measured scion diameter, tree height and number of shoots during winter 2016 as a measure of tree growth.

Key Results

During the fourth leaf, G778, G228, and G202 rootstocks produced about 75, 65, and 35 tons per hectare, respectively, while the MM109, M793, and M7 rootstocks produced about 42, 31, and 31 tons per hectare, respectively.

Conclusion and Discussion

G778, G228, G202, G222, and trees on the interstem rootstock combinations, G778/G222 and G778/M9 were more precocious and productive than standard industry rootstocks.

10 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 from 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. G202, a dwarfing rootstock, was planted together with the more vigorous rootstocks. Trees were planted during spring 2013 using randomised complete block designs for both plantings. Trunk renewal was applied in winter 2014 and 2015. Tree scion diameter, fruit production and fruit quality were evaluated during the 2017 season.

Key Results

This has been the first harvest since planting in 2013. The orchard produced big fruit of good red colour. G778/M9, M793/G222, G778, and G202 were the most productive rootstocks, and also more yield efficient than the industry standard rootstocks.

Conclusion and Discussion

G778/M9, M793/G222, G778, and G202 were more productive and yield efficient than standard industry rootstocks in the first year of production.

Evaluation of new apple rootstocks and interstem combinations in Langkloof (Helderwater)

X Siboza and I Labuschagne

Objectives and Rationale

The objective of this project is to assess the various new apple rootstocks (most from 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. G202, a dwarfing rootstock, was planted together with the more vigorous rootstocks. Trees were planted during spring 2013 using randomised complete block designs for both plantings. Trunk renewal was applied in winter 2014. Tree scion diameter, fruit production and fruit quality were evaluated during the 2017 season. Trees have reached the optimum height. Central leaders were cut back. Therefore, tree height measurements were omitted during the 2017 season to avoid biases.

Key Results

The most productive rootstocks on the dwarfing site were G778/G222, G778/M9, and G222. The most productive rootstocks on the vigorous site were G228, G778, and MM109. G778/G222, G228, and G778 outperformed all the rootstocks in terms of cumulative production.

Conclusion and Discussion

G778/G222, G228, and G778 outperformed the industry standard rootstocks in terms of precocity and productivity.

Apple replant rootstock trials for determining a screening technique

A Vermeulen

Objectives and Rationale

The objective of this study is to quantify the variation in apple rootstock genotypes regarding resistance/tolerance to apple specific replant disease (ASRD).

Methods

Rootstocks from the Cornell Geneva range and standard industry rootstocks were investigated under ASRD conditions in two field trials in the Elgin region. One-year-old ungrafted rootstock material was planted in Oct 2013. The weight of each plant as well as trunk diameter and the length of the leader 'shoot' was recorded at planting in 2013. Wet and dry weight measurements of shoots and roots were taken when the trials were terminated. Plant nutrient analyses of the stems and roots were also performed at trial termination. Nematode counts were performed for soil and roots from all plots at termination of the trials. In May 2015, soil samples were collected close to the roots of each rootstock planted in fumigated and unfumigated soil at both sites for molecular determination of the presence of ASRD-associated pathogens. DNA was isolated from soil of each of the samples using the ZR Soil microbe DNA Miniprep kit.

Key Results

From the percentage increase in trunk and total shoot growth, as well as plant weight measurements with termination of the trial, it was clear that rootstock tolerance was site specific, with possibly the exception of MM109 that seemed to be most susceptible to ASRD in both sites. However, this is in contrast to the previous round of field trials (2010-2012) which found MM109 to be the only rootstock that consistently showed tolerance to ASRD conditions in the field.

Conclusion and Discussion

From the percentage increase in trunk and total shoot growth, as well as plant weight measurements with termination of the trial, it was clear that rootstock tolerance was site specific,

with possibly the exception of MM109 that seemed to be most susceptible to ASRD in both sites. However, this is in contrast to the previous round of field trials (2010-2012) which found MM109 to be the only rootstock that consistently showed tolerance to ASRD conditions in the field. When looking at growth measurements in the field, two years after planting, M793 and M7 was the only rootstocks that showed better growth compared to the other rootstocks in both sites when only looking at unfumigated sites. However, when looking at the percentage growth increase with fumigation these rootstocks do not seem tolerant to ASRD conditions. CG3007 showed less growth in unfumigated plots compared to the other rootstocks, in both sites. Soil chemical and nutrient status were similar for the various rootstocks, therefore not affecting plant growth.

Lesion nematode counts were highest for G222 and MM109 (Vergelegen), which were also the more susceptible rootstocks at this site. This again indicates that site specific factors need to be taken into account when establishing rootstock choice for ASRD management.

Some interesting consistent results were noted with regards to plant nutrient analyses. Results indicated that M7 took up the highest amount of Na in both sites. G202 showed highest K content in roots in both sites and G778 showed highest P and N content in both roots and shoots for both sites. However, nutrient analyses results could not be related to ASRD tolerance/ susceptibly indicated.
Parasitic nematodes were indicated to have a site specific role as part of the ASRD complex.

Evaluation of newly bred stone fruit rootstock hybrids for the first and second economy

S Booi

Objectives and Rationale

The aim of this project was to assess ARC's newly bred stone-fruit rootstock hybrids for rooting ability, to evaluate grafting compatibility with indicator scion varieties under nursery conditions and to evaluate rootstock selections planted under field conditions for production potential.

Methods

The project assessed rooting ability and graft compatibility under nursery conditions and production potential under field conditions.

Key Results

Nine of the nineteen ARC rootstocks were planted in a field trial in 2011 at Bien Donné Research Farm to evaluate their production potential. 'Pioneer' plum on two peach-almond hybrids, OSM99-2 and OSM99-3, from the nine ARC rootstocks were not significantly different from the standard plum rootstock, Marianna over four harvest seasons. From the nine selections planted at Bien Donné Research Farm, five were chosen by Culdevco and industry partners for planting at commercial farms. Trees were planted out successfully at four commercial farms in winter 2015 by Dr Piet Stassen in consultation with Culdevco, two in the Western Cape and two in the Northern Province. The sites in the Western Cape were visited in spring 2016 and a visit to the farms in the Northern Cape is planned for spring 2017. Several ARC-bred rootstock hybrids were further evaluated for chilling requirement but the procedure that was used did not give relevant information that can be readily used by industry and as a result the procedure is under review.

Conclusion and Discussion

Ten from the nineteen ARC-bred rootstock selections with resistances/ tolerances for drought, nematodes (ring and root-knot) and high pH were found to root well and were compatible with plum and nectarine scion varieties 'Pioneer' and 'Alpine'. These need to be evaluated further under field conditions to evaluate their production potential. ARC-bred rootstock selections planted at different commercial farms should be monitored closely to identify which could be valuable rootstocks to the South African stone-fruit industry.

Screening of apple rootstocks for resistance to woolly apple aphid

C Costa

Objectives and Rationale

The objective of the project was to evaluate the potential rootstocks available to the SA apple industry for their comparative susceptibility, resistance or tolerance to woolly apple aphid infestation and to develop a screening protocol for use on new rootstocks as they become available in future.

Methods

Methodology entails the bulking up of plants via in vitro technique from mother plants, rooting of genotypes, establishment and hardening off under greenhouse conditions, transplanting into larger bags and transferring to shade-house to reach sufficient size for inoculation with WAA samples. Trees of the required minimum height of 40 cm were inoculated with root pieces of trees infested with WAA. Trees were examined and scored for symptoms of WAA infestation.

Key Results

Of the originally selected 23 genotypes, 21 were successfully micro-propagated and established within a reasonable (but extended) time-frame for this trial. Inoculation and subsequent re-inoculation resulted in symptoms which could be scored and some resistant genotypes could be identified. These were CG 5890, G228, G778, G202, CG 6969 and CG11. All our current main

commercial rootstocks (M793, MM109, M7, and M9) and some Geneva rootstocks (CG 6874 and CG 4013) were found to be highly susceptible.

Conclusion and Discussion

The project took longer than expected because of difficulty in micropropagation of some of the rootstocks. Eventually some recalcitrant and contaminated rootstocks had to be eliminated from the current trial. Trial trees had to be older and infestation period longer than originally proposed in order to obtain reliable results. The protocol developed was successful in identifying resistant and susceptible rootstocks, but it may take longer orchard trials to identify those rootstocks with a degree of tolerance to WAA.

Crop Production

Growing Season Climate

1 Effect of nets on growth, yield and fruit quality as well economic feasibility in plums

K Theron and N van Rensburg

Objectives and Rationale

We tested several plant growth regulators (PGRs) on plum trees grown under shade net so see whether these can control vegetative growth without any detrimental effect on fruit quality. In addition, we evaluated the effect of shade nets on fruit quality at harvest and after cold storage and shelf-life compared to fruit grown on trees in full sun.

Methods

Foliar or soil applications of the PGRs were made either at petal drop (PD), PD plus four weeks later or after harvest depending on the product. Effect on fruit set, summer pruning and yield and fruit quality were determined. A comparison of fruit quality from untreated trees in full sun were compared to fruit quality from trees grown under shade net, at harvest, after cold storage and after cold storage and subsequent shelf-life.

Key Results

Nets did not negatively affect yield per tree or fruit size of netted trees compared to outside trees in 'Larry Ann' or 'Midnight Gold' plums. The nets however significantly reduced wind and sunburn damage. In 'Larry Ann', gel breakdown was decreased in fruit from netted trees while the opposite was the case with internal browning. These problems were seen after 6 weeks cold storage at -0.5°C and one week shelf-like simulation at 10°C. No such internal problems occurred in 'Midnight Gold'. Foliar PGR applications reduced fruit set and increased fruit size in 'Larry Ann' and to a lesser extent in 'Midnight Gold' without a significant effect on vegetative growth.

Conclusion/Discussion

These are preliminary results and further research is needed.

2 Tree water relations and sunburn in pome fruit

W Steyn and G Mupambi

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.

Crop Production

Reproductive Biology

1 Evaluate the use of NAA and Ethephon to increase return bloom in apples and pears

X Siboza

Objectives and Rationale

The original objective of this project was to determine the effect of NAA and Ethephon application on return bloom in heavy bearing 'Fuji' and 'Abate Fetel' orchards. The research was expanded to 'Cheeky' pears in 2015/16.

Methods

During the 2012/13 season, four to two fortnightly sprays of 5 ppm NAA were applied from 40 days after full bloom (dafb) to 'Abate Fetel' and 'Fuji' in Vyeboom. During the 2013/14 and 2014/15 seasons, four fortnightly 5 ppm NAA applications were made from either 40 or 68 dafb to 'Abate Fetel' and 'Fuji'. In addition, Ethephon at 150 ppm was applied once at 40 dafb on its own or in combination with NAA (4 applications at 5 ppm). In 2015/16, applications of Ethephon (50 or 75 ppm in week 45; 50 ppm in weeks 45 and 47) and Ethephon in combination with NAA (50 ppm Ethephon in week 45 and 5 ppm NAA in weeks 47 and 49) were made to 'Cheeky' pear in Wolseley.

Key Results

NAA and Ethephon treatment yielded one positive effect on return bloom in 'Abate Fetel' and once enhanced return bloom in 'Fuji' over the three assessments done on these two cultivars. However, in general, NAA and Ethephon were rather ineffective in enhancing return bloom and increasing cumulative yield in 'Abate Fetel' and 'Fuji'. The application of Ethephon and NAA sprays on 'Cheeky' pear trees in 2015/16 did not significantly increase return bloom and cumulative yield in the 2016/17 season.

Conclusion/Discussion

The application of NAA and Ethephon did not have any substantial effect on yield and return bloom in both 'Abate Fetel' pears and 'Fuji' apples over three assessments. While treatment with Ethephon and NAA showed a trend to enhance return bloom in 'Cheeky' pear trees, the effect was not statistically significant and the cumulative yield over the seasons of the application were not affected by treatment. Our results do not provide sufficient support for the application of NAA and Ethephon during "on" seasons to increase return bloom and yield in 'Fuji' apples and 'Abate Fetel' and 'Cheeky' pears.

6 Evaluation of apple thinning programmes

X Siboza

Objectives and Rationale

The main aim of this project was to evaluate the chemical thinning agents metamitron (Nevis™) and 6-benzyl adenine (6-BA; MaxCel™) on their own or as part of thinning programmes over a number of seasons to develop an industry reference base on thinning results. One of the project aims was to find potential replacements for carbaryl (Sevin™).

Methods

Chemical thinning treatments were compared over seven seasons (2009/10-2015/16) in both EGVV and Ceres, except for 2009/10 in Ceres and 2014/15 in EGVV. Cultivars used included Fuji (all seasons except 2009/10), Golden Delicious (all seasons except 2011/12), Cripps' Pink, Cripps' Red and Royal Gala (only 2009/10 – 2011/12). Until 2011/12, the research focused on evaluating

the use of 6-BA in combination with other chemicals such as naphtelene acetic acid (NAA; Planofix™ or Pomaxa™) or on its own compared to industry standard thinning programmes. From 2012/13, the project scope was broadened to also evaluate metamitron. Treatments were applied by spray cart until 2010/11 and whole orchard rows served as plots with every second row serving as guard row. Treatments were applied by motorised backpack sprayer from 2011/12 onwards with single tree plots.

Key Results

2009/2010: 'Cripps' Red' benefitted from chemical thinning with either carbaryl or 6-BA. 2010/11: 6-BA could be applied as an alternative to carbaryl. The weather in the days following the first application facilitated good thinning, but inclement weather after the second application resulted in poor thinning. 2011/12: Most thinning treatments decreased fruit numbers and increased fruit size in 'Cripp's Red' and 'Golden Delicious'. 2012/13: Metamitron showed promise as a potential chemical thinner on 'Golden Delicious'. However, cloudy weather before, and sunny conditions after applications at an early stage resulted in over thinning. 2013 /14: Metamitron reduced fruit set and the hand thinning requirement in both 'Fuji' and 'Cripp's Red'. Two consecutive metamitron applications thinned more aggressively than NAA followed by metamitron. 2014/15: All three chemical thinning treatments were very effective and possibly over-thinned 'Golden Delicious' trees. Conditions were very good for chemical thinning. In 'Fuji', metamitron at 4 mm fruit size and 6-BA (750 ml) 7 days later was a very good thinning treatment. 2015/16: Metamitron at 4 mm fruitlet diameter increased fruit size in 'Golden Delicious' without affecting yield in EGVV. In Ceres, metamitron at 4 mm and 6-BA at 12 mm fruitlet size seemed to overthin 'Golden Delicious'. In 'Fuji', none of the treatments were effective in EGVV. In Ceres, all treatments were effective in decreasing the hand thinning requirement. Two metamitron applications, metamitron followed by 6-BA as well as NAA followed by NAA and 6-BA followed by carbaryl thinned very aggressively.

Conclusion and Discussion

Metamitron and/or 6-BA (750 ml) at 4 mm fruit size appeared to be effective apple chemical thinners. Double metamitron applications or metamitron followed by 6-BA may result in excessive thinning. More research is required to evaluate combinational use of the different thinning agents.

Chemical thinning of pears

X Siboza

Objectives and Rationale

Chemical thinning trials have previously been conducted on 'Early Bon Chretien', 'Forelle' and 'Rosemarie'. The results on 'Forelle' have not been very promising, but very good results have been achieved with the other two cultivars (the MSc thesis of Tinashe Chibikwa is available online). 'Abate Fetel' was not included in the research since attaining good fruit set has proved to be major problem. It is only in recent years that consistently heavy set has been achieved. Hence, the original objective of this project was to develop a chemical thinning programme for 'Abate Fetel' that would minimize hand thinning and result in regular, good quality yields. The scope of the project was subsequently expanded upon request from the Crop Production TAC to include 'Forelle'.

Methods

Chemical thinning agents such as naphtelene acetic acid (NAA; Planofix™ or Pomaxa™), 6-benzyl adenine (6-BA; MaxCel™), metamitron (Nevis™) or a combination of these chemicals were compared from the 2011/12 to 2015/16 seasons on 'Abate Fetel' (all 5 seasons) and 'Forelle' (from 2014/15) pear trees. For the 2014/15 season, the Crop Production TAC advised the evaluation of multiple Nevis™ applications or application of Nevis™ in combination with other thinning agents to try to increase the thinning effect that in previous seasons varied from no to slight thinning. Treatments were applied using a motorised backpack sprayer.

Key Results

The chemical thinning treatments were generally ineffective in thinning 'Abate Fetel' and 'Forelle' pears. In both 2011/12 and 2012/13, the timing of the spray treatments was not optimal due to weather conditions. During the 2013/14 season, 11 ml NAA at petal drop and 750 ml MaxCel™ 7 days later as well as Nevis™ (600 ml/1000L/ha) at 14 mm fruitlet diameter had a slight chemical thinning effect in 'Abate Fetel', but there was still a significant hand thinning requirement and fruit quality was not affected. Chemical thinning with Nevis™ (600 ml/1000L/ha) at 4 mm as well as with Nevis™ at 4 mm and 12 mm fruitlet diameter increased fruit size in 'Forelle' in 2014/15 without a discernible thinning effect. Return bloom was not affected. In 2015/16, all the chemical thinning treatments decreased fruit size of 'Abate Fetel' despite not affecting yield compared to the handthinned control. Treatments did not affect return bloom. Chemical thinning treatments did not affect the hand thinning requirement, yield, fruit size or return bloom compared to the control in 'Forelle' in 2015/16.

Conclusion/Discussion

In agreement with the earlier research of T Chibikwa and K Theron, chemical thinning was generally ineffective in 'Forelle'. Chemical thinning was only (slightly) effective in one season out of five in 'Abate Fetel'. Climatic conditions preceding, during and after treatment application may have affected results in two seasons. However, seen holistically, our research does not suggest that the thinning treatments applied (i.e. NAA, 6-BA, metamitron and combinations of these chemicals) are effective in thinning 'Forelle' and 'Abate Fetel' pears. Nevis™ application did increase fruit size in one season in 'Forelle', but the risk of phytotoxicity warrants caution and necessitates further research.

5 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 as 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

1 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

A suitable gravelly soil at a site near Grabouw has been identified and an irrigation trial designed in a newly planted apple orchard. Physical and chemical properties of the soil were determined, followed by the installation of irrigation equipment, soil water measuring instruments and rhizotrons for studying roots *in situ*. Irrigation systems were equipped with controllers that can be operated remotely by cell phones and soil water measurements are logged continuously and are accessible by computer. At the end of the season (June 2017) tree response to irrigation treatments was determined by measuring stem circumference and shoot growth. Root studies using the soil profile wall method was also carried out at that stage to evaluate final root distribution after the first season.

Key Results

Irrigation treatments were applied successfully according to the planned depletion levels between December 2016 and June 2017. The short cycle treatment (T1) received 11 mm every 3.8 days, the medium cycle treatment (T2) 19 mm every 7.3 days and the long cycle treatment (T3) 28 mm every 12.1 days. In total the three irrigation treatments, T1, T2 and T3 received 227.0mm, 189.4 mm and 174.4 mm respectively. Rainfall to an amount of 143 mm also added to the water supply of the trees.

Tree response in terms of shoot extension growth and trunk circumference was not significantly different between the irrigation treatments. Root studies yielded the following results:

- Significantly more roots penetrated deeper into the soil with larger quantities of water applied less frequently.
- The dark-coloured top soil was the preferred medium for the roots compared to the yellow-coloured subsoil that was also texturally different, but there were treatment differences regarding utilisation of the subsoil namely T3 > T2 > T1.
- Roots have penetrated to 80 cm during the first season already.
- No new root growth occurred during June.
- Non-destructive, *in situ* root scanning against the sides of a buried perspex chamber looks promising as a cheap and easy method of studying roots.

Conclusion and Discussion

The first season of the trial was completed successfully and all mileposts were achieved. 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.

Quantifying water use of high performing commercial apple orchards in the winter rainfall areas of South Africa

S Dzikiti, Z Ntshidi and N Mobe

Objectives and Rationale

Currently there is no accurate information on the water requirements of high yielding apple orchards (>100 t/ha +). Little is also known about how orchard water use varies from planting until the trees reach full-bearing age. This paucity of data may cause irrigation and water allocation decisions to be inaccurate leading to inefficient use of often limited water resources. This study investigated how orchard evapotranspiration (ET) and its components (i.e. tree transpiration and orchard floor evaporation) varied with leaf area. We also quantified tree physiological responses to environmental factors, fruit yield and quality dynamics, and water productivity in unstressed orchards.

Methods

The study was conducted over three growing seasons in the Koue Bokkeveld and Villiersdorp/Vyeboom production regions. Four of the orchards were high yielding full-bearing orchards planted to the Golden Delicious and Cripps Pink cultivars. The other four were at the beginning of bearing (5-7 yr.). The last four orchards were young non-bearing orchards (< 4 yr.) planted to the Golden Delicious, Cripps' Red and Rosy Glow cultivars. Tree transpiration was measured using sap flow sensors on 3-6 trees per orchard while orchard ET was quantified using eddy covariance systems. Additional water use data was derived using a soil water balance approach, Fruitlook, and from a dual source ET model.

Key Results

Seasonal total tree transpiration was strongly correlated to the transpiring leaf area than to crop load. The full-bearing 'Golden Delicious' orchards had the highest seasonal transpiration peaking around 7 800 m3/ha. Total ET of these orchards were in the range 10 000 – 10 500 m3/ha/season. The long growing season of the 'Cripps' Pink' orchards did not translate to high seasonal water use because of much lower transpiration rates in autumn and winter and also because the trees tended to have open canopies with a low leaf area index to promote the development of the red fruit colour. Contribution of the orchard floor ranged from 20-35% of ET in mature orchards to more than 60% of ET in young orchards.

Water productivity was in the range 10-21 kg of fruit per m3 of water transpired by mature trees to as low as 4 kg/m3 for trees at the start of the bearing age.

Conclusion and Discussion

Tree leaf area is a more critical factor in determining orchard water use. So canopy management is critical both to achieve optimal yield of good quality fruit and in controlling orchard water use. Water productivity increased linearly with increasing yield, at least to yield values of 140 t/ha which were the highest measured in this study. It is not possible to speculate whether further gains in yield would continue to raise water productivity at the same rate.

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. The WRC/Hortgro Science study proposes a multi-disciplinary approach to establish 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.

Methods

Determine soil physical properties (texture, chemical status, soil water retention curves) of two intermediate bearing orchards in the Koue Bokkeveld (KBV) and EGVV production regions each. Install and calibrate soil water content sensors, monitor soil water content throughout the season and calculate evapotranspiration (ET) according to a soil water balance for a Golden Delicious orchard and Cripps' Pink orchard in the KBV region (no suitable Golden Delicious orchard in EGVV).

Key Results

The orchard soil water balance was done in a sandy loam to sandy Golden Delicious and ridged loamy sand Cripps' Pink orchard selected for eddy co-variance and sap flow measurements in the KBV region. In the Golden Delicious orchard ET in the tree row ranged between 0.2 mm and 8.6 mm during the season and in the work row between 0 mm and 2.7 mm. A tree and work row weighted ET for the orchard and Penman-Monteith reference evapotranspiration (ET_o), respectively, reached maximums of 8.7 mm and 9.9 mm for the season. Cripps' Pink orchard maximum ET from the ridged area, tractor track and cover crop during the 2016/17 season was 3 mm, 3.2 mm and 3.1 mm, respectively.

Maximum orchard ET, weighted for the different components, and ET_o, respectively, amounted to 8.3 mm and 6.6 mm.

Conclusion and Discussion

In the Golden Delicious orchard moderate water deficits from October to mid-November 2016 may have slightly reduced vegetative growth. Continuous deficit irrigation from end January 2017 appeared not to affect fruit growth or yield negatively. The intermediate bearing Cripps' Pink orchard was over-irrigated for an extended period during summer. In both orchards (short-range and full surface irrigated) maximum orchard ET values exceeded 8 mm per day.

Crop Protection

Phytosanitary

1 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 might be subjected to phytosanitary regulations. To mitigate this risk, continuous monitoring and identifying FCM 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 and percentage damage of FCM on stone fruit, comparing middle and late nectarine cultivars.

Methods

Six orchards were monitored for FCM in Ceres and in Tulbagh. 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.

Key Results

No damage was found in any of these orchards, although moths were caught in the traps. Trap counts increased after harvest.

Conclusion and Discussion

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

2 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 fruits 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 two-weekly 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.

Key Results

False codling moth adults were found in traps in all orchards throughout the sampling period. However, fruit infestation occurred only in one orchard, with one pear being infested by one larva.

Conclusion and Discussion

More data are needed to establish that 99.99% of fruit are uninfested at the 95% confidence interval. For this a further 10 000 fruit need to be inspected.

5 Phytosanitary status of false codling moth, *Thaumatotibia leucotreta* (Meyrick) (*Lepidoptera: Tortricidae*) on plum cultivars

M de Villiers

Objectives and Rationale

False codling moth (FCM) is a pest of phytosanitary concern. Recently the European and Mediterranean Plant Protection Organisation (EPPO) conducted a Pest Risk Analysis on FCM to determine if it presents a risk to the region. It was concluded that it does present a risk and it was placed on the EPPO alert list. This resulted in a potential threat to market access for certain crops, which have been listed as hosts of FCM. Currently EPPO does not include plums in this list. In older literature, plums have been documented as a host for FCM. However, there is no recently published evidence that plums destined for export are a host of FCM. The objective is to determine seasonal phenology of FCM in plum orchards.

Methods

FCM activity has been monitored in nine orchards in the Western Cape, including three early, three mid and three late season cultivars. Delta traps baited with FCM lure were used to trap the moths at two-weekly intervals. In each orchard, 25 evenly spaced trees were chosen, with ten fruit per tree being inspected at two-weekly intervals. Fruit inspection started after thinning and continued until a pre-harvest fruit damage assessment was done, one to two weeks before harvest. For the latter, ten fruit per tree were inspected, of which five were harvested and inspected in the laboratory.

Key Results

Despite FCM being found in the traps in all orchards throughout the season, no damage was observed in the fruit.

Conclusion and Discussion

There does not seem to be a correlation between trap catches and fruit damage, indicating that trap catch information alone cannot be used in decision making for control options.

7 CATTS and ethyl formate fumigation as post-harvest treatments for stone and pome fruit and associated phytosanitary insect pests

S Johnson and R Smit

Objectives and Rationale

Two alternative post-harvest treatments were investigated for use against false codling moth and grain chinch bug. In addition to achieving insect pest mortality, we also investigated the effect of both treatments (heat and 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 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 phytotoxic effect of ethyl formate fumigation on a number of stone and pome fruit cultivars and assessed the effect of packaging on grain chinch bug mortality, which is easily achieved by fumigation with ethyl formate.

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. Preliminary results of the biochemical composition of grain chinch bugs indicate that physiological changes do occur in aestivation that may help insects survive adverse thermal conditions.

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

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.
The development of successful treatment regimes will help maintain current markets, which are constrained by available mitigation options, and will also allow for market expansion and growth of the industry.

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 dorsalis* was first detected in Kenya in 2003 and in Limpopo province in 2011. *Bactrocera dorsalis* is not established 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 as well as competition studies on *B. dorsalis* and *Ceratitis capitata* on nectarine, plum pear and apple to determine the potential threat of *B. dorsalis* to the fruit industry in the Western Cape. Test fruits were offered to 10 two week old adults of each species and sting marks were counted after 48 hours. Egg hatch, number of pupae and identity of the adults were recorded. 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 and 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. 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 although some significant hardening responses could be detected in certain treatments in adult *B. dorsalis* (e.g. after exposure to 37°C and 39°C), the magnitude of this plasticity was generally low compared to two other wide-spread and more geographically-range-restricted con-familial species, *Ceratitis capitata* and *C. rosa*.

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*, 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.

Identification of larval samples in PPECB-inspected stone fruit (False Codling Moth in stone fruit)

S Johnson, C Bazelet, P Addison

Objectives and Rationale

The objective of the project was to identify Lepidoptera larvae detected in stone fruit samples intercepted by PPECB inspectors, to establish the level of infestation by *Thaumatotibia leucotreta*, false codling moth (FCM). Given the raised awareness of the phytosanitary risk of FCM and the EU assessment thereof, information on the level of infestation by, and potential for interception of, FCM in harvested stone fruit is needed.

Methods

Nine packhouses across the stone fruit growing regions of South Africa were included for sample collection in the latter part of the 2016/17 season. Caterpillar-damaged fruit identified in the packhouse PPECB inspection points were removed and sent to Stellenbosch University for identification.

Key Results

Six specimens were received for identification from the Paarl and Ceres regions. The fruit of origin included two varietals of nectarine (August Red and Arctic Wolf) and three varietals of plum (Royal Amber, Black Pearl, and Ruby Star). One specimen was a pupa which had been crushed in transit and could not be identified. The five remaining specimens were identified as *Thaumatotibia leucotreta*.

Conclusion and Discussion

The overall number of samples received was very low and seven of the nine packhouses did not submit any samples for identification. However, observations from this project as well as others done during the 2017 season suggests that prevalence of FCM in South African stone fruit is greater than other moth pests. For more conclusive results to more accurately

determine the prevalence of FCM in stone fruit, it is recommended that monitoring for damaged fruit that reaches the packhouse be done for the full season and for multiple years, and that all suspect fruit intercepted in the packhouse be removed for identification of larvae, not only fruit from PPECB inspections.

Dispersal capacity of *Bactrocera dorsalis*

C Weldon, A Manrakhan and L Makumbe

Objectives and Rationale

The key outcome of this project was to establish the dispersal capacity of the invasive fruit fly, *Bactrocera dorsalis,* with regard to environmental and physiological variables. Knowledge of the dispersal capacity of *B. dorsalis* represents a basic component of a systems approach to eradicate incipient populations because it delimits the area that needs to be quarantined and treated and the size of buffer zones surrounding pest-free areas. It is now recognised that *B. dorsalis* is a synonym for the Oriental fruit fly, *Bactrocera dorsalis*.

Methods

Sterile *B. dorsalis* were used in mark-release-recapture experiments in the Vhembe District of Limpopo province to determine the effects of fly maturity, sex and availability of host fruit on dispersal. Sterile flies were obtained from the Seibersdorf Laboratories of the International Atomic Energy Agency. This work was preceded by a pilot study to determine the best way to mark released sterile flies with fluorescent pigments. To explore the physiological basis for field dispersal results, we also determined the influence of temperature on spontaneous locomotor activity and flight.

Key Results

We found that fluorescent pigments applied at a dose of 2 g/l of pupae could be used to mark sterile flies reliably for up to four weeks. Using sterile *B. dorsalis* marked in this way, our dispersal study established that females fly further from the release point before being recaptured than males, and that this is particularly pronounced when females are released amongst non-host plants. Younger males disperse further than older males released from the same point at the same time. *Bactrocera dorsalis* is largely inactive at temperatures lower than 20°C. The frequency and duration of walking and flight increases between 24 to 32°C. At a temperature of 36°C, the duration of resting begins to increase, which may indicate the onset of thermal stress. Using flies tethered to “flight mills”, we confirmed that flight performance was optimal within the range of 20 to 32°C. When flies were young, the duration of flights did not differ between the sexes, but as flies aged, males flew for longer than females during tests lasting one-hour.

Conclusion and Discussion

Fly age, sex and the proximity of host plants influences the distance that *B. dorsalis* travel from a point of origin. Based on observations of spontaneous flight in the laboratory, the dispersal ability of younger male flies may result from more short flights when temperatures are suitable. It is clear that female *B. dorsalis* are also strong fliers, but their tendency for flight appears to be arrested if they are in an environment with host plants.

Crop Protection

Nematology

Host status of certain cover crops for the root lesion nematode, a major pest of economic importance in apples

R Knoetze

Objectives and Rationale

Endoparasitic lesion nematodes (*Pratylenchus spp.*) are the main nematodes of economic importance on apples in South Africa. 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. The objectives for this project has been adapted to ensure statistical reliability and to take into consideration the fact that cover crops that will be evaluated are essentially winter crops. Our objectives for this reporting period (April 2017 – July 2017) was to optimize the *in vitro* culturing method for *Pratylenchus*, source and culture the most important *Pratylenchus* spp. on apple and propagate our cover crops.

Methods

Corn (*Zea mays*) was included as a positive control in the trials. This is a deviation from the original workplan, which suggested tomato plants as positive control, since corn has proven to be much better host, both from literature and personal experience.

Key Results

Nematodes were extracted from infected apple roots. Carrots were cleaned, peeled and surface-sterilised to reduce contamination. Nematodes were surface-sterilised to enable the generation of pure, uncontaminated cultures. The carrot discs were

inoculated with nematodes by delivering 100 to 150 nematodes per disc. After incubation at 25 to 28°C for three to four weeks, nematode emergence was checked. Various cover crop seeds were sowed in sterile soil. When plants reached the one or two leaf stage, they were transplanted into pots filled with sterile soil, watered daily and fertilized once a week.

Control of woolly apple aphid using entomopathogenic fungi

N Stokwe and L Mathulwe

Objectives and Rationale

The objectives of this study are: (1) Collect soil and WAA infested root samples from different apple orchards, (2) Trap EPF from the soil samples using wax moth larvae.

Methods

Collection of soil samples from different apple orchards

Soil samples have been collected from only 2 farms so far. Orchard soil samples were collected from under the tree canopies. Surface litter was removed and soil samples taken by means of a shovel to a depth of 15 cm. Samples were placed in clear plastic bags, labelled and transported to the laboratory.

Trapping of EPF from soil samples

In the laboratory each soil sample was sieved through a metal sieve with a mesh size of 4 mm and then transferred to 400-ml plastic containers with lids. Ten last-instar larvae of *G. mellonella* were placed on the surface of each soil sample. All soil samples were incubated at 25 ±2 °C in the dark. Dead larvae were removed every three to four days, for three weeks. All dead larvae were surface-sterilised with 70% ethanol prior to incubation to prevent opportunistic external saprophytic fungi from growing on the cadavers. Cadavers with symptoms of fungal infection (hardening of the cadaver or the emergence of conidiophores) were be placed on medium composed of 60 g SDA (Sabouraud Dextrose Agar, Merck) supplemented with 1 ml Dodine, 50 mg/L Chloramphenicol and 50 mg/L Rifampicin to isolate the fungal cultures.

Key Results

As the project has just started, there are no results to report as yet.

Conclusion and Discussion

The literature review and laboratory studies are progressing as planned.

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

Codling moth (CM), *Cydia pomonella* (L.), is a key pest of apples and pears in South Africa. Chemical control and mating disruption are currently standard practice. The use of entomopathogenic fungi (EPF) as an additional biological tool for CM control has not yet been fully explored in South Africa for commercial application. Further research into the use of EPNs under suboptimal environmental field conditions, as well as into the use of EPF in an integrated pest management (IPM) system for purpose of sustainable apple production, with minimum chemical control, is required.

Methods

Codling moth eggs were reared on an artificial diet, under diapausing conditions. After soil samples were baited with CM, wax moth, and mealworm, they were placed atop the soil, in a closed plastic container. All fungi and nematodes were isolated, purified, and identified to species level, using molecular techniques. For the selection of effective *Metarhizium* and *Beauveria* isolates, the fungi obtained from the different sources mentioned, were grown on Petri dishes until sporulation. The spores were harvested, and a Potter tower was used to apply a specific concentration to late-instar CM larvae. Different bioassays, using a combination of nematodes and fungi, and inoculations at various time intervals, were conducted. Lethal dose assays and environmental conditions required with regards to temperature and humidity were investigated. The field trials consisted of four treatments, with eight tree replicates per treatment, in a randomised design. Soil samples were collected in the Western Cape Province, from which a number of unidentified fungi and EPNs were isolated that were undergoing screened for pathogenicity at the time of the current report.

Key Results

Metarhizium brunneaum, *M. pingshaense*, *M. robertsii*, *M. anisopliae*, *Purpureocillium lilacinum*, and *Beauvaria bassiana* were identified from orchards. In the EPN field trials, *H. zealandica*, *S. feltiae* and *S. jeffreyense* proved to be more effective than *S. yirgalemense*. *Metarhizium robertsii* and *M. anisopliae* were found to be most effective against CM larvae.

Conclusion and Discussion

The two fungi *M. robertsii* and *M. anisopliae* isolated from the field and *S. jeffreyense* will be used in field trials to determine their individual and collective pathogenicity.

Ring nematode (*Criconemoides xenoplax*) distribution, characterisation and culture methods

A Malan and M Odendaal

Objectives and Rationale

The ring nematode, *Criconemoides xenoplax*, has become an economically significant pest in South African stone fruit and grapevine. However, knowledge of its occurrence, morphology and molecular characterisation is still lacking, or inadequate. The overall aim of the project was to gather basic information on such nematode.

Methods

The above was achieved by characterising nematodes from different areas with regards to their morphological and molecular differences. An effective culture technique for future ring nematode research was also investigated by means of using annual hosts in a greenhouse. Commercial grapevine rootstocks were screened for susceptibility against the nematode. Soil samples representative of the different grapevine and stone fruit areas were also collected. The number of ring nematodes were enumerated, with them being individually picked for use in morphological, morphometrical and molecular studies. A total of five commercial grapevine rootstocks were inoculated with 2000 ring nematodes per plant. After a period of 6 months, the plants were removed from the pots, and the soil was washed, using a sugar flotation technique.

Key Results

The highest number of ring nematodes was obtained from Richter 110, indicating them to be the most susceptible to such nematode. Ramsey showed the least reproduction of ring nematode, with the lowest final nematode counts. However, no significant difference was found between Ramsey, Richter 99, Paulsen 1130, and Ruggeri 140. *Criconemoides xenoplax* was the only ring nematode species recorded in all areas sampled in the Western Cape. The use of annuals as an alternative culture practice proved to be unsuccessful.

Conclusion and Discussion

All soil samples taken from stone fruit were positive for ring nematodes. In general, the number of nematodes on grapevine were much higher in comparison with those found on stone fruit. None of the annual host sustain the reproduction of nematodes and grapevine would be the preferred host to culture high number of ring nematode for future research.

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. No pesticide is registered for the control of nematodes in apple nurseries and no other management options exist to limit the spreading through infected nursery material. Various aspects of the immersion technique were therefore evaluated as a cheap, safe and easy to apply method to solve this nematode problem.

Methods

During 2015 the immersion technique was evaluated to control Lesion nematodes in the roots of rooted layers with 30ml of Nemacur per 100L water at immersion time of five 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 eight hours because of the larger root size of the trees. Four nematicides were evaluated. To reduce the operating time of the immersion technique the time of immersion was reduced from eight hours to two hours. With a third experiment Nemacur was evaluated again with trees covered totally with leaves as well as trees without any leaves. 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.

Key Results

In the first experiment during 2015 Nemacur gave good control of 77% in rooted layers. In the second experiment during 2017 fairly good control of 72% was obtained with Nemacur in nursery trees. The other three nematicides supplied not more than 52% control. In the third experiment with nursery trees covered with leaves and other without any leaves, the success of control was the same in both cases namely 71%. With the fourth experiment the percentage control of Nemacur in nursery trees increased from 71% to 99% by replacing the normally used milk filter.

Conclusion and Discussion

With the results obtained during 2017 it is clear that the immerging technique is a very promising method to manage the Lesion nematode problem for the apple industry. After follow-up research in 2018 a definite action plan for the industry will be available.

6 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

Objectives and Rationale

Entomopathogenic nematodes were applied in a 1m^2 area under the canopy of apple trees on the Welgevallen experimental farm. Thereafter, nematodes were extracted from soil samples collected two, 21 and 42 days post-treatment. Pre-treatment samples were also collected. The results were used to determine possible variations in density and diversity of the natural population caused by the inundative application of EPNs.

Methods

Nematodes were quantified by extracting them from 32 plots comprised of four different treatments with eight repetitions per treatment. The samples were collected in a clockwise pattern around the trees within a 1m^2 area where treatments were applied. Nematodes were identified to family level and data interpreted using various indices.

Key Results

The nematode feeding groups for all treatments indicated a similar pattern in their distribution, demonstrating that changes in population could be due to external effects rather than EPNs. RMANOVA, using specific indicator nematode families, showed no significant differences in the nematode populations for the duration of the experiment. Succession within the soil food web could not be demonstrated since no increases in general opportunists, carnivores or omnivores were observed. No plant-parasitic nematode control was observed attributable to treatments. The faunal analysis for each treatment indicated the most significant effect when 5 x10^6 IJ's per m^2 is applied.

Conclusion and Discussion

No clear responses in the nematode community could be established attributable to the inundative application of EPNs under the natural conditions in this orchard. An EPN application twenty-five times the recommended dose per m^2 had a positive effect on the inferred soil health, indicating an improvement in the structure of the soil food web. It is important to note that this is by no means a viable option to improve soil health in orchards since it is not economically feasible.

7 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. 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. 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 the USA, whereas *P. jordanensis* was identified in Australia.

Most of the research and resistance breeding in other countries is focused on *Pratylenchus penetrans*. 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 by Hugo it would seem that *P. penetrans* is not the primary species in South Africa.

In the survey by Hugo, 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 in this area.

Methods

A survey is being conducted of the *Pratylenchus* spp. present in apple orchards. Samples taken from ±100 apple orchards throughout South Africa. The survey will include EGVV, Langkloof, etc. One sample per 250ha will be taken. Only roots are being processed to determine whether *Pratylenchus* spp. present, as the species in the roots will be the infective ones.

Key Results

Most of the samples have been processed and nematodes sent for sequencing for molecular identification of the species. The nematodes will also be subjected to species specific primers to determine if this method is more cost effective, but still accurate. The preliminary results from the sequencing reactions show that *Pratylenchus hippeastri* were present in most samples and *P. vulvnus* had the second highest occurrence.

Conclusion and Discussion

The last few areas will be sampled and the *Pratylenchus* species from all the samples determined. The populations collected thus far will be reared on carrot disks and transferred to apple seedlings to be maintained as pure cultures to use in future projects.

8 Entomopathogens from local agricultural soil and their potential to control the banded fruit weevil (BFW), *Phlyctinus callosus* (Schoenherr) (*Coleoptera: Curculionidae*)

P Addison, A Malan and B Dlamini

Objectives and Rationale

Phlyctinus callosus (BFW) is an important pest of deciduous fruit and grapevine in South Africa. Control of BFW is important, due to the damage caused to fruits, leaves and roots, as are exports subject to phytosanitary regulations. Entomopathogenic nematodes (EPNs) and entomopathogenic fungi (EPF) are found in soils throughout the world and are effective biocontrol agents for the control of soil-borne and above-ground insect pests. The aim of the study was to survey for new EPNs and EPF from agricultural soils from the Western Cape and to evaluate their potential as biocontrol agents of BFW.

Methods

A total of 70 soil samples were collected from cultivated habitats, including organic and commercial deciduous fruit orchards and vineyards. The soil samples were baited with *T. molitor* sampled for both entomopathogens. Using the 24-well bioassay protocol, *H. bacteriophora* isolated from a commercial apple orchard in Grabouw and *H. safricana* isolated from an apple orchard in Ceres at 200 IJ/insect were used to test their ability to control adult BFWs. Five bioassay plates with 12 adults in each were used for each nematode species and the controls received ionized water only. The mortality caused by each EPN and the number of IJs that penetrated the host was determined for each EPN species. The procedure was repeated on different dates and with freshly prepared inoculum.

Key Results

Entomopathogens isolated: EPNs were isolated from 14 soil samples (20%) representing all the sampled habitats. EPNs isolates isolated from the survey belonged to the genus Heterorhabditis and the different species identified were *Heterorhabditis bacteriophora* Poinar 1975 and *Heterorhabditis safricana* Malan, Nguyen, de Waal & Tiedt 2008. EPF were found in 36 soil samples (51.4%) representing all the sampled habitats. The different species identified from the different habitats were *Beauveria bassiana* and *Metarhizium anisopliae*. Both entomopathogens were isolated from commercial orchards and vineyards, and organic orchards.

Virulence assays against BFW adults: The adult BFW were found to be susceptible to the two nematode species isolated from commercial apple orchards in the Western Cape province, South Africa. The mortality ranged from 36.7% and 52.5% after they were inoculated with 200 IJs/insect over a period of 3 days. *Heterorhabditis bacteriophora* isolated from a commercial apple orchard in Grabouw gave significantly greater ($P < 0.01$) control of the adult BFW on both test dates (52.5%), than *H. safricana* isolated from an apple orchard in Ceres. Adult BFW were found to have been penetrated by both EPN species isolated and *H. bacteriophora* gave significantly greater ($P < 0.01$) number of nematodes that penetrated the adult BFW on both test dates than *H. safricana*.

Conclusion and Discussion

Results of the study indicates that soils from deciduous fruits orchards and vineyards and organic orchards of the Western Cape contain entomopathogens that can be utilised as a biocontrol agents for managing both soil-borne and above ground stages of *P. callosus*.

9 Bioprospecting of agriculture and natural ecosystems for entomopathogenic nematodes

A Malan and D Odendaal

Objectives and Rationale

The aim of the study was to determine the occurrence and distribution, of endemic entomopathogenic nematodes (EPNs) in South Africa. The objectives that were aimed at in this study included finding new, low-temperature-adapted EPN isolates for use against key pests (specifically codling moth), during the cool seasons.

Methods

EPNs were isolated from the different soil samples, using such live insects as codling moth, wax moth and mealworm for trapping. The different nematode isolates found during trapping were identified using morphological, scanning electron microscopy, cross-breeding, and molecular techniques.

New species found during the survey were described in full, as new species' descriptions from South Africa include *S. sacchari*, *S. fabii*, *S. jeffreyense*, *S. nguyeni*, *S. litchi*, and *Steinernema* n. sp. (as yet unnamed). The most abundant species found with a high frequency were *Heterorhabditis bacteriophora* and *Steinernema khoisanae* in the Western Cape. Three *H. zealandica* isolates were identified associated with three different symbiotically associated bacteria due to the colour change in the wax moth larvae, which turned steel-grey, red, or greenish.

Key Results

Such commercially available species as *S. feltiae*, *S. carpocapsae*, and *H. megidis* have not yet been isolated from any South African soil. All nematode species maintained by recycling every three months.

Conclusion and Discussion

New EPN species discovered have been tested for pathogenicity and low-temperature activity. All South African EPN species isolated thus far are high-temperature-adapted nematodes, making their storage in formula at room temperature viable.

Crop Protection

Soil Health

1 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 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. Similar indices in relation to main treatment effects between ARD and fumigation (sterile soils), were observed. Nitrogen fixing cover crop species and species with bio-fumigant properties had better AI3 scores than in the absence of no cover crop or when grain species were sown. Positive correlations between AI3 and soil/tree parameters lacked.

Conclusion and Discussion

AI3 indices reflected gradients in mineralizable substrates across soil layers. Indices confirmed the known positive effects of mulching on soil, were able to detect differences between cover crop practices, and between rootstock genotype responses. Lack of distinction between the two main treatments, ARD and fumigation, was presumably due to microbes in fumigated soils that had reverted to that in control soils at the time of sampling. The general lack of positive correlations between AI3 and soil/tree parameters could be because short-term changes in enzymes are generally more noticeable than soil/tree parameters; longer-term trials could prove different.

6 The effect of different cover crop management practices on the soil and performance of apple trees

J Fourie and C Kapp

Objectives and Rationale

Industry indicated a need to improve the health of orchard soils. The study aims 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, Conclusion and Discussion

Soil preparation causes a major upheaval in the biological component of the soil. The treatments in which dwarf Fescue and Saia oats was used as cover crop, respectively tended to recover faster. The annual cover crops created conditions under which N is more readily available to the tree roots. During wet seasons and relatively high summer rainfall, non-bearing apple trees do not need to be irrigated until December in the Vyeboom region. The canola/Caliente 199 mixture should not be used as cover crops in the Vyeboom area. Slashing ryegrass regularly, the stand can be reduced progressively. Saia oats and the Saia oats/pink Seradella mixture suppressed the winter growing weeds the best. Narrow-leaf ribwort dominated the treatment in which dwarf Fescue was established. Flax-leaf fleabane dominated in the treatments with annual crops. The production of the treatment in which the dwarf Fescue perennial was established was 6t/ha less than that of the treatment with the N-fixing cover crops in 2016 and 5.34t/ha less than that of the Saia oats monoculture during 2017.

Crop Protection

Plant Pathology

1 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 propagation material and nursery trees is not known. Cankers and wood rot can be present inside visible clean material. Therefore, the aim of this project is to identify the fungal canker pathogens present in propagation material and nursery stone fruit trees.

Methods

Green scion shoots were collected of one nectarine and three plum cultivars. Shoots were surface sterilised, buds were removed and placed on amended PDA. The rootstock cultivars include two plum and three nectarine cultivars. Dormant shoots from rootstock mother trees as well as ungrafted, rooted rootstock plants were sampled, surface sterilised and isolations made. The fungal pathogens that grew were identified with cultural and molecular techniques.

Key Results

From the green scion shoots, low levels of bud infection were observed. In total 0.44% buds were infected. The nectarine scion variety had the highest infection level of 1.15%. The most abundant species isolated were *Coniochaeta prunicola*. Dormant rootstock shoots had higher levels of infection, with 7.8% of shoots infected with possible canker or wood rot pathogens. The pathogens that were isolated most often include *Leucostoma persoonii* and *Diplodia seriata*. For the ungrafted, rooted rootstock plants 18.5% of 378 plants had infection of possible canker and wood rot pathogens. Two pathogen groups occurred often, namely *Cadophora* species and *Dactylonectria* species. Rootstock plants were mainly infected at the crown, but also below the pruning wound at the tip of the main shoot.

Conclusion and Discussion

The propagation material investigated had infections with canker pathogens. Buds from green scion shoots had very low levels of infection. Ungrafted, rooted rootstock plants had higher level of infection than the dormant rootstock shoots. Infections were more often at the crown area of the rootstock plants and accompanied with dark brown streaking originating from the base.

2 The role of stress factors in predisposing plum trees to invasion by bacterial pathogen *Pseudomonas syringae pv. syringae*

T Coutinho, K Bophela and K Takalani

Objectives and Rationale

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

Methods

Two disease surveys were conducted in September/October 2016 and March 2017, in the major plum-producing areas in the Western Cape Province to assess bacterial canker prevalence and severity. Rhizospheric soil samples, for estimating the population of ring nematodes and *Phytophthora* present in the soil, were collected. Plant material displaying typical symptoms of bacterial canker was also obtained for isolation purposes. The resulting isolates were identified by sequencing of the *cts*, *gapA, gyrB* and *rpoD* genes. A soil baiting technique was used in order to detect *Phytophthora* spp. from the soil samples.

Key Results

Severe wilting and death of plum trees was observed in the majority of the surveyed plum orchards, which is indicative of high levels of water stress. Thirteen to 22% of trees surveyed displayed symptoms of bacterial canker. Additionally, the ring nematode populations in rhizospheric soils were low in 2016 and much higher in 2017 in the majority of the farms surveyed. This change in the population density is probably due to weather pattern shifts from cool conditions at the start of summer to very hot conditions early this year. Fifteen pseudomonad strains were obtained from bacterial canker symptoms and following phylogenetic analysis were found to fall into two phylogenetic groups within the *Pseudomonas syringae s*pecies complex. We can thus conclude that both *P. syringae sensu stricto* and *P. viridiflava* are associated with the disease in the Western Cape. Forty-six isolates of *Phytophthora* were obtained from 18 of the 28 soil samples collected.

Conclusion and Discussion

Ring nematode infestations, presence of bacterial canker symptoms and *Phytophthora* in the soil differed between orchards/farms and appeared to be influenced by the rootstock and scion selected. Therefore, finding the most

appropriate rootstock and scion with enhanced tolerance to this pest and pathogens may provide the best long-term benefit to the industry. Once the drought currently being experiencing in the Cape is over, and the weather pattern returns to "normal" it will be interesting to compare our results at these two extremes, to determine if water stress plays a role in disease/pest outbreaks.

3 Management of apple replant disease using phosphonates

A McLeod and M Nyoni

Objectives and Rationale

Apple replant disease (ARD) is a disease of economic importance in South Africa. The first aim was to determine whether semi-selective chemicals (phenylamides, fenamiphos, imidacloprid and phosphonates) can increase tree performance in orchards established on ARD non-fumigated and fumigated soils. The other aims were to determine the best method for applying phosphonates to manage *Phytophthora* root rot on young apple trees, and to evaluate the *in vitro* sensitivity of a few oomycetes to phosphonates.

Methods

The efficacy of ARD management treatments were evaluated in three orchards using tree growth performance, yield and pathogen quantifications. The effect of phosphonate application methods (soil drench, stem spray, stem paint and foliar sprays) on root phosphite concentrations, tree growth responses and *Phytophthora* concentrations were evaluated in three orchard trials. The sensitivity of different oomycete ARD pathogens to phosphite will be determined *in vitro*.

Key Results

In the three ARD orchard trials, tree growth could be improved significantly relative to the control by the independent use of semi-selective chemicals, or fumigation with two chloropicrin/1,3-dichloropropene formulations. All treatments performed similar in tree growth, which was significantly better than the control. Yield data showed that all fumigant treatments were effective in two of the orchards, whereas the independent use of semi-selectives was unable to increase yield significantly in all three orchards. Evaluation of phosphonates to suppress *Phytophthora* root rot in orchard trials, showed that different phosphonate application methods yielded similar levels of shoot growth in trees, which was significantly better than the control in two trials, but not in the third trial. Determining the sensitivity of oomycetes *in vitro* is still work in progress.

Conclusion and Discussion

The independent use of semi-selective chemicals can increase tree growth to a similar level than fumigation treatments, but not yield. Semi-selective chemicals added to fumigated soil can increase yields, relative to applying only a fumigant, in some orchards. All phosphonate application methods are able to control *Phytophthora* root rot.

4 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

The pathogenicity of possible canker/dieback pathogens were assessed with two-year-old detached shoots as well as two-year-old shoots in the orchard.

Methods

Forty fungal species (75 isolates) isolated from apple propagation material were tested for their ability to form lesions on apple shoots. Detached shoot assays using two-year-old shoots of the cultivars Golden Delicious and Early Red One were done. Mycelial plugs of the fungal isolates were inoculated onto sterilised shoots and kept in moist chambers for five weeks. The lesions formed were measured and isolations were made to confirm the presence of the inoculated fungus. The same fungal isolates were inoculated onto two-year-old shoots on Golden Delicious trees in two orchards. The shoots from these field trials were harvested after four months. Lesions were measured and isolations were made. The results of the field trial is currently pending.

Key Results

For the detached shoot assays all of the fungal species caused lesions on both Golden Delicious and Early Red One. Fungal species that were pathogenic on both cultivars include *Phomopsis* sp. 4, *Diaporthe eres*, *Diaporthe ambigua*, *Neofusicoccum parvum*, *Diplodia seriata*, *Phaeoacremonium australiense*, *Phaeoacremonium prunicola*, *Phaeoacremonium subulatum* and *Trametes versicolor*. For four species both isolates formed lesions significantly different from the negative control and include: *Cadophora luteo-olivaceae*, *Diaporthe ambigua*, *Diaporthe eres* and *Phaeoacremonium viticola*.

Conclusion and Discussion

Species of *Diaporthe*, *Neofusicoccum*, *Phaeoacremonium* and *Trametes versicolor* proved to be pathogenic with the detached shoot assays on two apple cultivars. The pathogenicity status of fungal species of which the lesions were not significantly different from the control needs to be confirmed with results from the field study.

5 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

Tissue culture plants of different rootstocks and rooted cuttings of M116 rootstocks were used in the trials. 12,5cm plastic pots were filled with sterilized soil. Pots were inoculated with one of the three *Phytophthora*-isolates. One seedling of each rootstock was planted in pots and left to grow for 14 weeks.

The plants were automatically watered three times per day in order to simulate a waterlogged soil. At plant the stem lengths were recorded. After the growing period the plants' stem lengths were recorded, where after the plants were removed from the pots and the soil was carefully washed from the roots. The total weight of the seedlings as well as the root weight was measured for all the plants.

Key Results

Isolations from the roots were done on all the plants to try to re-isolate the *Phytophthora*-isolates from the roots. 8880 isolations were done and only one isolate was recovered from rootstock G202:Ph1/7.

In general, the control plants performed much worse in growth than the plants that were planted in pathogen-infected soil. Looking at percentage growth it is clear that there is huge variation between the different isolates on each rootstock and that there is very little statistical differences between rootstocks and isolates.

Conclusion and Discussion

No visual differences in plant growth and root mass were noted. No definite conclusions can be made from these results.

Crop Protection

Integrated Pest Management

1 False codling moth population genetics: gene flow in agricultural environments

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, 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 have to be developed for false codling moth.

Key Results

A number of commercial companies have been contacted to enquire about the development of microsatellite markers for false codling moth.

Conclusion and Discussion

No concrete conclusions can be made at this stage.

2 The effects of biotic and abiotic factors on the distribution of economically important weevils in the deciduous fruit industry

P Addison, B Dlamini and M Magagula

Objectives and Rationale

It is proposed that an in depth analysis be undertaken to determine which abiotic and biotic factors plan 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 prioritizing 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, fertilization 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.

Key Results

Field sites were established in Grabouw, Ceres and Stellenbosch (one orchard and one vineyard block each). Initial seasonal monitoring has started, using cardboard bands and two fruit damage assessments have taken place (in Grabouw), indicating high damage levels (above 50%).

Conclusion and Discussion

Initial findings show that *P. callosus* appears to be the dominant weevil species. One poster was presented at the recent ESSA/ZSSA conference in Pretoria during July 2017.

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.

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 using both will be 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 one plum orchard under FCM MD. Six releases were done. Eight FCM traps were placed in each orchard and wild and sterile FCM catches were recorded weekly.

Key Results

A high number of sterile FCM were caught weekly in the OFM MD orchards and no MD orchards. However, no sterile and wild moths were caught in the FCM MD orchard. There was a difference in wild FCM trap catches between the OFM MD orchards and the control orchards. The percentage damage differed between the different treatments and orchards.

Conclusion and Discussion

OFM MD may have an effect on FCM under low populations, but under high moth populations it is not sufficiently effective.

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: codling moth (*Cydia pomonella*), Mediterranean fruit fly (*Ceratitis capitata*), banded fruit weevil (*Phlyctinus callosus*) and wax moth larvae (*Galleria mellonella*). 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 fly were reared weekly. A total of 980 banded fruit weevil larvae and 44 adults were reared. The first generation weevil adults started to lay eggs six weeks after emerging as adults.

Conclusion and Discussion

A medium-scale 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.

5 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.

Materials and 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 larvae and pupae. Mating disruption experiments were executed in stone fruit blocks to determine the level of disruption for five (0,1/3FD,2/3FD,1FD,4/3FD) Isomate™ densities.

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 larvae (70-100%) and pupae (8-27%)
- EPF still require identification and testing

Assessment of field fitness
- Continuous fruit sampling
- Attended a morphometric analyses workshop (Oct 24-28, 2016)

Mating disruption experiments
- Field sites selected
- Mating disruption works against FCM in stone fruit
- 0.33xField dose to 1xField dose=83% disruption, 1.33xField dose=96% disruption

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.

6 Investigating biological control agents for the management of *Ceratitis capitate* (Wiedemann)

P Addison and M James

Objectives and Rationale

The aim of this project is to find suitable biological control agents for *Ceratitis capitata* in the form of entomopathogenic fungi, nematodes and parasitoid wasps, which can be incorporated into current management practices, such as SIT and reduced-risk pesticides in South Africa, to improve area-wide pest management.

Methods

Since the last report all EPNs isolated from local soil samples have been identified. All EPF have been identified morphologically and are in the process of being identified molecularly as well. All EPN lab work (initial screenings, soil bioassays, concentration tests) and EPF lab work (initial screenings using 1x107conidia/ml and soil bioassays using two local species) has been completed.

Surveying for parasitoids involved experiments using sentinel traps. Apples were infested with *Ceratitis capitata* eggs or larvae and set out in the field in a unique net trap. The same was done with *C. capitata* pupae exposed on cardboard in the net trap. After several days of exposure in the field, fruit and pupae were returned to the insectary and placed in vented plastic containers to rear out flies and their parasitoids which attacked them.
Non-destructive DNA extractions were carried out on fruit reared wasp specimens. Specimens will be repinned and deposited at Iziko SA museum. PCR optimization of the DNA is currently in progress and PCR products will be sequenced by the Central Analytical Facility at Stellenbosch University.

Key Results

Soil sampling has yielded a high number of local EPN and EPF species. EPN experiments highlighted the virulent local EPN *Heterorhabditis noenieputensis* as a potential biological control. This work has also been submitted to Crop Protection for review and publication.

EPF experiments have shown locally isolated EPF to be as virulent as the commercial products tested. In the soil bioassays, both local EPF (a *Beauverria bassiana* and *Metarhizium anisopliae* isolate) caused mortality, followed by mycosis of emerged flies.

No wasps were obtained using sentinel traps, but methods used could be

modified for future studies. Bucket traps trapped a wide variety of insects from multiple orders, together with a few fruit flies and this data is in the process of being analysed.

Conclusion and Discussion

This study has added to the knowledge on locally occurring EPN and EPF isolated from soil.

Potential biological control agents in the form of EPNs (e.g. *H. noenieputensis*) and EPF have been identified for future *C. capitata* control.

Molecular work on parasitoid wasps will provide important knowledge on fruit fly wasps in SA.

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 is poorly understood. This study is aimed at monitoring pests and diseases in a covered orchard to determine 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, orchard is 2.45 ha in extent and is planted to Granny Smith on a range of rootstocks (CG 222, M7, M9, and M109). The orchard was planted in 2012 and extended in 2013. The orchard is contiguous and no 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 shot 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 orchard is not in full bearing and further growth of trees is expected. The project should be extended to assess the effects of shade netting on orchard floor management including cover crops.

Crop Protection

Precision Agriculture

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

Modern high density orchards in South Africa require a new approach for pesticide spraying. An effective dosing system developed for modern orchards in Germany and Austria is the MABO dosing model, which also reduces spray drift. Spray deposition must be correlated with biological efficacy, i.e. pest and disease control. 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 and spray drift sampling system will be done using orchard trials along with fluorescent pigment sprays, photomacrography, digital image analyses and ISO protocols as guidelines. The biological efficacy model will be evaluated using apple seedlings sprayed with mancozeb, spray deposition quantification and *Venturia inaequalis* infections.

Key Results

Two pilot spray trials evaluated the MABO dosing model in two orchards.

In general, MABO spray deposition was similar, or better than the current industry norm. In a 3.5 m row width orchard, a high-profile sprayer with horizontal air crossflow, calibrated according to the MABO model, performed better than low profile sprayers and the Martignani with regard to vertical pesticide coverage. The results from this orchard further indicated that the use of a 70%:30% nozzle layout, as frequently used in industry, is no longer relevant in modern orchards. In a 4 m row width orchard, the use of an even distribution of nozzles resulted in good overall coverage. Preliminary spray drift investigations showed that black polyvinyl drift collectors and photo macrophotography along with image analyses have potential for drift quantification.

Conclusion and Discussion

The MABO model has potential for pesticide application in high density orchards in South Africa. High profile sprayers may be better suited for modern orchards. The two spray trials will be repeated in the 2017 season.

Evaluating an ascospore release forecasting model and orchard disease monitoring methods for improving apple scab management

A McLeod

Objectives and Rationale

Apple scab caused by *Venturia inaequalis* is a disease of major economic importance. The RIMpro model is a disease forecasting model that could improve apple scab management in South Africa. The first aim of the project is to validate the RIMpro model for predicting fusi infection periods in South Africa. The second aim is to evaluate different orchard monitoring methods for determining the potential ascospore dosage (PAD) and risk of fusi in orchards.

Methods

The biofix (first release of ascospores; parameter required as input for RIMpro) was determined in four orchards for the 2016/17 season using two different methods. The RIMpro model was evaluated in five orchards in the 2016/17 season. Trap trees and rotorod samplers were used for monitoring infection events and ascospore releases respectively. PAD was calculated at the end of the 2016/17 season in five new orchards that will be used in the 2017/18 season.

Key Results

The biofix could only be determined in one of the four orchards. The trap trees only developed lesions in three of the orchards. Trap trees often developed lesions when no RIM value was predicted, and high trap tree infections did not correlate with high RIM values.

The latter was also true for the iLeaf model. Evaluation of the PAD in five new orchards for the 2016/17 season showed that three different PAD orchard evaluation methods resulted in the same ranking order of the five orchards.

Conclusion and Discussion

The performance of the RIMpro model was likely influenced by incorrect leaf wetness calculations, which are very important for scab infections. Inaccurate leaf wetness estimates by iLeaf weather stations, which was used for RIMpro predictions, was identified as problematic. Another problem might be that some growers could have accidently applied fungicides to trap trees, and that trap trees got cross contaminated while being incubated for lesion development. The low labour intensive PAD method (25 trees, four shoots per tree) is as effective in estimating inoculum load in orchards as the other more labour intensive methods.

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 patterns 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

1. Incorporate monitoring data into a Geographic Information System (Data management procedure).
2. 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).
3. 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

The results, using more in-depth CART analysis with a new data classification system showed that long-term midseason (January to March) average

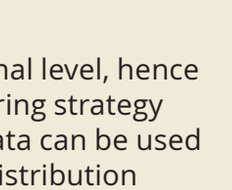
rainfall could be used to model the general spatial distribution of Medflies in the Western Cape. The distance to urban areas and different crop types seems to have an influence on the fly distribution on a local scale but not necessarily on a regional level. Unfortunately, the Fruitlook data that was sourced in order to explain the weekly/monthly variation in the spatial distribution of Medflies did not yield any significant results.

Conclusion and Discussion

The fruit fly data that were available to us for this study, showed to be of importance at a regional level, hence the area-wide monitoring strategy that is applied. This data can be used to model the spatial distribution of Medflies within fruit production areas. These models could be used to demarcate/indicate areas that may have a greater risk of clustering of high numbers of Medflies than other areas based on the climatic and topographic characteristics of that area. With the available exploratory variables, area-wide Medfly risk maps will be produced to assist area-wide Medfly programme managers to improve the implementation of their management actions.

Post-Harvest

Quality Management



1 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 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 seven 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.

Methods

Forelle pears from two populations sourced from the Vyeboom area were treated seven, nine, 14 and 21 days after harvest with SmartFresh℠ (600 ppb) 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 seven 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.
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.

Conclusion and Discussion

From the results it is evident that mealiness susceptibility of Forelle pears can be influenced by factors other than post-harvest procedures. This can include, but not be limited to climate, soil, nutrition and water regimes, tree age and rootstock. It is therefore recommended not to apply SmartFresh℠ to fruit later than 14 days after harvest, since no information exists to predict which orchards can be treated at 21 days after harvest. Should the need arise for fruit to be treated later than 14 days after harvest, trials should be conducted on specific orchards as required.

2 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

Three populations of Granny Smith apples were packed into MK6 apple and MK9 open display apples 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 four and nine weeks RA cold storage.

Key Results

High levels of superficial scald were detected on fruit. However, no trend could be observed relating to a specific treatment. Fruit in small and large perforated bags had a shorter 90% cooling rate compared to fruit in non-perforated bags.

Conclusion and Discussion

Marginal differences occurred regarding post storage quality between fruit stored in regular non-perforated bags, no bag, and fruit stored in small and large perforated bags. A decrease in FAC time occurred for fruit stored in no bags, or in small and large perforated bags, compared to fruit stored in non-perforated bags.

The use of Harvista™ (pre-harvest 1-MCP) application to control superficial scald on Packham's Triumph pears

D Viljoen

Objectives and Rationale

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 (pre optimum), optimum (eight days after release) and post optimum (10 days after optimum). Fruit were harvested ± three days after spray application and stored for three, five and seven months at -0.5°C in RA.

Key Results

Untreated control fruit stored for seven months were generally softer after cold storage compared to other treatments and storage times. Unacceptable levels of superficial scald occurred on untreated control fruit from the pre optimum and optimum harvested fruit stored for seven months. Low levels to none occurred on Harvista™ treated fruit. High incidence of superficial scald also occurred after shelf life on untreated control fruit from the first two harvests stored for five and seven months. Unacceptable levels also occurred on Harvista™ treated fruit, but to a much lower extent.

Conclusion and Discussion

Pre-harvest Harvista™ sprays controlled superficial scald development during cold storage successfully up to five months. Reduced incidence of superficial scald was exhibited on fruit subjected to a pre harvest Harvista™ spray stored for seven months. During shelf life, however, superficial scald developed on fruit from all of the treatments of the five and seven months storage duration. There was scald control to a certain degree by Harvista™ compared to untreated control fruit. However, levels were unacceptable.

Identification of factors involved and control of astringency in pears

D Viljoen

Objectives and Rationale

The objective of the study for the 2012 to 2014 seasons was to assess the effect of harvest maturity, storage duration, SmartFresh℠ and CO_2 spiking on astringency in Cheeky and Forelle pears.

The revised objective of this study in the 2015 and 2016 seasons was to continue work on establishing a physiological profile of Cheeky with particular reference to the effects of harvest maturity and storage duration on fruit quality, and expression of astringency and internal browning.

Methods

2012 to 2014: Cheeky pears sourced from 2 orchards in Ceres over three maturities were stored for six, 12 and 18 weeks at -0.5°C, followed by a shelf life of seven days at 20°C. Forelle pears sourced from an orchard with a history of astringency from the Vyeboom area were subjected to either CO_2 or SmartFresh℠ or left untreated and stored for four, eight, 12, 16 and 18 weeks at -0.5°C, followed by seven days at 20°C. All fruit were assessed for storage and shelf-life quality.

2015 to 2016: Fruit from three orchards in the Ceres area were harvested at four different maturities and cold stored at -0.5°C RA for six, 12, 16 and 20 weeks (six, eight, 12 and 16 weeks for 2015 season), to assess the effect of harvest maturity and storage duration on the expression of astringency and internal browning.

Key Results

2012 to 2014: In the 2012 season astringency occurred in the later harvested (Harvest 3) Cheeky pears, and declined with longer storage. No mealiness was detected. During the 2013 and 2014 season results regarding astringency were inconclusive. Low levels of mealiness occurred after

six weeks cold storage followed by a shelf life. At longer storage durations however, mealiness did not occur. Astringency of Forelle pears decreased with longer storage periods. Fruit subjected to SmartFresh^{SM} did not exhibit any mealiness. In the 2013 and 2014 seasons high levels of mealiness occurred in the untreated control fruit up to eight weeks and 12 weeks cold storage respectively.

2015 to 2016: No internal browning and very little astringency (only in 2015 season) were detected in the fruit. Although not always significant, fruit were greener after four (2015), six (2016) and eight (2015) weeks cold storage compared to fruit stored for longer. Low incidence of superficial scald occurred on early optimum harvested fruit (Harvest 1, 2016) cold stored for 20 weeks. Mealiness was detected in only a small number of fruit in the 2015 season. None of these were cold stored for longer than 8 weeks. Early optimum fruit (Harvest 1) of the 2016 season did not ripen to such an advanced state following six weeks cold storage and a seven day shelf life period compared to the other harvests.

Conclusion and Discussion

CO_2 treatment after harvest did not decrease astringency in Forelle pears to such an extent to make it worthwhile. SmartFresh^{SM} prevented mealiness in Forelle pears. Mealiness in Forelle not subjected to SmartFresh^{SM} decreased with longer storage periods (12 weeks and longer).

Currently the average release for Cheeky pears is 7.0 kg. Optimum harvest maturity for Cheeky pears is between ±7.2 kg and 6.8 kg. Although very little to no mealiness was detected, fruit stored for eight weeks had the lowest firmness after shelf life. The most susceptible time for pears to mealiness is at eight weeks cold storage. Fruit should be monitored for mealiness susceptibility especially during this time. Fruit became overripe after 20 weeks storage. Consequently Cheeky pears should not be stored for so long.

TSS levels of ± 12.0% are currently acceptable according to industry standards. Pre optimum harvests up to two weeks after commercial harvest had TSS levels higher than 12.0%. Therefore TSS levels of pre optimum and late harvested Cheeky pears are not susceptible to low levels.

Pre optimum harvested fruit can be stored 12 weeks with no colour break. Optimum and later harvested fruit should not be stored longer than eight weeks to prevent colour break. Superficial scald, senescent scald, flesh decay and senescent breakdown in fruit stored for 20 weeks render this storage duration as high risk and should rather be avoided.

Following the results from the 2012 to 2016 season, fruit can be harvested from 1 week before current release criteria up to one week after current release date. Only fruit harvested before current release date can be stored for up to 12 weeks. Later harvested fruit should only be stored for up to 8 weeks to avoid colour break. Care should be taken for mealiness susceptible orchards at eight weeks storage. To avoid astringency fruit harvested before release should be stored for at least eight weeks. In later harvested fruit no astringency was detected in fruit up to eight weeks cold storage.

To determine the minimum flesh firmness that FEMA fruit can be exported without becoming overripe after storage, and to determine the effect of extended storage of FEMA fruit (stock rolling)

D Viljoen

Objectives and Rationale

To determine the effect of FEMA fruit packed at 4.0 kg on fruit quality after four to six weeks cold storage, and to determine the maximum storage period from harvest at a range of packing firmness's before fruit quality is compromised.

Materials and Methods

A FEMA orchard in Vyeboom was harvested first at FEMA release followed by two more harvests, one and two weeks after release respectively. Fruit were subjected to a standard 600 ppb SmartFresh^{SM} treatment and stored for five, eight, 12 and 14 weeks at -0.5°C. Evaluations were conducted at the end of cold storage and after a simulated shelf life of seven days at 20°C.

Key Results

2014: Fruit harvested from the first (week 12, 5.9 kg) and second (week 14, 5.7 kg) harvests and stored for 12 weeks did not ripen below 5.0 kg during a seven day shelf period and so no mealiness developed. Harvest 1 stored for 16 weeks however, ripened to 2.9 kg, but did not express mealiness as fruit had been subjected to sufficient cold storage (>12 weeks). Fruit harvested in weeks 15 and 16 (Harvest 3, 5.0 kg; Harvest 4, 4.9 kg, respectively) and stored for less than 12 weeks at -0.5°C, generally ripened below 4.0 kg with the resulting expression of mealiness. Fruit stored for 12 weeks resulted in no mealiness in Harvest 3, and only 7.3% in Harvest 4 fruit. This data suggests that the SmartFresh^{SM} concentration applied was not effective in maintaining flesh firmness after 16 weeks cold storage in Harvest 1 fruit and in post optimum fruit harvested in weeks 15 and 16. No astringency was noted during the trial.

2015: Due to seasonal factors fruit firmness did not drop. Subsequently fruit were not harvested at the desired firmness of 4.0 kg. Fruit colour reached the maximum acceptable level of 3.0 according to the standard industry colour charts at Harvest 3, thus not making it worthwhile to harvest more mature fruit. Post shelf life fruit quality was acceptable even after 14 weeks cold storage. SmartFresh^{SM} effectively prevented ripening resulting in a sweet, crisp fruit with suppressed mealiness expression.

No astringency was noted during the trial.

2016: Fruit harvested just before FEMA release protocol (Harvest 1, 6.2 kg), treated with 600 ppb SmartFresh^{SM} did not express any mealiness after cold

storage and a shelf life, even after 16 weeks. Fruit harvested within FEMA standards (Harvest 2, 5.8 kg) expressed low incidence of mealiness after 16 weeks cold storage. In fruit harvested outside the FEMA standards (Harvest 3, 5.2 kg) and treated with 600 ppb SmartFresh℠, mealiness was already detected after five weeks cold storage in low quantities (3.8%). Internal browning and internal breakdown were detected after eight weeks storage. No astringency was noted during the trial.

Conclusion and Discussion

In the 2014 season fruit firmness lower than 5.0 kg at harvest were obtained. It was advised that these fruit should be cold stored for at least 12 weeks to reduce the incidence of mealiness. In the same season, fruit harvested within the FEMA release criteria ripened to 2.9 kg after 16 weeks cold storage and shelf life. In the 2016 season, fruit harvested in the FEMA release criteria of the same storage time, did not ripen lower than 5.1 kg.

Results suggest that a higher concentration of SmartFresh℠ (1000 ppb) could be considered to ensure that fruit do not soften and express mealiness. Further work should possibly focus on a maximum firmness that can be harvested and still result in a good eating quality. Orchards are sometimes compromised with overripe fruit and advanced skin colour, while having acceptable sugar levels above 14%. Long term storage of these orchards which may not have made the FEMA release due to high firmness, can result in the expression of post-storage disorders such as internal browning and mealiness.

Results suggest high risk of orchards harvested with flesh firmness of 4.0 kg.

6 To determine the effect of sugar/ acid ratio and other maturity indices on the eating quality of Forelle pears destined for the FEMA programme as a means of improving the FEMA release criteria

D Viljoen

Objectives and Rationale

One of the major challenges with FEMA Forelle pears is that in many instances the two major release parameters, flesh firmness and sugar levels may remain constant and not change over two or three weeks. This has led to scrutiny of other parameters, and in particular the sugar/acid ratio as a possible means of an alternative and more accurate means of releasing an orchard under these circumstances.

The aim of this study is therefore to assess sugar and acid levels and their ratio, on the eating quality of FEMA fruit, and to determine if this could be used as an additional means of releasing an orchard in years when flesh firmness does not drop as quickly as expected.

Methods

Forelle pears harvested at different maturities from three of the major growing areas were treated with 600 ppb SmartFresh℠ within seven days after harvest and stored for five weeks at -0.5°C. Evaluations conducted were maturity at harvest, SmartFresh℠ efficacy testing, start of shelf life after five weeks cold storage and end of shelf life after a simulated shelf life at 20°C for seven days after cold storage. Fruit were also subjected to a basic sensory evaluation.

Key Results

Fruit from the first population was harvested at firmness' lower than 6.0 kg for Harvests 2-4. TSS levels were lower than 14% and acidity was lower 0.10%. Fruit from the other two populations had firmness' higher than 6.0 kg for the first three harvests with TSS levels higher than 14%. Acidity at harvest was higher than 0.15% for Population 2 and higher than 0.24% for Population 3. The fruit that had the best eating experience was from Population 1.

Conclusion and Discussion

From the 2016 results it is evident that acidity might have a greater influence on taste than TSS. At low acidity levels TSS might have a greater influence on taste than at high acid levels. It is thus recommended that different acidity classes should be established where each class has its own sugar/acid ratio boundary values.

7 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 applied before onset of cold storage. Plums on the other hand were subjected to treatments with or without ethylene after cold storage. Immediately after cold storage, both nectarines and plums were subjected to different ripening temperatures for various durations determined based on the rate of quality deterioration. The ripening patterns were monitored and effect of the various treatments on fruit quality parameters of interest were assessed.

Key Results

Nectarines – Regal Pearl: Regal Pearl nectarines that were pre ripened before cold storage developed the

best internal quality, however soft tips were a cause of concern. The post cold storage ripening temperature of 20°C gave best fruit quality for pre ripened and non-pre ripened fruit. Pre ripening shortened the period of the ripening process after cold storage by two to three days, compared to non-pre ripened nectarines.

August Red: For some reason the decay levels after storage were extremely high on the August Red nectarines sourced for this study. The quality was so poor that neither flesh firmness nor fruit quality could be assessed. Research on this cultivar must be repeated in 2018, in addition to the scheduled trials.

Plums – Songold: Overall, ethylene treatment after cold storage just before onset of post storage ripening resulted in faster ripening of Songold plums as measured using flesh firmness. There was a tendency, albeit non-significant, for ethylene application after cold storage to cause higher levels of IB and GB. This must be reconfirmed. No clear skin colour differences occurred between the treatments in this trial.

African Delight: Start of shelf life quality was determined but no further examinations could be conducted due to the high levels of decay. Flesh firmness was done on selected fruit without decay, so the results are not necessarily indicative of the true treatment effect. Ethylene applications had no effect on flesh firmness of African Delight plums. However, post cold storage ripening at 25°C had a significant effect on reducing flesh firmness.

8 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 tolerance of 1.5°C, and 3°C. Accumulation periods of three, seven 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

Fortune, Laetitia, Songold and African Delight plums not cooled before packing were obtained from a commercial pack house in Franschhoek. Each cultivar was divided into nine treatments. The variables were accumulation periods of three, seven and 10 days and temperatures of -0.5°C, 2°C and 3°C. After the accumulation periods, the Laetitia and Songold plums were stored at dual temperature regimes consisting of two days at -0.5°C, seven days (Laetitia) and nine days (Songold) at 7.5°C and the balance at -0.5°C, for a total storage period of 49 days for Laetitia and, 42 days for Songold. Fortune and African Delight plums were cold stored at -0.5°C for 35 and 56 days respectively. The plums were evaluated for flesh firmness, decay, shrivel and internal disorders after cold storage, as well as after five days shelf life at 10°C.

Key Results

Accumulation temperatures of 2.0°C and 3.0°C instead of -0.5°C had no negative effect on quality of Fortune and African Delight plums. In the case of Laetitia GB was significantly lower in fruit exposed to 2°C and 3°C compared to -0.5°C. Shrivel tended to be higher in Laetitia at the higher accumulation temperature, but with African Delight plums the opposite occurred. Quality of Songold differed between before and after shelf life evaluation and results were therefore inconclusive.

Conclusion and Discussion

It is clear that cultivars differ in the extent to which the quality is affected by higher temperatures during accumulation. Of the cultivars tested over the two years of the study, African Rose, Fortune (if exported at a single temperature of -0.5°C), and African Delight showed no negative quality effect if accumulated at 3.0°C before being subjected to export temperatures. Laetitia may develop more shrivel at 3.0°C but internal quality was better than at -0.5°C. Sunkiss was sensitive to 3.0 °C and had better quality at 2.0°C and -0.5°C. Songold showed a tendency for more GB at 3.0°C if it was harvested at a flesh firmness <6 kg. In conclusion, the maximum pulp temperature at loading for most cultivars plum can be adjusted to 2.0°C and possibly even 3.0°C, but this must be verified commercially.

9 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 for nectarines with a penetrometer fitted with an 11 mm plunger. In late cultivars harvested relatively firm the 11 mm plunger has proved problematic since firmness readings are highly variable. The aim of this trial was to establish if 8 mm plungers can be used to provide a more accurate flesh firmness determination for nectarines.

Methods

Five nectarine cultivars were harvested at regular intervals starting four to seven days prior to the expected commercial harvest date. There were three harvest maturities for each cultivar, with the exception for September Bright for which there were two. At each harvest, the flesh firmness was determined with a penetrometer fitted with plungers of 11 mm and 8 mm in diameter. Fruit were then cold stored at -0.5°C for 4

weeks and examined before and after a shelf life of five days at 10°C.

Standard deviations were determined for flesh firmness at each of the harvest maturities to determine the variability in the firmness readings. Maturity and quality data were analysed using one-way ANOVA.

Key Results

Consistent with 2016 results, the standard deviation in flesh firmness at harvest was higher with the 11 mm plunger compared to the 8 mm plunger. The variation in flesh firmness for fruit harvested at specific sizes or skin colour will therefore be less with the 8 mm plunger. In all cases, statistical differences in flesh firmness readings with the 11 mm probe between harvest maturities, was mirrored by readings with the 8 mm probe. Separation between maturities was therefore possible with both plungers.

DAFF regulation for nectarines specifies flesh firmness measured with an 11 mm plunger should be a maximum and minimum of 11.3 kg and 4.5 kg, respectively, with 13.6 kg permissible for some cultivars with TSS higher than 12%. This research suggests it best to use an 8 mm plunger, with the corresponding values of 6.5 kg maximum, 3.0 kg minimum and for selected cultivars with TSS higher than 12%, a maximum of 8.0 kg. Fruit from the first and second harvests generally developed less internal problems and decay compared to fruit from the last harvest.

Conclusion and Discussion

Flesh firmness was determined accurately with the 8 mm plunger and variation between readings was less compared to the 11 mm plunger. It is therefore suggested that the 8 mm probe should be used for determination of optimum harvest maturity of nectarines and that the DAFF regulations should be changed accordingly. In the case of Summer Fire, the maximum flesh firmness of 11.3 kg (11 mm probe) should be changed to 8 kg (8 mm probe) as this will improve post storage quality.

Optimum cooling and transport temperatures for plums from areas situated far from cooling facilities/depots

A de Kock

Objectives and Rationale

Temperature profiles of uncooled plums and force-air cooled (FAC) plums on site (at the farm) and transported in refrigerated trucks, from Ladismith to Paarl were recorded in two separate consignments. These temperature profiles were simulated under laboratory conditions and a field-heat removal (FHR) treatment was added. The objective was to obtain typical temperature profiles for different cooling and transport methods and to quantify the effect of these temperature profiles, as well as FHR on plum quality.

Methods

The temperature profile of uncooled plums transported in refrigerated trucks, to the cooling/ loading facilities (Paarl area), as well as FAC plums in the production area (Ladismith) were determined by data collection with loggers, from packing until the end of forced-air cooling. Fruit pulp and air temperature were recorded in three commercial pallets during each transport leg. These temperature profiles were simulated under laboratory conditions and a field heat removal (FHR) treatment was added, to ascertain the effect on plum quality.

Key Results

Pulp temperatures of uncooled plums, in standard 5.0 kg boxes, loaded at 24.4°C to 17.9°C were not reduced but it was maintained during transport at 2°C. The exception was plums packed in punnets, where pulp temperatures were reduced by 5.5°C. In FAC plums, pulp temperatures were maintained. In 2016, flesh firmness and shrivel was similar in FAC and FHR plums. Uncooled plums were significantly softer and more shrivel occurred. In 2017 the trend was similar.

Conclusion and Discussion

Fruit quality data suggests that FAC on site, as well as field heat removal to 10°C, may be beneficial in terms of flesh firmness retention, moisture loss and shrivel control, compared to uncooled plums transported in refrigerated trucks. In some instances these results were significant.

The effect of temperature from orchard to cold store on apricot quality, specific to areas far away from cold storage facilities

A de Kock

Objectives and Rationale

Temperature profiles of uncooled apricots and apricots force-air cooled (FAC) on site (at the farm) and transported in refrigerated trucks from Ladismith to Paarl, were recorded in separate consignments. These temperature profiles as well as field-heat removal (FHR) was simulated under laboratory conditions. The objective was to obtain typical temperature profiles for different cooling and transport methods and to quantify the effect of these temperature profiles, as well as FHR on apricot quality.

Methods

The temperature profile of FAC and uncooled apricots transported from the production area (Ladismith) in refrigerated trucks, to the cooling / loading facilities (Paarl area), were determined by data collection with loggers, from packing until the end of force-air cooling. Fruit pulp and air temperatures were recorded in three commercial pallets during each

transport leg. These temperature profiles, as well as FHR were simulated under laboratory conditions to determine the effect on Charisma and Imperial apricot quality.

Key Results

Pulp temperatures in FAC apricots were maintained during transport, and decreased by up to 0.2°C in fruit loaded at 2.0°C. Pulp temperatures were not reduced, but were maintained in uncooled apricots transported in refrigerated trucks from Ladismith to Paarl.

Generally, flesh firmness was similar in FAC apricots, and uncooled apricots transported cold, but were lower in apricots subjected to FHR. Internal disorders tended to be less in the FAC apricots compared to uncooled apricots. Apricots subjected to FHR developed more internal disorders than FAC and warm transported apricots.

Conclusion and Discussion

Fruit quality data suggests that FAC on site and cold transport from Ladismith to Paarl may have a beneficial effect on apricot quality in terms less internal disorders, lower moisture loss and marginally firmer fruit compared to uncooled apricots transported in refrigerated trucks. FHR had a negative effect on flesh firmness and general quality compared to FAC and uncooled apricots. It is therefore recommended that apricots should be cooled as soon as possible after harvest, and if loading will take place far from the source that the apricots must be transported in refrigerated trucks. Because FHR had a detrimental effect on quality, fruit should not be partially cooled before transport. In most cases warm handled fruit had acceptable quality, albeit not as good as fruit cooled immediately after packing.

Post-Harvest

Physiological Defects

1 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. It is clear from a 2015 industry survey that different types of browning exist. The purpose of this study was to use X-ray micro- and nano-CT to determine microstructural differences between normal fruit tissue and tissue affected by browning.

Methods

Fruit harvested from an orchard in Ceres had very little browning after storage. A sub-sample was subjected to 50% CO_2 for three days after harvest at ambient temperature. Fruit were cut to determine the incidence, type and intensity of browning, to define internal browning caused by high CO_2 concentration. Twenty fruit with browning and 20 fruit without browning were chosen for X-Ray CT scanning. Micro-CT is conducted on the whole fruit to determine tissue density on different regions of the fruit. Nano-CT was done on cylindrical samples obtained using a cork-borer to determine porosity, connectivity and sphericity of affected and unaffected tissue. Brown and unaffected pre-sorted fruit from Elgin region was sourced and will be reported on in a next feedback.

Key Results

No significant difference in tissue density of the core between affected (brown) and unaffected (white) fruit was found from micro-CT scans. The core was the region mainly affected by CO_2 induced browning. The results of nano-CT scans showed that the porosity was lowest in affected (brown) tissue.

Conclusion and Discussion

The lower porosity in brown tissues with low connectivity amongst the pores impair the movement of respiratory gases and accumulate CO_2, causing tissue damage. Factors influencing browning, tissue porosity and other factors are being further explored.

2 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. Watercore is exacerbated by delayed harvest, especially in seasons where sugar levels in the fruit are high. PPECB inspectors are rating this disorder as internal breakdown 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

Forelle pears were harvested from five FEMA blocks and subjected to a

600 ppb SmartFresh℠ application within seven days after harvest. Fruit were evaluated after five, eight and 12 weeks cold storage and after a seven day shelf life. Fruit samples were also subjected to 50% CO_2 for three days after harvest, cut open and evaluated for watercore and internal browning (IB) incidence. Data were correlated with post storage data to develop a prediction test for IB development.

Key Results

Five FEMA orchards were harvested of which two was very late (week 14). The CO_2 prediction test yielded almost no IB fruit. During post storage evaluations no watercore or IB was detected.

Conclusion and Discussion

No watercore and IB was detected in the 2017 season even though the orchards had a history of watercore or 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. It is therefore necessary to continue with the project should this disorder occur in the seasons to come.

Postharvest 'Forelle' (*Pyrus communis L.*) mealiness influenced by shading the outside canopy fruit

E Crouch, R Cronje, W Fourie and L Schoeman

Objectives and Rationale

A preliminary study showed that a correlation between canopy position and mealiness development exists. The objective of this trial was to determine if fruit canopy position is linked to mealiness development through environmental factors, such as light and temperature, and whether mealiness could be manipulated by shading outside canopy fruit.

Methods

Three shading treatments were randomly applied on the western outer canopy, red blush pears on December 13, 2016: (1) totally exposed control; (2) shading of fruit and their surrounding leaves (3) shading of fruit, but not the fruits' surrounding leaves. Fruit surface temperature was measured on the day of harvest during the hottest part of the day. Fruit were harvested at optimum maturity (±6.2 kg) and maturity indices, as well as mealiness incidence were determined after eight weeks of cold storage at -0.5°C and seven days of ripening at 20°C.

Key Results

Totally exposed outer canopy fruit were mealier and fruit surface temperature 8°C higher compared to the shaded fruit. The higher mealiness incidence was associated with a yellower background colour, higher TSS, lower TA and lower firmness. Shaded fruit with their surrounding leaves exposed had the same diameter, were slightly longer and 7.2 g heavier than totally exposed fruit.

Conclusion and Discussion

Fruit which were directly exposed to high light irradiance had higher fruit surface temperatures and were more susceptible to mealiness development. This indicates the possibility of light and temperature being determining factors involved in 'Forelle' pear mealiness development.

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 led 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 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 or three weeks after harvest and evaluated after ± five months CA cold storage. Fruit was subjected to 50% CO_2 for three days after harvest at ambient temperature and evaluated daily for IB to compare to IB expression after five months cold storage.

Key Results

Two orchards exhibited more than 10% IB after end of five months storage and shelf life. RA stored fruit generally had higher IB incidence compared to fruit stored under one of the CA regimes. IB incidence in CA stored fruit was higher than 10% for only one orchard. High incidence of IB developed during the CO_2 prediction test (≤ 47.5%).

Conclusion and Discussion

Generally fruit from orchards used in this trial did not develop high levels of IB. Generally fruit stored in RA exhibited higher IB incidence compared to fruit stored in one of the CA regimes.

Preliminary study to assess Internal Browning development potential from high watercore incidence FEMA Forelle

D Viljoen

Objectives and Rationale

High levels of watercore were detected in the 2016 season. The objectives therefore were:

- To determine if watercore from FEMA fruit will diminish to acceptable levels during five to 12 weeks cold storage.
- To determine if watercore from FEMA fruit will develop into internal browning during five to 12 weeks cold storage.
- To determine if carbon dioxide can be used to predict IB development during storage.
- To provide guidance to quality standards should PPECB be faced with similar decisions regarding watercore versus internal breakdown.
- To determine if watercore severity influences sorbitol reabsorption by the fruit and IB development.

Methods

Three populations of FEMA Forelle were identified as high watercore incidence fruit and sourced at CFG. One population came directly from the orchard and was subjected to a standard 600 ppb SmartFresh^{SM} application at the ExperiCo facilities. The other two populations were already subjected to a commercial SmartFresh^{SM} application. Fruit were subjected to 50% CO_2 at ambient for three days after sourcing as means of internal browning prediction. Fruit were evaluated after an immediate shelf life for seven days and five, eight, and 12 weeks storage followed by seven days at 20 °C.

Key Results

Fruit maturity data indicated that fruit were within FEMA standards regarding flesh firmness and TSS levels. The CO_2 prediction test did not yield any internal browning development, even after three days.

Watercore was detected in low quantities, the highest being 5.3% in one population at time of sourcing. This particular population had lower incidence of watercore after cold storage and shelf life, but increased levels of internal browning after eight and 12 weeks storage (5.7% and 3.7% respectively). Untreated control fruit had 4.1% watercore incidence after 12 weeks cold storage and 5.3% internal browning after five weeks cold storage. This suggests that fruit with watercore may be at a higher risk of exhibiting internal browning the longer the fruit are stored.

Conclusion and Discussion

Watercore incidence was at such a low level at time of maturity measurements from these orchards historically prone to watercore, that no set conclusion can be drawn if cold storage can cause watercore to disappear, or whether high incidence of watercore increases the risk of internal browning. Internal browning did develop (3.7% - 5.7%) in fruit that had 5.3% watercore incidence at the start of the trial suggesting that this may well be the case. Preliminary results also noted a decrease in watercore with increasing cold storage. Results need to be validated over a further season. Without a high incidence of watercore, it is difficult to see clear trends and make accurate conclusions.

Physiological profiling on 'Rosy Glow' apples harvested at different maturities, with special reference to internal browning development potential

H Tayler and A de Kock

Objectives and Rationale

Improved colour development potential and high yield characteristics of 'Rosy Glow' apples led to an increase of propagation and planting thereof. No ground work (physiological profiling or storage protocols) had been done for this 'Cripps Pink' strain.

Objective 1: To establish the effect of harvest maturity and storage duration on the overall quality of 'Rosy Glow' apples stored for two, four and six months RA (relative atmosphere) at -0.5°C and 1.0°C with special reference to internal browning development (2014/ 2015).

Objective 2: To establish the effect of box liners and 1-MCP on optimum maturity 'Rosy Glow' apples under CA (controlled atmosphere) cold storage conditions and the effect of cooling rate under RA cold storage conditions (2016).

Methods

Objective 1: Fruit were harvested at three different harvest maturities (pre-optimum, optimum and post-optimum) and stored for two, four and six months under RA conditions at -0.5°C and 1.0°C, followed by a seven day shelf life period at 20°C.

Objective 2: 'Rosy Glow' apples were harvested at optimum maturity where after they were split into either a 1-MCP/ liner component CA trial or a cooling component RA trial. The former were either subjected/ not subjected to 1-MCP stored for three and four months CA at 1.0°C and then packed with/ without liners. The latter was either step or rapid cooled and stored for two and a half months RA at 1.0°C. All fruit were evaluated after six weeks "packed" RA at 1.0°C and after seven days shelf life at 20°C.

Key Results

2014: From the data it was evident that 'Rosy Glow' apples are prone to superficial scald incidence when harvested at a pre-optimum maturity and cold stored under RA conditions. Low incidence of internal browning occurred.

2015: Again data indicated that pre-optimum harvested fruit stored under

RA conditions exhibited the highest incidence of superficial scald. Low severity of internal browning was exhibited only after extended RA storage (six months) cold stored at -0.5°C.

2016: It could also have been a low incidence year, but after one season of testing, CA storage seemed to alleviate the occurrence of superficial scald. Low levels occurred in the RA component of the trial. The addition of 1-MCP resulted in the expected firmness and colour benefit. The addition of a box liner alleviated greasiness and to an extent colour break from occurring and 1-MCP alone was sufficient to control greasiness. Although it increased stem and calyx end decay incidence, this dissipated during the shelf life period.

Conclusion and Discussion

Data collected over three years suggest that 'Rosy Glow' apples may not be as susceptible to internal browning as in 'Cripps' Pink' apples when harvested at optimum maturity. CA storage and box liners are advised. Unacceptable levels of superficial and peduncular scald render the fruit unsuitable for extended RA storage. The addition of 1-MCP should be considered if fruit are to be stored for an extended period, but this may lead to an increase in internal browning. Further studies should include this to assess this risk.

Post-Harvest

Storage Techniques

1 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 in order to extend the storage life to possibly six months.

Methods

Abate Fetel 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. Fruit were obtained from two production areas, Grabouw and Ceres. Fruit quality evaluations were done after each shelf-life period.

Key Results

Optimum and post-optimum harvested Abate Fetel was successfully stored for six months without physiological disorders in fruit from both production areas when Smartfresh™ was used. All the fruit treated with Smartfresh™ had a greener skin colour retention and was firmer than the other treatments, for both maturities. If no Smartfresh™ was used, CA 6% O_2 was the best treatment after four months plus seven day shelf-life. It also tended to be the best CA regime for storage up to six months with regard to scald development but the skin colour was very yellow with scuff marks.

Conclusion and Discussion

Smartfresh™ was effective to prevent the development of superficial scald and soft scald on Abate Fetel. However the fruit did not decrease in firmness after shelf-life and did not reach the ready-to-eat stage. This season another storage temperature of 1°C will be incorporated to possibly enable ripening of the Smartfresh™ treatments. Currently there is no difference between the Smartfresh™ treatments and it is not clear if CA adds an additional benefit to Smartfresh™ treatment.

2 Non-chemical storage technologies for apple and pear superficial scald prevention

A Botes and T Kawhena

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 reductions in maximum residue levels (MRLs) highlighted the urgent need for alternative control strategies. These alternative technologies need to be tested for the South African pome fruit industry to determine whether superficial scald incidence is prevented during long term storage, and if it contributes to better fruit quality and shelf-life. The overall aim of this project is to examine the potential of non-chemical storage technologies to control superficial scald in 'Granny Smith' and 'Packham's Triumph'.

Methods

Granny Smith was harvested at two maturities and four treatments

(RLOS+ULO-CA, RLOS+CA, DCA and RA) were applied. Three treatments (RLOS+ULO-CA, RLOS+CA and RA) were applied to optimum harvested Packham's Triumph. Fruit quality evaluations were done after each shelf-life period.

Key Results

In the 2015 season, RLOS+ULO-CA was effective in preventing superficial scald on pre-optimum and optimum Granny Smith up to 10 months with seven day shelf-life. DCA and RLOS+CA effectively controlled scald on pre-optimum fruit up to eight months while on the optimum fruit DCA was effective until ten months and RLOS+CA until eight months. All low oxygen treatments resulted in firmer fruit and better skin colour retention, with generally no differences between them. In 2016 pre-optimum fruit stored under RLOS+CA already had superficial scald after four months with seven day shelf-life, RLOS+ULO-CA had superficial scald after six months and DCA after eight months. On the optimum apples, all the low oxygen treatments had superficial scald after six months with seven day shelf-life.

In 2015 and 2016 season RLOS+ULO-CA and RLOS+CA was effective in preventing superficial scald on optimum Packham's Triumph up to 10 months with 14 day shelf-life. These treatments resulted in firmer fruit with better skin colour retention than the RA treatment. No off-tastes were detected.

Conclusion and Discussion

For two seasons RLOS was effective in preventing superficial scald development on Packham's Triumph for long term storage. It is just important to monitor the alcohol concentration after each stress period. RLOS was only effective to prevent superficial scald on Granny Smith for long term storage in the first season. The 2016 season had a very high potential for superficial scald development and the technology was not effective enough to prevent the physiological disorder.

Alternatives for the use of DPA: Critical minimum DCA storage exposure periods followed by RA and CA storage to inhibit superficial scald on Packham's Triumph pears

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 reductions in maximum residue levels (MRLs) highlighted the urgent need for alternative control strategies. The aim of the project is to optimise an effective alternative technique to the use of DPA by determining the critical minimum storage period that fruit needs to be exposed to DCA storage conditions to inhibit superficial scald, and the effects of RA storage following DCA storage on the development of superficial scald.

Methods

Initial low oxygen stress (ILOS) in combination with CA, DCA and RA for two, three, five and seven months including a simulated shipment RA period with shelf-life was tested in 2012 and 2013 seasons. Additional trials were conducted in 2014-2016. Optimum harvested 'Packham's Triumph' pears from the Ceres and Grabouw production areas were used. Fruit were stored at DCA conditions for five day, two weeks, four weeks, eight weeks,12 weeks, 16 weeks and 20 weeks, then subjected to additional RA periods for six weeks and 10 weeks and shelf-life periods for zero and seven days at 20°C to determine the critical minimum exposure period to control superficial scald effectively. The efficacy of intermittent DCA periods, with exposure periods of 10 days, four weeks, eight weeks, 16 weeks and 32 weeks to control superficial scald, was determined (2014-2016 seasons). Quality evaluations were conducted on fruit of each treatment at each storage period combination according to industry standards. The main focus was on the development of superficial scald during evaluations.

Key Results

DCA-CF successfully inhibited the development of superficial scald on Packham's Triumph from Grabouw and Ceres production areas for up to 20 weeks storage followed by six weeks and 10 weeks simulated shipment with seven day shelf-life. ILOS+CA controlled superficial scald for 16 weeks followed by six week and 10 weeks simulated shipment with seven day shelf-life for both production areas. It is possible to apply an intermittent DCA period of 32 weeks (with a 14 day RA break) with six weeks shipment with shelf-life without superficial scald development. No off-tastes were detected at any of the treatments.

Conclusion and Discussion

DCA-CF can be recommended as a non-chemical alternative for medium to long term storage of 'Packham's Triumph' pears with a 10 weeks shipment period to prevent superficial scald. DCA is already implemented by the South African pear industry. ILOS+CA is effective for short term storage of Packham's Triumph. The efficacy of DCA is not reduced by intermittent breaks of 14 days RA between DCA periods of up to 32 weeks.

Extended cold storage of Abate Fetel pears for EU market

D Viljoen

Objectives and Rationale

The objective of the study is to successfully store Abate Fetel under controlled atmosphere (CA) and/or regular atmosphere (RA) for six months after harvest, without compromising the fruit quality, with emphasis on the prevention of superficial and soft scald development.

Methods

Abate Fetel pears treated with SmartFresh℠ after harvest and stored under regular atmosphere (RA) conditions for six months, were evaluated for post storage quality, in comparison to pears treated with SmartFresh℠ after harvest, followed by three months controlled atmosphere (CA) storage and three months of RA storage (partial CA). Control fruit were stored in CA for six months with no SmartFresh℠ (2012 and 2013 season) or six months in RA with no SmartFresh℠ (2014/15 season). Fruit from five different populations (sources) were evaluated for regularly used ripening parameters and storage disorders, directly after storage at -0.5°C (start of shelf-life) and after seven days at 20°C (end of shelf-life).

Key Results

2012: Fruit subjected to SmartFresh℠ were generally of better quality compared to the untreated control fruit, regardless of storage regime. Fruit from all three treatments (six month CA without SmartFresh℠, six month CA with SmartFresh℠, three month CA plus three month RA with SmartFresh℠) ripened to an eating ripe firmness of 1.5 to 4.0 kg. This was due to the high ethylene levels that indicated that fruit were respiring and able to ripen. Results demonstrated the limitations of long term CA storage of Abate Fetel due to high soft and superficial scald incidence and senescent breakdown. The ability of three month partial CA storage in combination with SmartFresh℠ application to reduce scald-type external disorders on long term stored Abate Fetel fruit was clearly demonstrated.

2013: Fruit subjected to SmartFresh℠ were generally of better quality compared to the untreated control fruit, regardless of storage regime. Fruit subjected to SmartFresh℠ exhibited no soft or superficial scald, regardless of storage regime. Fruit from the three month partial CA storage in combination with SmartFresh℠ application exhibited lower incidence of internal browning and CO_2 damage than the other two treatments. Fruit from all three treatments ripened to an eating ripe firmness of 1.5 to 4.0 kg. This was due to the high ethylene levels that indicated that fruit were respiring and able to ripen.

The three month partial CA storage in combination with SmartFresh℠ application could potentially be a solution for long term storage of Abate Fetel pears, because of the reduction in scald-type external disorders, and lower incidence of internal browning and CO_2 damage.

2014: Overall fruit quality was improved after storage in 2014 compared to the fruit quality in 2012 and 2013. Fruit that was stored under CA conditions still looked appealing on the outside, but was not acceptable for consumption due to the internal browning and CO_2 breakdown incidence.

The trial indicated that fruit subjected to SmartFresh℠ could be stored for extended periods because superficial and soft scald incidence were inhibited and internal fruit quality was good. However, RA storage should rather be considered over CA storage.

2015: The advantage of using SmartFresh℠ applications for retention of flesh firmness, green skin colour and reduction of progressive disorders of Abate Fetel pears, was demonstrated. However, SmartFresh℠ treatment in combination with RA storage for 6 months could not consistently suppress superficial scald development during shelf-life simulations below commercially acceptable levels. Although the best results in terms of external appearance and reduction of superficial scald, soft scald and senescent scald were observed in fruit stored in partial CA, fruit were susceptible to (internal) CO_2-breakdown (≤ 18.2%).

2016: Fruit subjected to 300 ppb SmartFresh℠ within four days after harvest and RA stored for six months resulted in the best quality fruit of the three different treatments. This treatment however, is not fool proof since in two of the populations, high incidence of flesh decay developed during cold storage. This could have been due to no phytosanitary dips after harvest. In two of the populations fruit did not ripen to firmness' lower than 4.0 kg. Fruit with no SmartFresh℠, RA stored for six months, had high incidence of superficial scald and should not be considered as an option for long term storage. The partial CA storage treatment poses the risk of internal CO_2 breakdown in fruit. A shorter CA period, or delay in CA start should be considered for this treatment. Fruit also did not ripen to firmness' lower than 4.0 kg.

Conclusion and Discussion

Long term (six months) storage of Abate Fetel pears, with no SmartFresh℠ application in RA or CA, should not be considered, as superficial and soft scald can develop during storage or shelf life.

Partial CA storage (three months CA followed by three months RA) of Abate Fetel pears treated with SmartFresh℠ after harvest resulted in firm pears with little to no superficial and soft scald development. However, internal CO_2 breakdown was a major defect in fruit of this storage regime. In some instances fruit also did not ripen during shelf life to firmness' lower than 4.0 kg. It is recommended not to follow this regime and should partial CA storage be considered, more research on shorter CA periods, delayed start of CA and lower SmartFresh℠ concentrations should be considered.

SmartFresh℠ treated fruit stored for six months in RA gave inconsistent results over the seasons. In the 2016 season however, little to no superficial and soft scald was detected on this fruit. It is thus the method with the best potential. It is recommended to first

do research on what is the causative factors of superficial and soft scald in this method (e.g. maturity, climate, etc.) before these pears be stored commercially under this regime.

It is recommended to determine the maximum storage duration of Abate Fetel pears by storing fruit for five, six and seven months in RA (with SmartFresh℠). It is also recommended to determine the effect of delayed CA or shorter partial CA periods on the quality of fruit.

Should the market accept light green pears, it should be considered to store fruit at higher temperatures to solve the ripening issues. Fruit can be subjected to a SmartFresh℠ application after harvest and stored at +0.5°C in RA. One to one and a half months before selling the temperature can be raised to 2°C. This method however, will not be suitable should the pears be sold as green.

Post-Harvest

Post-Harvest Decay

1 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 (syn. *Neofabraea alba)* is considered to be the predominant fungal species causing bull's eye rot (BER) on 'Cripps' Pink' apples in the Western Cape. The incidence, pathogenicity and distribution of other fungal pathogen species known to occur on pome fruit world-wide has not been investigated in South Africa to date.

Methods

We collected BER infected apples from two packhouses in the Western Cape (one sample set with fludioxonil application, one without any post-harvest fungicide application). The *Neofabraea* sp. isolates retrieved from second grade fruit from Western Cape are currently identified to species level and subjected to pathogenicity tests on apples (cultivars Fuji, Cripps' Pink, Golden Delicious). Furthermore 20 isolates of each identified species will be tested *in vitro* for fungicide sensitivity. Two isolates will be used for inoculation of fruit, which will be treated with fludioxonil in a dip at the recommended dose. BER incidence and severity will be compared on two apple cultivars (Cripps' Pink, Golden Delicious).

Key Results

Eight new BER isolates from fruit stored under regular atmosphere in a cold room since March 2017 were collected (samples from two orchards), as well as isolates from a different packhouse where fludioxonil was applied in the drench.

Conclusion and Discussion

The 2017 season appears to have been suitable for BER infection, which is a sporadically occurring pathogen. Fludioxonil application did not prevent BER infection. The identity and fludioxonil sensitivity of the new *Neofabraea* sp. isolates will be investigated.

2 Development of a fungicide resistance monitoring service for SA pome fruit pathogens

C Lennox 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 to 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 (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 AP 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 flusilazole (DMI) was 0.22 mg/L, and 87% of the tested isolates were categorised as sensitive. Baseline sensitivity to cyprodinil (AP) was 0.88 mg/L and 0.08 mg/L dodine (guanidine). 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 from Elgin and Koue Bokkeveld orchards 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 three 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.

Detection and quantification of *Botrytis cinerea* incidence and severity in harvested pears for the development of a monitoring system to support commercial exports

S Ferreira, I Wilson, M Wells and N Mangwana

Objectives and Rationale

A method to monitor *Botrytis cinerea* inoculum levels will greatly assist in the management of the *Botrytis* rot in pears. The objective of this project was to develop a system to continuously detect and quantify *B. cinerea* levels in orchards, packhouses and packed fruit. As a secondary aim, we attempted to correlate the inoculum levels present with decay levels measured at the end of storage and shelf.

Methods

During the first season, pear blossoms and fruit were harvested from orchards at full bloom and optimal harvest maturity respectively. These samples were either artificially inoculated with known amounts of *B. cinerea* spores or left un-inoculated. From these samples genomic DNA was extracted and used in a quantitative Real-Time PCR (qRT-PCR) reaction to determine the relative *B. cinerea* DNA content present in pear blossoms and the calyx-end of fruit at specific time-points. For the second season, fruit samples from several orchards were taken at various time-points during production and storage. In these samples the *Botrytis cinerea* DNA content was monitored and at the end of the storage period fruit was sampled to determine the incidence and severity of *Botrytis* rot.

Key Results

<u>Season One</u>

1. *B. cinerea* DNA was detectable in a) blossoms at full bloom and b) the calyx-end of fruit harvested at optimal maturity.
2. There was a strong correlation between the *B. cinerea* DNA content and the number of spores artificially inoculated in both blossoms and the calyx-end of fruit.
3. The minimum quantifiable limit of the test is between 10-100 spores for blossoms and 100 spores for calyx-end tissue.
4. Fifteen fruit per sample pool is an adequate sample size and produces reproducible results.
5. In samples where *Botrytis cinerea* was artificially inoculated into the calyx-end, there was a significant reduction in the *B. cinerea* DNA content after chlorine flume treatment. This was not true for samples where no artificial inoculation was done.

<u>Season Two</u>

6. *Botrytis cinerea* DNA was detected at all time-points for all production areas analysed.
7. The inoculum amount did not

significantly change from the levels measured at the very first time-point. This shows the importance of infection early in production (possibly bloom) in determining the level of inoculum present during storage.

8. Flume treatment during storage did not have a significant effect on the *Botrytis cinerea* inoculum within the calyx-end.
9. The initial infection, most probably occurring during bloom, seems to be crucial in determining the level of *Botrytis cinerea* inoculum present during production and storage.

Conclusion and Discussion

A method to detect and quantify down to 10–100 spores in blossoms and 100 spores in the calyx-end of pears was developed. We could monitor inoculum levels from harvest to the end of storage and there was not a significant change in inoculum levels during storage. These results show the accuracy and applicability of the method to monitor *B. cinerea* inoculum levels and the importance of early season infections (possibly bloom) in determining the inoculum levels present during storage.

Survey and investigation on the impact of various fungicide application methods and technologies on decay control of plums in the packhouse

I Wilson and A de Kock

Objectives and Rationale

The application of fungicides may be highly efficient for control of post-harvest decay of plums. However, successful control, without exceeding maximum residue limits, relies on appropriate and highly accurate fungicide application, dosages, and methods. Currently, little is known on the methodology of fungicide application in the South African plum industry. The aim of this study is to conduct a survey at various packing lines in plum packhouses in the Western Cape to determine and review the specifications at which fungicide application technologies are used.

Methods

Atomiser systems of 17 plum packing lines were surveyed to determine which fungicide application technologies are most prevalent, and to gather information on treatment specifics.

Key Results

Two fungicide atomising systems were used in industry:

a) Atomisation by nozzles (70% of packing lines)

b) Atomisation by a spinning disk (30% of packing lines)

Noteworthy factors, critical for successful fungicide application, were identified including:

- The spacing of nozzles
- The fungicide spray deposition on the fruit by the nozzles
- The concentration of the product
- The mixing of the product

All of the systems studied could improve fungicide applications by using best practises in the abovementioned factors.

Conclusion and Discussion

Fungicide cost cannot be considered the major driver in decisions regarding fungicide application, when application methods do not deliver the product effectively. Results from this study could encourage the design and installation of accurate atomiser systems in the plum industry.

Production of antimicrobial lipopeptides by *Bacillus* spp for biological control of post-harvest phytopathogens in the perishable fruit industry

K Clarke, V Rangarajan, W Herbst and S Mazibuko

Objectives and Rationale

Fungal phytopathogens cause considerable damage to post-harvest fruit crops. Synthetic chemical fungicides used to control post-harvest disease have been associated with adverse environmental impact and health issues. A novel environmentally benign bio-fungicide (lipopeptide molecules) has been produced from *Bacillus* sp. and shown to be effective against post-harvest fungal phytopathogens associated with perishable fruit crops. The research has primarily focused on optimising the upstream production kinetics and downstream purification of the lipopeptide product on the laboratory scale.

Methods

Bacillus cultures were conducted in shaking incubators and in instrumented bioreactors. Microbial growth was quantified using a spectrophotometer and cell dry weight. Glucose concentration was determined using high pressure liquid chromatography or HPLC and by colorimetric analysis. Nitrate concentration was measured using an ion chromatograph and ammonium concentration by colorimetric analysis. Lipopeptide concentrations were determined by HPLC.

Purification was effected by acid precipitation (four pH values), solvent extraction (11 solvents) and adsorption onto macroporous resin. Lipopeptide analysis was conducted by HPLC and by Thin Layer Chromatography (TLC). Protein and lipid impurities were assessed by TLC.

Efficacy verification: Antifungal efficacy against phytopathogens prevalent on post-harvest fruit was determined by means of radial diffusion assays.

Key Results

Upstream processing: The effects of nitrogen concentration and nitrogen source on the antifungal lipopeptide production kinetics have been quantified.

Downstream processing: Percentage purities and recoveries for acid precipitation and solvent extraction purification procedures have been quantified.

Efficacy: Antifungal efficacy of a 10-fold concentrate was confirmed for *Alternaria brassicicola*, *Botrytis cinerea, Rhizopus stolonifera and Penicillium expansum.*

Conclusion and Discussion

Antifungal lipopeptides were produced by *Bacillus amyloliquefaciens* DSM 23117 and quantified by reverse phase high pressure liquid chromatography (RP-HPLC). Using discrete ratios of ammonium to nitrate, the nitrogen source was shown to exhibit a significant influence on the production kinetics. The antifungal concentration in the culture supernatant exhibited a general downward trend with decreasing amounts of nitrate with a 2.6-fold difference in the maximum and minimum lipopeptide concentrations in the cultures containing only nitrate or ammonium respectively. A similar trend was observed in cell concentration which exhibited a 3.3-fold reduction, and a corresponding 1.3-fold increase in specific antifungal concentration, over the same range. Purification of the culture supernatant was effected by acid precipitation. Precipitates were recovered by centrifugation and drying and the lipopeptides quantified by RP-HPLC. High recoveries were attained at lower pH levels. Various solvents were used to optimise antifungal lipopeptide recovery. Antifungal efficacy of a tenfold concentrate was confirmed for *Alternaria brassicicola*, *Botrytis cinerea, Rhizopus stolonifera* and *Penicillium expansum* in zone clearing assays, demonstrating the successful production of a concentrated and partially purified biofungicide effective against post-harvest phytopathogens, specifically those affecting post-harvest fruit.

The prevalence of *Botrytis cinerea* in and on plums, and alternative host plant tissue: A preliminary investigation on the occurrence of the fungus pre-and-post harvest in order to elucidate pathogen ecology, for new decay control strategies

I Wilson and S Ferreira

Objectives and Rationale

Botrytis cinerea causes grey mould decay in plums, which is of commercial importance to the South African stone fruit industry, since efforts to control decay are not always effective, with subsequent financial forfeitures to producers. It is possible that knowledge on some facets of the ecology of the fungus is incomplete which hampers optimal control of the fungus. The aim of this study was to investigate the prevalence of *B. cinerea* in both pre- and post-harvest plum tissue, as well as in weeds, over the plum production season. The occurrence *B. cinerea* over time, and in different tissue types in the orchard, may give insight into the ecology of the fungus, which in turn could reveal critical points for decay control.

Methods

An orchard with a known high incidence of Botrytis grey mould, and high weed infestation, was identified. For 25 trees, samples of blossoms, mature fruit at harvest, and mature fruit during and after storage was evaluated for the presence and quantity of *B. cinerea* DNA using quantitative real time polymerase chain reaction (qRT-PCR) technology. Weeds were also screened for the presence of *B. cinerea*.

Key Results

- *B. cinerea* was detected in various samples throughout the whole timeline of sampling, which included blossoms, fruit at harvest, and from fruit during or after cold storage.
- Notably the fungus was always present in blossoms in high quantities.
- *B. cinerea* was detected in more than 14 weed species obtained from the orchard floor, and it was present in weeds both during spring and summer time.
- Potato Dextrose Agar isolations from fruit or weed tissue failed to isolate *B. cinerea*.
- Despite the application of a post-harvest fungicide, *B. cinerea* DNA levels, as well as fruit decay, increased in a strong linear relationship with storage time. Thus, the longer the storage period, the greater the amount of DNA and decay in fruit.
- The amount of *B. cinerea* DNA in fruit also directly correlated to percentage decay.
- Notably, the amount of *B. cinerea* DNA in blossoms showed a strong

positive correlation (R^2 = 0.9653) to percentage fruit decay at the end of the storage period.

Conclusion and Discussion

This preliminary investigation, on the presence of *B. cinerea* in various host tissues, brought forth previously unknown insights on the pathogen. *B. cinerea* was frequently found in healthy plum and weed tissues and the strong correlations between levels of *B. cinerea* DNA in plum tissues with decay in plums were evident. These results urge further exploration into the unknown aspects of the nature of this fungus. An investigation on the role of insects or wind in *B. cinerea* transfer from weeds to trees in bloom may prove useful in finding weak links in the life or disease cycle which could be targeted for decay control. Possibly, repetitive fungicide applications to blossoms to prevent primary infection early in the growing season and eradication of weeds could contribute to successful decay control. However, confirmation of results in other plum cultivars in various cultivation areas is needed. These results may not be universal to all plums or stone fruit. Should these trends remain, and possibly more new information come to light, it is imperative that appropriate, tested, management strategies be devised for accurate decay control.

Post-Harvest

Packaging and Logistics

1 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

Improving the current packaging of nectarines to achieve optimal shrivel control without negative effects on general fruit quality and determine the effect of improved relative humidity (RH) control in cold stores on moisture loss and shrivel control for nectarines.

Methods

Fruit were sourced from a commercial packhouse and repacked in different packaging types and accumulated in two different cold rooms, one room standard without humidity control and other with humidity control. Fruit was weighed at repacking and then after cold storage and shelf life to determine moisture loss. Fruit quality was also assessed after cold storage and shelf life period.

Key Results

It was evident that fruit packed without any wrappers or perforated bags lost significantly more moisture compared to those packed in wrappers and bags. However, this moisture loss only manifested as shrivel after the shelf life period. After shelf life, shrivel and internal quality problems became evident.

The worst quality was caused by packing Augustine Red nectarines in 36 x 4 mm perforated bags and storing at ± 80.0% RH and -0.02°C. This treatment led to low flesh firmness and high levels of IB, woolliness and OR.

Conclusion and Discussion

Fruit packed in standard nectarine wrappers and accumulated at -0.02°C and 80.0% RH (standard cold room) exhibited the best fruit quality at the end of cold storage and end of shelf life, across all quality parameters. However, it is important to note that intended higher RH conditions anticipated in the humidity control cold room did not materialize. This was ascribed to constant opening of the room during the accumulation period prior to transportation to the port.

2 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 on plums.

Methods

Fruit were sourced from commercial packhouses and repacked into different packaging types and accumulated in two different cold rooms, one that was standard and other with humidity control. Fruit was weighed at repacking and then

after cold storage and shelf life. Fruit quality was also assessed after cold storage and shelf life period.

Key Results

Laetitia: It was evident that plums packed without wrappers or perforated bags lost more moisture compared to those packed in wrapper and perforated bags. Shrivel was significantly higher on fruit packed without wrappers or bags in both the standard and humidity controlled cold room compared to the other treatments. Skin cracks were high on fruit packed in 36 x 4 mm perforated bags and accumulated in the humidity controlled cold room, as well as on fruit packed in 36 x 4 mm perforated bags and fruit packed in 72 x 4 mm perforated bags and accumulated in the standard cold room.

African Delight: It was evident that plums packed with perforated bags with high numbers of perforations and accumulated at a higher temperature will lose more moisture loss than fruit packed in perforated bags with fewer perforations and accumulated at a lower temperature. Mass loss due to moisture loss was a good indication of the shrivel risk with levels increasing with increased mass loss. No internal quality problems occurred after cold storage.

Conclusion and Discussion

This research is based on results generated in one season and must be repeated before recommendations can be made.

Laetitia: Non-perforated wrappers maintained fruit quality the best, at the end of cold storage plus shelf, life, across all parameters with the exception of skin cracks.

African Delight: Perforated bags with 18 x 4 mm hole configuration maintained fruit quality well, at the end of cold storage and end of shelf life, across all parameters. However, in this population of plums the no wrapper or no bag treatment showed the least shrivel, a finding which must be reconfirmed.

The development of the industrialisation process for various ideas towards optimisation of cargo freight capacity utilisation (space, mass, packaging, refrigeration) in refrigerated shipping containers to reduce logistic costs while maintaining product quality

K Bouwer, M Dodd, N Bridge, T Myburgh and S Nel

Objectives and Rationale

The cost of exporting fruit with refrigerated containers has increased more than 30% during 2013/14. The cost of shipping is linked to a refrigerated container unit. In this project, we investigated the opportunities to export more fruit per container to save on shipping costs.

Methods

A document was compiled to list all the factors that define an optimum solution for container utilization. Research was done on historical changes in shipping methods for exporting fruit. Many of the current methodologies are based on historical decisions and these were challenged. Interviews were held with fruit exporters and logistical handlers to obtain their expectations and concerns. Constraints in the form of transport load regulations and dimensions of containers were researched and listed for most of the target exporting countries. The volume of refrigerated container shipments was analysed and from this a cost chain defined to assist in quantifying opportunities. An analysis of packaging types was done to reflect the current container utilizations. Industrial engineering optimization techniques were applied to develop potential solutions for improvement in container utilization.

Key Results

The optimization of container utilization showed that a theoretical 29 tons of apples can be loaded in a container without any restrictions. In practice, only 14 to 18 tons of apples are loaded, and only 18 to 22 tons of pears. Stone fruit shows a better utilization, but still with room for improvement. The type of packaging used is contributing to the variation in container utilization. Most of the unused space is also taken up by pallet bases and packaging material. Smaller carton sizes usually lead to lower utilization due to the edge effect.

The following opportunities are listed with expected savings:

- **Option 1:** Euro Pallet or 21 pallets: Save 2.5%
  (This option is used for avocados and is the easiest for implementation.)
- **Option 2:** Reduce weight of packing material: Save 3%
  (Reducing weight by using alternative light weight packing material for cartons and pallets)

- **Option 3:** Reduce pallet base height: Save 4–6%
  (The pallet base height is 158mm. pallet can be replaced with slip sheets or lower profile pallets)
- **Option 4:** Optimal carton size (bigger cartons, less edge-effect)
  (This option reduces the space that cartons take up inside the container)
- **Option 5:** Optimal pallets: (e.g. 2200 x 1200) Save 15–17%
  (The pallet manager program can be used to develop alternative palletizing units)
- **Option 6:** Combinations of above: Save up to 25%

Conclusion and Discussion

The conclusion is that there are definite opportunities for improving the utilization of refrigerated shipping containers and that the cost benefits that would ensue justify the continuation of such a task. Various options for improvement were identified which need to be developed in more detail. A central managing body is recommended to remove the barriers of implementation by sharing the benefits with all involved.

The task at hand is considerable, but it pales in comparison to the cost benefits the whole industry can derive from the improved utilisation of refrigerated shipping containers. Even a conservative 5% saving will lead to an 8% increase in net farm income and an annual benefit of R135 million for the industry.

Post-Harvest

Fundamental Understanding

Moisture loss studies in Japanese plums (*Prunus salicina* Lindl)

E Lötze and I Kritzinger

Objectives and Rationale

A comparison of cuticle ultrastructure, chemical composition, peel permeability and lenticels is required between Japanese plum cultivars to understand why some cultivars are more prone to post-harvest moisture loss and shrivel. Different packaging solutions were tested to reduce fruit moisture loss.

Methods

Five different polyethylene bags were tested on ‘Sapphire; ‘Laetitia’, ‘Songold’ and ‘African Delight’. Internal and external fruit quality, weight loss, and shrivel incidence were inspected after cold storage and shelf-life. Extraction and compositional analysis of cuticular waxes was completed and cutin extraction was completed. Peel samples for SEM visualisation were prepared and SEM imaging was performed. Peel permeability of ‘Songold’ and ‘Laetitia’, as well as the number of open lenticels per fruit were determined.

Key Results

Moisture loss and shrivel incidence was reduced by bags with micro-perforations, but bags with very few perforations increased chilling injury. A relationship between moisture loss (%) per fruit and shrivel occurrence could not be established. The total number of lenticels and number of open lenticels differed between cultivars, but no correlation could be established between peel permeability and the number of open lenticels.

Conclusion and Discussion

Moisture loss through open lenticels are not directly related to peel permeability. Fruit peel permeability seems to be highly variable between cultivars, seasons, and individual fruit. Since other peel factors also play a role in the tendency towards fruit moisture loss and shrivelling, these factors must be investigated further. The use of micro-perforated LDPE bags to reduce both moisture loss and shrivel seems promising, but cultivars will have to be evaluated individually and there will have to be a trade-off between increasing RH to reduce moisture loss, while still preventing decay and minimizing chilling injury.

Moisture loss studies in nectarines

K Theron, M Jooste and K Chigwaya

Objectives and Rationale

Moisture loss during long term storage is one of the main post-harvest problems in nectarines. The long handling chain which fruit are exposed to, from harvest until the end of shelf-life, exposes fruit to moisture loss. Moisture loss occurs as a result of the vapour pressure deficit (VPD) between the fruit and surrounding atmosphere. In addition to causing loss of saleable weight, moisture loss also results in fruit having a shrivelled appearance. Moisture is lost from fruit through various openings in the fruit peel such as micro-cracks and lenticels.

Methods

We investigated the effect of fruit to fruit variation, harvest date, tree and orchard effects and cultivar differences on the variation in water

vapour permeance ($P'H_2O$) of three nectarine cultivars namely 'Alpine', 'Summer Bright' and 'August Red'. In addition, 'August Red' nectarines were exposed to different handling chains from harvest until the end of shelf-life to determine the VPD at different stages in the handling chain in order to establish the point which is most effective in reducing moisture loss and shrivel. We also investigated whether pre-harvest applications of potassium silicate (K_2SiO_3) can reduce post-harvest moisture loss, shrivel and split pit in 'Southern Glo' nectarines and the effectiveness of different packaging films in reducing moisture loss and shrivel in 'August Red' and 'Alpine' nectarines.

Key Results

Large fruit to fruit differences were the main contributor (>45%) to the variation in $P'H_2O$, followed by harvest date (>35%), cultivar differences (>7%) and orchard effects (>3%) whilst tree effects did not contribute to $P'H_2O$. Generally, the $P'H_2O$ of all three cultivars increased steadily as the harvest date approached and continued to increase post-harvest, but $P'H_2O$ at optimum harvest was not closely correlated to their susceptibility to shrivel. None of the proposed handling chains performed better than the current standard handling protocol in reducing moisture loss and shrivel. Soil and foliar K_2SiO_3 applications were not effective in reducing post-harvest moisture loss, shrivel or the incidence of split pit in 'Southern Glo' nectarines. The use of Xtend® and high density poly-ethylene (HDPE) bags significantly reduced moisture loss and shrivel in nectarines in both pulp trays and plastic punnets than the standard nectarine HDPE wrappers, but resulted in more internal defects.

Conclusion and Discussion

It is therefore important to reduce moisture loss at harvest by following the standard handling protocol and by packing fruit optimally.

A study of the peel permeabilities of Japanese plums to moisture during fruit development on the tree

K Theron and G Lötze

Objectives and Rationale

Although packaging solutions to reduce shrivel in plums exist, shrivel incidence is still high for most cultivars. This indicates that some moisture loss takes place prior to the fruit being packed. Differences in the water vapour permeance ($P'H_2O$) of fruit peel are influenced by variation in fruit size and harvest maturity of the fruit. Little knowledge currently exists on pre-harvest factors, such as the status of the $P'H_2O$ of the fruit peel at different fruit maturities, or how it is influenced by orchard, tree or fruit factors. Knowledge of the fruit peel permeability, how it is influenced by the season and how cultivars compare will greatly aid in deciding on optimum handling protocols for specific cultivars.

Methods

Five orchards were used for five cultivar and five uniform trees per orchard were randomly chosen. $P'H_2O$ was determined weekly from four weeks before the anticipated optimum harvest date until approximately two weeks after the optimum harvest date.

Key Results

In general the $P'H_2O$ of 'Angeleno' and 'Fortune', two cultivars not susceptible to shrivel, remained lower than the other three cultivars over the sampling periods. 'African Rose', a cultivar that is susceptible to shrivel had the highest overall $P'H_2O$ over the sampling period, with the two new cultivars 'Ruby Sun' and 'Ruby Star' also relatively high and they performed more similar to the shrivel susceptible 'African Rose' than the non-shrivel susceptible cultivars, 'Angeleno' and 'Fortune', which indicates that these two cultivars might also be susceptible to shrivel.

Conclusion and Discussion

Previously it was found that very little difference and correlation over time in overall $P'H_2O$ of 'African Delight', 'Laetitia' and 'Songold' and shrivel susceptibility occurred. From the first seasons data on the five cultivars examined during the 2015/16 season, there appears to be some indication of a link between changes in $P'H_2O$ and shrivel susceptibility in the three cultivars where the shrivel susceptibility is known. However the results obtained for a study on nectarines and the previous plum study showed that large differences occur between seasons.

Post-Harvest

Technology Transfer

Development of a post-harvest digital quality management platform in the form of mobile phone and desktop applications (apps) to assist technology transfer for fruit

A de Kock

Objectives and Rationale

The creation of a digitally supported information system as complementary tool for transfer of post-harvest technologies and information to assist stakeholders in the stone fruit business. The project comprised several phases.

Methods

In Phase 1, which ran from July 2015 to September 2015 a digital template was formulated. During Phase 2, from November 2015 to December 2016, the digital template was populated with cultivar specific and generic information, for Apricots, Peaches, Nectarines and Plums. Beyond the scope of this project, the information generated will be used by Hortgro Science to complete Phase 3, the development of mobile phone and desktop applications (apps).

Key Results

All milestones of Phase 1 and Phase 2 have been reached. The digital template has been created and populated for the various stone fruit types. The master document has been handed over to Hortgro Science for continuation of the next Phase of app development. The information generated has been discussed and inputs received from various industry role players.

Once functional, the system will be presented and demonstrated at various forums, including for training. The intention is to make the information available in digital format so that users have 24/7 access to important verified stone fruit quality maintenance and management knowledge.

Expansion and updating the post-harvest digital quality management platform for mobile phone and desktop applications (apps) to assist technology transfer for stone fruit

A de Kock

Objectives and Rationale

Improvement of technology transfer in the fruit industry is an ongoing challenge. To improve technology transfer a basic digital platform was created and initiated in 2016. The intention of this project is to further develop and optimize the app. The objectives below are envisaged.

Methods

- Establish which cultivar owners are willing to add cultivars to the cultivar specific list
- Supply new information to Hortgro Science for uptake in the digital system
- Attendance of relevant industry meetings with the aim to gather information for uptake by Hortgro Science on system
- Introduce the app system to the industry and to DAFF/ PPECB

Key Results

1. Contact was made with cultivar owners of which the data was not available. All agreed to share information for inclusion into the app (completed).
2. The data was populated for uptake into the app (completed).
3. The relevance of the data was verified (completed).
4. Contact was made with relevant role players and JMF meetings attended to establish required changes and possible aspects to be addressed (milestone completed to 75% of the target).
5. Meetings were held with PPECB to discuss the app concept. The app could not be introduced in a fully working state, since the app was not ready for ExperiCo to do complete data input and problems incurred on the Hortgro IT systems (22% completed).
6. Meetings were held with other role players to discuss the app concept. The app could not be introduced in a fully working state, for reasons given above (20% completed).
7. Discussions were held with Dipar to enable data input and requirements of the app (70% completed).
8. Discussions were held with consultants, but the final product could not be verified or edited due to constraints mentioned earlier (20% completed).

Conclusion and Discussion

The system could not be introduced to users in particular extension officers in all stone fruit producing areas, due to the delay in Dipar development of the app. Inputs from ExperiCo were only completed to the value of R109,299.75 of the original cost projected of R163,500.00 (± 67%). The deliverable not met was not due to ExperiCo, but rather the app system not being ready, as well as problems incurred in uploading onto the Hortgro website.

Post-Harvest

Market Access

Confronting Climate Change

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 initiative also provides detailed management information that supports management programs to improve resource-use efficiencies (such as electricity, fertilizers, agro-chemicals and fuels), increased energy independence and improving financial performance of the business.

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 farms, packhouses, wineries and the industry as a whole.

This is accomplished by ensuring that the fruit and wine industries are:

- well informed about relevant issues through a centralized information and training resource;
- equipped to be able to measure its carbon footprint and benchmark it against best practices;
- positioned to implement carbon reduction practices that incorporate effective; mitigation and adaptive strategies to meet the challenges of climate change.
- positioned as market leaders in relation to their global competitors

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 using the data entered by the user and a PDF report is generated for the user. Training through workshops as well as telephonic and email support is offered to users.

Communications takes place via a bulk email list, the website, industry websites and communication channels and Twitter.

Data quality is managed through a benchmarking process of sense-checking of the data.

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 first phase collaboration where a regional carbon footprint will be calculated. It will now be followed in Phase 2 by a carbon sequestration component that will also be determined on a regional level. This is considered as a first step 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 and more sustainable businesses
2. Enhanced industry competitiveness
3. Regulatory and Standards readiness and compliance

The project will continue in to Phase 4 with particular focus of broadening the reach of the project to other commodities and growing its commercial potential.

Assessment of accumulative DPA residues throughout storage and packing facilities

D Viljoen

Objectives and Rationale

The use of DPA for the control of superficial scald on apples and pears is no longer an option for fruit exported to the EU. This is due to regulations where the acceptable MRLs were reduced from 10.0 (pears) and 5.0 ppm (apples) to 0.10 ppm. The aim of this trial was to assess the potential risk of cross-contamination on untreated fruit by analysing DPA residue levels on fruit at the bin, cold store and pack line level.

Methods

In the 2013 season, DPA contamination was monitored at flume, bin and cold store level. Flume water, floor and wall swabs, and untreated fruit in cold rooms previously used for DPA treated fruit storage were analysed for DPA residue.

In the 2013 to 2016 seasons, DPA residue levels were monitored over ±5 months on untreated fruit in rooms that previously stored DPA treated fruit and in rooms that had not stored DPA treated fruit previously.

In the 2016 season untreated fruit were subjected to a 2000 ppm DPA dip and send to three laboratories as part of a ring test.

Key Results

2013: Untreated fruit stored with DPA treated fruit had residue levels higher than 0.1 ppm after only four weeks of storage. There was no contamination from old and new plastic bins and new wooden bins. Only after 14

weeks cold storage levels of 0.05 ppm were detected on fruit stored in old wooden bins. Low to no residue levels was detected in flume water. Untreated fruit in cold rooms that stored DPA previously had DPA levels lower than 0.1 ppm.

2014:
Fruit from 7 new CA rooms and 5 old CA rooms were analysed monthly over 5 months for DPA residue levels. Ten samples predominantly from the old rooms had residue levels higher than 0.1 ppm.

2015:
Fruit from 5 old CA rooms and five new CA rooms were analysed monthly over 5 months for DPA residue levels. One fruit sample from an old room had residue levels higher than 0.1 ppm.

2016:
The highest DPA residue level measured on fruit was 0.021 ppm.

Conclusion and Discussion

Initial studies (2013) indicated that storage of untreated fruit with DPA treated fruit will result in contamination of the untreated fruit rendering them not suitable for the EU market. There is no risk of contamination from bins, pack lines and new cold stores. Initially cold stores that stored DPA treated fruit previously did pose a low risk of contaminating fruit. However, from data monitored over the 2014 to 2016 seasons it is evident that contamination risk diminished and should not be a concern. Should DPA be kept off site, there would be little to no risk of contamination of untreated fruit. There could be causes for concern if the MRL for DPA on pome fruit drop to 0.05 ppm.

Utilisation of SmartFresh℠ and/or pre-ripening to enable successful shipping of dual-temperature regime plums at a single temperature of 0.55°C for 24 days for cold-sterilisation purposes

H Viljoen

Objectives and Rationale

This extension project was conducted to establish if SmartFresh℠ application and warming treatments utilized during cold storage can counter quality losses which may develop during cold-sterilization treatment of plums traditionally stored at dual-temperature. The two best treatments identified in the previous three seasons were used.

Methods
Four cultivars were sourced from Franschhoek, Robertson and Wellington, and subjected to the different treatments and temperature regimes as indicated in the report. The fruit were evaluated after applicable cold storage periods and after a subsequent shelf life period of five days at 10 °C.

Key Results

Previous reports (2014–2016) indicated cultivar differences. Quality maintenance of African Rose, Sapphire, Fortune and Ruby Red plums were best maintained over the three seasons of testing, by applying SmartFresh℠ during the accumulation period, followed by no warming before shipping [T6] and applying SmartFresh℠ during the accumulation period, followed by three days warming at 20°C before shipping [T4]. However, quality maintenance of African Rose, Sunkiss and Sapphire (based on end of cold storage results of Sapphire) plums were also maintained by applying SmartFresh℠ during the accumulation period, followed by 10 days warming at 7.5°C before shipping [T1] in some of the seasons. In 2017, with African Rose, Sapphire, Laetitia and Ruby Sun the quality was best maintained by applying SmartFresh℠ during the accumulation period, followed by no warming before shipping.

Conclusion and Discussion

The results obtained over the three seasons and the extension project gave a good indication of the protocols that need to be followed to ensure good quality maintenance of different export plum cultivars. Each additional cultivar needs to be tested to ensure it can handle the cold-sterilization conditions without negative effects on quality after cold storage and shelf life.

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