ANNUAL REPORT

15 - 16

HORTGRO science
Growing Fruit IQ

The Technology Collective

Our purpose is to direct and guide research to address short and long term needs of the deciduous fruit industry.

CONTENT

CHAIRMAN'S REPORT

Stephen Rabe

PROFILE

Stephen is the Director of Agri Services at Fruitways. He also fulfils a role as chairperson of the HORTGRO Science advisory council.

- *Communication*
- *5 Initiatives*
- *Climate change*
- *Drought*

PLEASE READ THIS!

Hopefully the additional prompt in the heading will get more to read the content of my Chairman's report as we have made a concerted effort to focus on communication and I am proud of the content being generated from within HORTGRO Science and I will try to do my part in promoting this effort. If you would like an example of this please refer to the 2016 Technical symposium summary report, visit - *http://bit.ly/28Q6duo* in which a concise executive "gumboot "summary has been made of the presentations.

To ensure we maintain the focus of the Advisory committee as well as operational management on carrying through on our strategic initiatives we have allocated committee members as custodians for the various initiatives and they are responsible to interact with management and report back at meetings on progress made, the
5 initiatives together with the custodians are as follows:

1. Industry Future Vision – Louis von Broembsen and Linde du Toit
2. Long Term Research Strategy – Charl Stander and Matthew English
3. Communication Strategy – Stephen Rabe and Louis von Broembsen
4. Funding Strategy – William Myburgh and Joseph Hendricks
5. Operational Excellence Strategy – G Smuts.

If any member would like to contribute or add to the content of these initiatives, please contact a committee member to take the conversation further.

The year 2016 will be remembered by the drought that persisted across all regions of our industry and I am afraid the consequence of this will still be felt in certain areas for at least 2 years. This has prompted the research community to pay attention to the impact of climate change on the way we manage our resources going forward.
A project titled: "Quantifying water use of high performing commercial apple orchards in the winter rainfall area of South Africa" has been initiated in conjunction with the Water Research Commission (WRC). This is a critical project that focuses on water productivity – making every drop count, and will have an impact on water allocation.

I will not go into too much detail as the report following this will contain all the relevant research information and we are conscious of the following quote by Winston Churchill, "This report, by its very length, defends itself against the risk of being read." To mitigate this risk I propose you choose one of the programs; crop protection, crop production or post-harvest and focus on this to get the value captured in the various reports.

Last but not least I would like to thank all who participate and give of their time and knowledge in ensuring we remain focussed on the needs of the levy payers. To HORTGRO Science management, on behalf of all producers, our heartfelt thanks for the commitment and passion displayed by Hugh and his team.

"It is through the foresight of my predecessors that Stellenbosch University is in this unique position as they have always strived to maintain a strong department with close interaction with the industries it serves. It is important to maintain this interaction as the four year academic programme trains students for a professional career and the training therefore needs to be very relevant to industry. The biggest danger for an academic department is to lose senior academic staff as it takes time for younger academics to find their feet in both academia and industry. Careful succession planning is therefore important. Also the pressure from the University is towards academic output and academics are not rewarded for working closely with industry on industry related problems."

Prof Karen Theron
Chair in Applied Pre-Harvest Deciduous Fruit Research at Stellenbosch University

HORTGRO SCIENCE - THE PROCESS

GENERAL MANAGER'S REPORT

Hugh Campbell

PROFILE

Hugh is the General Manager of HORTGRO Science and also sits on various boards within the deciduous fruit industry.

- *Cultivar acquisition strategies*
- *Science communications*
- *HORTGRO Science Tech Book*
- *Network of experts*

INTRODUCTION

2015/16 is a year where a number of strategic changes were introduced. A cultivar acquisition strategy was crafted to relook at the way we secure new cultivars for the stone and pome fruit industries. This process has catalysed a relook at the breeding programme that is funded by the industry at the ARC. All breeding projects were terminated at the end of March 2016 and interim budgets were accepted for the period 1 April 2016 to end March 2017. From 2017, selected programmes will be initiated to address the key gaps that have been identified. Part of the strategy talks to the introduction of an independent cultivar evaluation scheme which has as its primary objective the thorough evaluation of local and imported cultivars in order to minimize the risk to growers. Rootstocks will also be evaluated under the independent evaluation scheme. HORTGRO Science made a shift a few years ago when it appointed a communications specialist, Elise-Marie Steenkamp to head up our communication programme. As noted in the communications report, this aspect has grown to a HORTGRO level, so we have stretched our tent pegs and further strengthened the communications team. We are continually challenged to create and service platforms that adequately meet the practical requirements of our different target audiences bearing in mind that our key focus is on the grower. A welcomed addition to this annual report is the HORTGRO Science Tech book which is a compendium of the technical publications published in 2015. Please spend some time reviewing each programme that is reported on. The executive summary of each project will give you an overview of the projects that are being funded.

The purpose of HORTGRO Science is: "To generate and transfer the knowledge, technology and practices required to mitigate, avoid or overcome threats/risks, and to exploit opportunities, that impact the on-going economic sustainability of South African pome and stone producers while ensuring the development and retention of skills."

We would be amiss if we did not thank the network of over 200 experts who contribute to the research process. Researchers, technical advisors, technical experts, growers and many more who give up many hours to contribute to the overall technical and research aspects that are dealt with within HORTGRO Science. Over 100 research projects are reviewed by peer work group members and technical advisory committees. In addition, we get hugely valuable inputs from the participants of our 30 odd workgroups, each focusing on a different aspect but contributing to the greater whole. Thank you.

PERSONNEL/MANAGEMENT

HORTGRO Science was saddened to lose the extensive expertise of Dr Mariana Jooste. Mariana has made a considerable contribution to the area of post-harvest research – particularly on stone fruit.

Dr Juanita Heunis, who worked alongside Dr Ken Pringle for many years in the Department of Conservation Ecology and Entomology at Stellenbosch University, has emigrated to

Australia. We wish both well in their future endeavours.

The staff of HORTGRO Science are anticipating their pending move to upgraded offices at Welgevallen - Stellenbosch Universities Department of AgriSciences experimental farm. An office hub has been created to accommodate agricultural industries who work with the university.

Personnel of HORGRO Science:

- **Hugh Campbell** – General Manager
- **Richard Hurndall** - Research and Technology Manager & Programme Manager: Post-Harvest
- **Prof Wiehann Steyn** – Programme Manager: Crop Production (Extraordinary Associate Professor in the Department of Horticultural Science, Stellenbosch University)
- **Matthew Addison** – Programme Manager: Crop Protection (based at the Department of Conservation Ecology and Entomology, Stellenbosch University)
- **Elise-Marie Steenkamp** – Group Communications Manager. A Communications Department was created within HORTGRO with Elise-Marie's moving to run the department. A portion of her time is allocated back to HORTGRO Science.
- **Dane McDonald** – Science Communications Specialist.
- **Theresa Sonnenberg** – Research Administrator.
- **Dr Xolani Siboza** – Regional Fruit Production Researcher.
- **Dr Daleen Stenekamp** – Applied Researcher: Crop Protection positioned at Stellenbosch University
- **Terence Asia** – Technical Assistant: Crop Protection positioned at Stellenbosch University

The 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

Fruit Research at the Department of Horticultural Science, Stellenbosch University:

Prof Karen Theron

Contract positions funded through research projects:

Laura Allderman – Dormancy projects

Dr Marelize De Villiers – FCM projects

The research process is managed on a programme as follows:

1. **Genetic optimisation (Breeding):** Ken Tobutt from the ARC leads the stone and pome fruit breeding and evaluation programme. Strategic direction for this programme is provided by the Fruit Route Advisory Committee.
2. **Sustainable farming:** Crop Production – Prof Wiehann Steyn. Crop Protection – Matthew Addison.
3. **Product integrity (Post-Harvest)** – Richard Hurndall.
4. **Market Alignment and a Sustainable Supply Chain** - Lindi Benic, in her capacity as HORTGRO Manager of Trade and Market Access, leads the market alignment programme.
5. **Communications programme** - Elise-Marie Steenkamp.

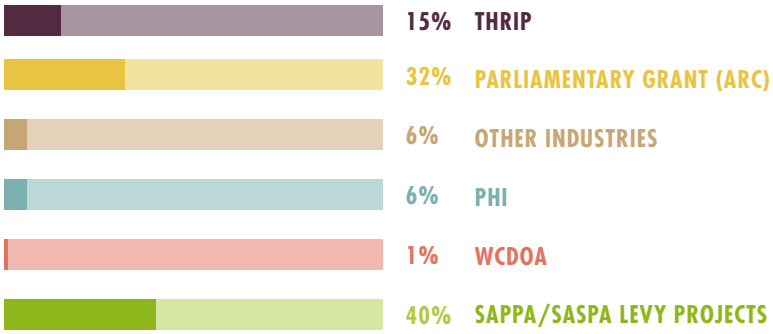
RESEARCH PROJECTS / FUNDING

Funding, along with people (capacity) and infrastructure are the critical elements of a successful research programme. Funding is a limiting factor in the smaller industries like peaches and nectarines where there is very little funding available for research projects as the breeding programme takes up 53% of the project funding. HORTGRO Science receives its primary funding from the grower levy from SAAPPA and SASPA. 54% of the standard levy for pome fruit and 55% of the stone fruit levy is channelled to research and development. The following is a list of the primary funding resource of HORTGRO Science:

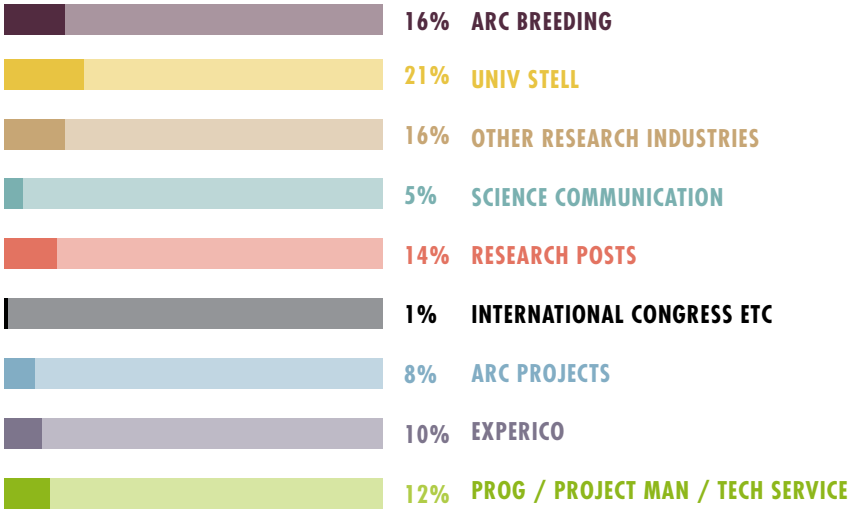
- SAAPPA & SASPA levy funds (39% of funds)
- Parliamentary Grant (32% of funding) - channelled through the ARC from the Department of Agriculture, Forestry and Fisheries (DAFF). All projects at the ARC are co-funded;
- The Post-Harvest Innovation Fund (PHI) (6% of funding). This fund is part of the sector innovation fund, one of the funding programmes at the Department of Science and Technology (DST). PHI focuses on post-harvest research within the fruit and vegetable industries. This funding cycle ends at the end of December 2016;
- National Research Fund (NRF) is funded through DST and provides bursaries;
- Technology and Human Resources for Industry Programme (THRIP) funding (15% of the funding) – this is a Department of Trade and Industry (DTI) initiative focused on the training of students. The DTI has changed the rules and management of THRIP funding. Previously the universities and research institution applied to THRIP for funds. This has changed and the industry is now required to make the application. In addition, the focus of the new THRIP is on agroprocessing only which could affect the type of projects that we would be able to present to THRIP for funding;
- Western Cape Department of Agriculture (WCDA) (1% of funding). WCDA are the primary funders of the Confronting Climate Change Initiative. The wine, table grape and citrus industries are co-funders of this project.
- International Atomic Energy Agency (IAEA). The focus of the IAEA is on the utilisation of sterile insect release for the control of key pests and related research.
- Other industries (6% of funds). A number of projects are co-funded by other industries (mostly pome fruit, stone fruit, dried fruit, canning fruit, as well as the table grape, citrus and wine industry).

Figure 1 on the following page indicates the funding leverage for pome and stone fruit. For every R1 of industry funding (levy) invested in a project, R1,56 is leveraged from alternative funding sources.

FUNDING LEVERAGE 2015/16 - FIG 1



FUNDING ALLOCATIONS 2015/16 - FIG 2



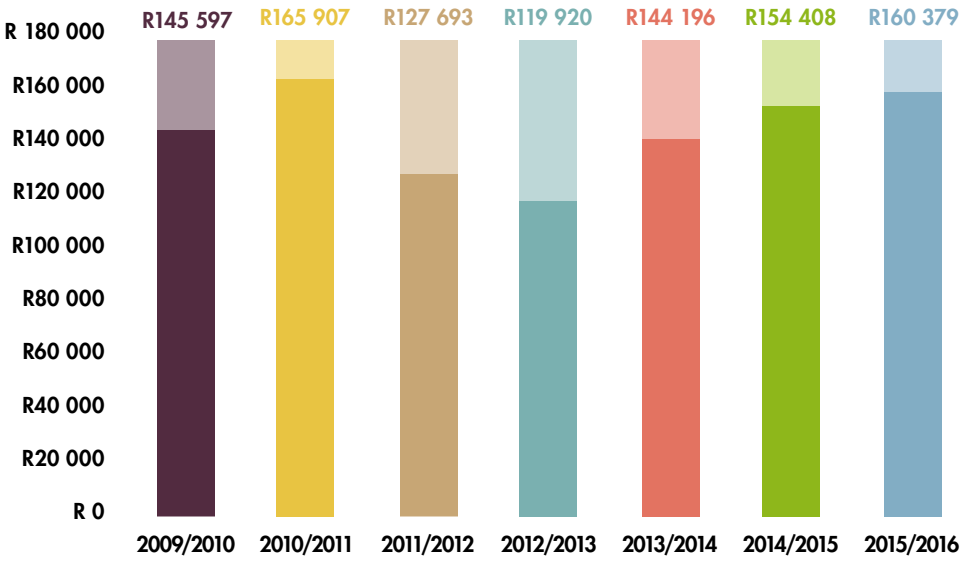
2015/16 RESEARCH PROJECTS PER RESEARCH INSTITUTION - TABLE 1

The following table gives an overview of the research institutions utilised in 2015/16

RESEARCH INSTITUTE	PROJECTS 2015/16	PROJECTS 2014/15	PROJECTS 2013/14	PROJECTS 2012/13
ARC Infruitec-Nietvoorbij	**29**	**30**	**36**	**36**
ARC Breeding	20	21	21	21
ARC Research Projects	09	09	15	15
Stellenbosch University	**33**	**34**	**39**	**38**
US – Horticulture	12	14	16	15
US – Pathology	5	5	5	5
US – Entomology	14	14	18	18
US – Engineering	1	1		
US – Soil Science	1			
HORTGRO Science Technical Services	**18**	**15**	**20**	**20**
ExperiCo	**18**	**19**	**16**	**15**
CA Science		**1**	**1**	**1**
Nemlab	**2**	**1**	**1**	**1**
Blue North	**1**	**1**	**1**	**1**
University of Pretoria	**2**	**2**	**1**	**1**
UP – Zoology	1	1	1	1
UP - Soil Science	1	1		
CSIR	**1**	**1**	**1**	**1**
Westcape Biotech	**1**	**1**		
Consultants	**4**	**5**		
C Jarmain		1		
P Stassen	3	3		
K Bouwer	1	1		
TOTAL	**109**	**110**	**116**	**114**

2009-2015 AVERAGE PROJECT COST PER NEW PROJECT YEAR - FIGURE 3

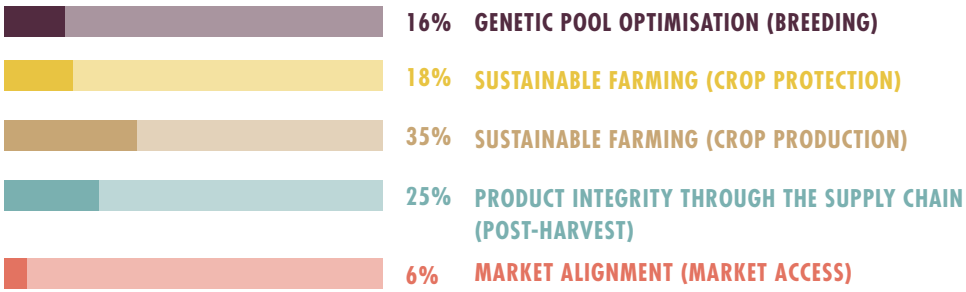
The average cost per project went up in 2015/16 by 4%. These figures must be viewed with caution as the reasons for a project cost increase are multiple.



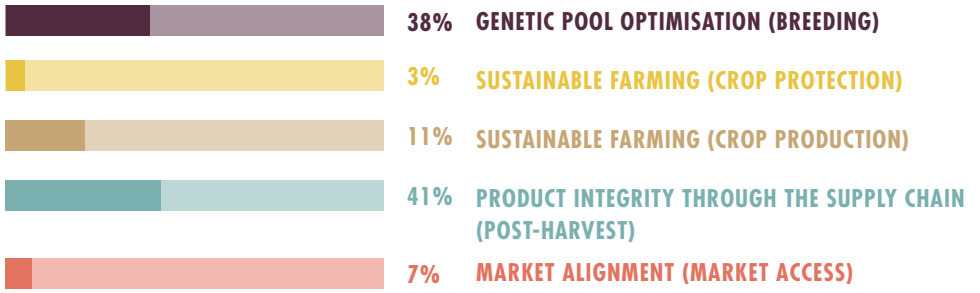
Funding allocation per research investment focus area:

The following graphs give a representation of the funding allocation per programme.

POME
2015/16 INVESTMENT PER RESEARCH INVESTMENT FOCUS AREA - FIG 4



STONE
2015/16 INVESTMENT PER RESEARCH INVESTMENT FOCUS AREA - FIG 5



Each research investment area or research programme is discussed in more detail within this report. Please refer to the relevant chapter of this report for a summary of each research project funded during the 2015/16 financial year.

RESEARCH CAPACITY AND TRANSFORMATION

There is a great need in the industry to develop well rounded technical people who can serve in different technical positions across the specialist field of crop protection, soil science and horticulture. During this past year we have experienced lot of movement within the technical field. It is equally important to ensure that we develop the next generation of researchers. It must be emphasised that it is critical that we retain and grow the different departments of agriculture within our universities as we will not be able to produce the right quality of graduates if we do not have the skilled scientists and lecturers in place. Currently 44% of the research projects have a female as the project leader (down from 53% last year) and 22% of the projects have a black project leader, similar to last year. What is encouraging is that 34% of our projects involve the training of students at post-graduate level and as noted below, 41 post-graduate students are currently registered on HORTGRO Science projects. 49% of our post-graduate students are black. We are encouraged by these figures and are looking forward to seeing these post-graduate students landing in industry in different positions. A new initiative was launched this year with the Deciduous Fruit Development Chamber (DFDC) whereby a specific day focusing on the emerging grower was introduced into the HORTGRO Science Technical symposium. The symposium was also expanded into a 5 day event. The Western Cape Department of Agriculture was instrumental in the process and also assisted in funding the costs of all the emerging growers from the Western Cape to attend the symposium. What is encouraging is that 20% of the total participants who attend the symposium were emerging growers. Emerging growers from Mpumalanga, Free State and the Eastern Cape also attended the symposium. Funds were made available by HORTGRO and HORTGRO Science to fund

these growers. This initiative will be developed further in 2017. An exciting new APP has been developed with funding from HORTGRO Science and the Post-Harvest Innovation Fund (PHI). This user-friendly APP focuses on the post-harvest aspect of stone fruit and will become an important resource to all growers and anyone involved in the supply chain. 41 post-graduate students are funded through bursaries supplied by research projects. During the reporting year, PHI funded a number of bursaries on projects related to post-harvest. The full value of these bursaries amount to R3 967273.This excludes specific bursaries funded through HORTGRO that focus more on undergraduate students.

OVERSEAS VISITS AND INTERNATIONAL SYMPOSIUM / EVENTS

HORTGRO Science supported a number of international visits and funded or co-funded a number of visits and events in South Africa that created greater exposure to our researchers, technical community and growers.

- **April 2016:** The 3rd International Symposium Fruit Fly (TEAM) - Tephritid Workers of Europe, Africa and the Middle East took place in Stellenbosch. International and local researchers took part in this symposium. There was good attendance by the local technical fraternity. HORTGRO Science was a co-sponsor of this event.
- **May 2016:** Prof Wiehann Steyn (HORTGRO Science) and Prof Karen Theron (Chair in pre-harvest applied deciduous fruit research at Stellenbosch University) were invited by IRTA (Research and Technology, Food and Agriculture) in Barcelona, Spain to visit their research facilities and meet with numerous researchers and commercial entities in Spain. Funded by external funds.
- **June 2016:** The ISHS VIII International Post-Harvest Symposium in Spain was attended by Richard Hurndall and Dr Ian Crouch (prize for being Researcher of the Year 2014).
- **July 2016:** Sonwabo Booi, Stone fruit rootstock breeder at the ARC visit to Dr Michael McKenry (Nematologist) at Kearney Agricultural Research and Extension Centre, California, USA was partly sponsored by HORTGRO Science.
- **August 2016:** HORTGRO Science funded a one week visit of Marc Trapman from Germany and an expert on RIMpro, an apple scab management system. Work sessions and site visits were held with the researchers involved in the project on 'Evaluating an ascospore release forecasting model and orchard disease monitoring methods for improving apple scab management'. Workshops were held with the technical industry along with growers.
- **September 2016:** The ISHS XI Orchard Systems 2016 International Symposium held in Bologna. A strong contingent of South Africans attended this event that was held in South Africa four years ago.

POST GRADUATE STUDENTS WORKING ON PROJECTS FUNDED BY SAAPPA / SASPA - TABLE 2: STUDENTS IN 2015-16

POST - GRADUATE STUDENTS	MSc	PhD	POSTDoc	TOTAL
White Male	4	4		8
White Female	6	5	2	13
Black Male	4	10	2	16
Black Female	1	3		4
TOTAL	15	22	4	41

AWARDS

The following awards were made during the 2015/16 year. HORTGRO Science would like to congratulate the award winners.

HORTGRO SCIENCE BEST FINAL REPORT 2015

Awarded to Elke Crouch Project: "The influence of cell number and size (indirectly cell division) and cell wall bound and free Ca2+ on the development of 'Forelle' pear. As well as the evaluation of NIR as an early detection method for mealines"

HORTGRO SCIENCE BEST POPULAR ARTICLE 2015

Awarded to Saskia von Diest, Cheryl Lennox and William MacHardy
Article "Shredding leaves in autumn lowers apple scab levels in the next season"
Published in the June/July 2015 issue of SAFJ.

HORTGRO SCIENCE BEST VISUAL COMMUNICATION (PHOTOGRAPHY) 2015

Awarded shared by Adriaan Theron and Imke Kritzinger

HORTGRO SCIENCE BEST VISUAL COMMUNICATION AWARD (VIDEO) 2015

Awarded to Caro Kapp

DECIDUOUS FRUIT INDUSTRY INNOVATION AWARD 2016

Awarded to Prof Piet Stassen

HORTGRO SCIENCE/PROF DAAN STRYDOM STUDENT AWARD 2016 FOR TOP 4TH YEAR HORTICULTURAL SCIENCE STUDENT IN 2015

Awarded to Trevan Flynn

ENVIROPAEDIA ECO-LOGIC AWARDS

Bronze Award in the category Climate Change (sponsored by the Department of Environmental Affairs) awarded to the Confronting Climate Change Initiative

HORTGRO SCIENCE TIMELINE

OCT 2015

1. Pathology Peer Work Group (PWG) meets 2. Entomology PWG meets 3. Soil Science and Horticulture PWG meets 4. AFB meeting with Alan Winde 5. Forelle Producers Association meeting 6. Post-Harvest PWG

NOV 2015

1. Packhouse Action Group meeting 2. Post-Harvest Technical Advisory Committee meeting (TAC) 3. Researcher Thank-You Breakfast at Mont Marie in Stellenbosch 4. HORTGRO Science Advisory Council 5. Crop Production TAC 6. CA and Post-Harvest Group meeting 7. SA Pink Lady Association meeting

DEC 2015

1. Langkloof Seminar & Field day 2. Project Rebirth of National Fresh Produce Markets Steering Committee meeting Pretoria 3. Crop Protection TAC 4. Meet with Western Cape Dept of Agric Research Director 5. CPAG (Crop Protection Advisory Group) 6. SAFJ Strategy session 7. Stone Fruit Tree Die-back Workshop Simondium

JAN 2016

1. Pome Fruit Joint Market Forum (JMF) 2. Stone Fruit JMF 3. Dormancy Workgroup 4. Scoping of Independent Evaluation of Cultivars 5. Stone & Pome fruit training meeting 6. Meeting of the Noordelike steenvrug studiegroep

FEB 2016

1. Orchard of the Future workgroup 2. Stone fruit JMF 3. Irrigation and Nutrition workgroup 4. Pome Fruit JMF 5. Soil Health Workgroup 6. Rootstock Evaluation Committee meeting 7. Rootstock and Nursery Tree workgroup 8. Stone Fruit JMF 9. National Markets visit - Jhb, Pretoria, Durban

1. Packhouse Action Group meeting 2. Stone Fruit JMF 3. Postharvest PWG and TAC 4. Pome fruit JMF 5. Project Rebirth of National Fresh Produce Markets Steering Committee meeting Pretoria 6. Oak Valley OoF Orchard walk

MAR 2016

APR 2016

1. Stone Fruit JMF 2. IPM meeting 3. Fruitfly symposium TEAM 2016 Stellenbosch 4. Green Economy - Pome fruit 5. FCM Task Group 6. Chair in Deciduous Fruit pre harvest research - review

1. Pome Fruit Joint Market Forum (JMF) 2. Stone Fruit JMF 3. Dormancy Workgroup 4. Scoping of Independent Evaluation of Cultivars 5. Stone & Pome fruit training meeting 6. Meeting of the Noordelike steenvrug studiegroep

MAY 2016

JUN 2016

1. HORTGRO Science Technical Symposium 2. Pome Fruit JMF 3. Richard Hurndall attends ISHS Postharvest Symposium in Spain 4. DAFF Special programme at ARC 5. CA Tour Elgin 6. Western Cape Drought Dialogue meeting 7. DAFF Pretoria

1. Postharvest PWG 2. Postharvest TAC 3. Pathology PWG 4. Entomology PWG 5. 6th International Biofumigation Symposium in Stellenbosch 6. Crop Protection TAC 7. Soil Science and Horticulture PWGs 8. Crop Production TAC

JUL 2016

AUG 2016

1. PAG meeting 2. Free State Apple Symposium 3. HORTGRO Science Advisory Council Meeting 4. Confronting Climate Change Steering Committee 5. Marc Trapman visit: RimPro and fusi management

1. Prophyta Short Course 2. TTAC Meeting 3. IPM Meeting 4. Apple Replant mini-symposium 5. Cover Crop Field day 6. Soil health workshop with international partners 7. H Campbell, K Theron, W Steyn, and X Sibosa visist breeding programmes, nurseries and plant improvent organisations in Belgium and The Netherlands

SEP 2016

COMMUNICATIONS

Elise-Marie Steenkamp

PROFILE

Group communications manager at HORTGRO.

Grower needs

New projects

South African Fruit Journal

Online media

"You don't really understand something unless you can explain it to your grandmother." - Albert Einstein

HORTGRO Science's communication programme has undergone another major shift this year, when it merged with HORTGRO's Communications Department. To this end, Dane McDonald, joined the Stellenbosch team in April 2016 as the resident science communicator. HORTGRO's communications team now has more capacity and better skill sets than ever before. In terms of communicating science our strategy and goals stayed the same. We remain focused on the needs of our growers, thereby producing quality content, timeous dissemination, and the integration of information on various platforms. In order to keep up with the latest developments in the field and whenever an opportunity arises, we make it a priority to attend science communication workshops, seminars and round tables. New projects this year were:

- A monthly newsletter which was well received within our community. The media spin-offs we have had from the newsletter had high value in terms of Public Relations (PR).
- In March Stone Fruit Growers asked for a resurrection of the Timely Hints fact file. To this end we engaged with various experts and our first TH edition 'hit' our growers in August this year. So far the feedback has been positive.
- In an attempt to address the continuing challenges with the South African Fruit Journal (SAFJ), we have initiated a HORTGRO Science Tech Book, which will be available with the Annual Report. The first Tech Book will be a compilation of all the technical and science-related articles that were published in 2015. A similar edition will be made available for the 2016 articles.
- Designed a rootstock evaluation pamphlet.
- FruitLook collaboration: 6 part series with infographics.
- The development of a post-harvest stone fruit APP is also on track and our launch date is in the first quarter of 2017.

Sharing a magazine with other industry partners is never easy - therefore the SAFJ remains a challenge. We focused on producing what is within our control; quality content, with a high-standard of visual aid. The HORTGRO Science website is our 'shop window' to the world. Our news items are presented on the opening page, we have different research sections, and an archive where SAFJ articles dating back to 2010 can be found. For HORTGRO Science events we have an online registration system with a self-generating invoice-system as well as an e-commerce option, enabling registrants to pay-online. The Facebook page has seen 'organic' growth of more than 100% over the past year. At the time of writing we have 477 likes, with 61% of fans being male and 37% female. Our fan base stretches from Malaysia, India, Saudi Arabia, UK to the USA. About 28% of our fans are between 25 – 34 years of age. In the past year we also uploaded a total of 35 videos onto YouTube. The three most viewed slots

NEWSPAPER & BROCHURE

IPHONE & TABLET

WEB

SOCIAL MEDIA

were:

- Pruning – Apricot Trees (860 views)
- Orchard Management – Weed control (344 views)
- Pruning – Plum Trees (140 views)

The HORTGRO Science Technical Symposium 2016 mushroomed into a five day event, with the first day focusing specifically on the needs of New Growers. Also new to the symposium was the Post-Harvest Day. Overall the symposium was a tremendous success, as was attested by the record attendance figures over the five days and the positive feedback we received. Media thought leader, Max du Preez, opened the symposium. Our three international guest speakers were, Dr Walter Guerra, head of the Pomology Department at Laimburg Research Centre in South-Tyrol, and Professor Prof Elias Fereres of the Department of Plant Production at the University of Cordoba, Spain, and Prof Michael Reid, UC Davis, USA.

We also hosted a Crop Production Seminar in the Langkloof in December 2015, as well as a Cover Crop Information Day in September 2016 at Vyeboom, a False Codling Moth Seminar, we facilitated an Apple Replant Disease mini-symposium, and hosted a Packhouse Action Group workshop.

A total of 13 Fresh Notes were sent out during the past year, addressing industry challenges like heat damage, drought conditions, internal browning, irrigation principles and Maximum Residue Limit (MRL) notifications. HORTGRO Science also released 6 press releases to the general media. All the stories were picked up by national and international media groupings.

BREEDING AND EVALUATION

The ARC's Breeding & Evaluation programmes for apples, pears, apricots, peaches and plums that are partly funded by industry pay particular attention to adaptability to warm winters and resistance to pests and diseases, as well as to yield and fruit quality, in the case of scion cultivars, and to ease of propagation and orchard performance, in the case of rootstocks. Progress is reviewed each winter by Culdevco, ARC's licensee, and in the spring by the Fruit Route Steering Group. And promising Phase 2 selections are displayed at periodic Fruit Exhibitions held at the Infruitec campus.

ARC INFRUITEC-NIETVOORBIJ

Ken Tobutt

PROFILE

Ken is a specialist researcher in Crop Development at the Agricultural Research Council.

- *Genetic studies*
- *Reskilling and training*
- *Student progress*
- *Programme sustainibility*

Progress in the various breeding and evaluation projects to develop tree-fruit cultivars for the South African industry is summarized in the following abstracts (and readers are welcome to contact project leaders for more information). Rather than review these here, I want to mention some of the ancillary and complementary work that is being undertaken and also some other 'context'.

Once more, the THRIP project allowed progress in the area of molecular genetics which increasingly underpins modern breeding programmes with student inputs funded variously by HORTGRO Science, ARC-PDP, NRF-PDP and THRIP. Microsatellites were used to check germplasm accessions for trueness to name and to tag several interesting traits in pear and to start similar work in apple. And known function gene markers were designed or optimised to genotype accessions or, potentially, seedlings with respect to e.g. cling-stone vs freestone in peach, incompatibility in plum and apricot, or high versus low fruit acidity in apple. However, NRF has currently suspended THRIP funding which is of great concern as it impinges not only on our efforts to develop marker-assisted breeding but also on the training of students.

Staff member Trevor Koopman completed his PhD studies on apple scab and defended his PhD thesis in October 2016. And training of students continued. Solomon Nladi should soon complete his PhD thesis on pear mapping and Lawrence Kwalimba and Thembeka Nyawo their MSc theses on fingerprinting and characterising the stone-fruit germplasm collections. Zama Mbulawa is continuing her PhD and Khethani Mhelembe commenced his, both on mapping and understanding traits in apple. The collaborations with the Stellenbosch University Departments of Plant Pathology, Genetics and Horticultural Sciences, which provide the co-supervisors, are invaluable.

A highlight was the invitation extended to Taaibos Human to speak in Turkey on pear breeding in May 2016. Sonwabo Booi secured KIC funding to visit the USA to enhance his knowledge of nematode resistance in October 2016.

Two new policies announced by HORTGRO Science, representing SAAPPA and SASPA, are already affecting the Phase 1 and Phase 2 breeding programmes. From next year, Phase 2 & 3 will be planted on commercial farms and the recording of the trials managed by a private company paid by ARC and Culdevco as the IP holders. And the Phase 1 seedling blocks will be managed and planted by commercial entities though the breeding and selection – for a refocused set of objectives – will still be the responsibility of the ARC breeders. Furthermore, the contract between ARC and Culdevco is due for renewal or termination. It will be interesting to see how matters work out. As ever, we thank the industries for their financial support – and also for their provision of plant material, information and advice.

BREEDING AND EVALUATION

Project List

FINAL PROJECT REPORTS

Concluded in 2016

APPLE, PEAR, PLUM, PEACH, APRICOT
K TOBUTT - Three studentships to apply molecular markers to the pome-fruit and stone-fruit breeding programmes.

APPLE
T KOOPMAN - Determination of apple scab races occurring in South African apple growing regions to underpin breeding for resistance.

FINAL PROJECT REPORTS

All conducted at ARC Infruitec-Nietvoorbij

APPLE
J KRIEL - Breeding high quality disease resistant apples for first and second economies.

PEAR
T HUMAN - Breeding of pear cultivars.

PEACH
W PIETERSE - Breeding of peaches and nectarines for commercial and emerging farmers.

PLUM, PEACH, APRICOT
S BOOI - Breeding of new peach rootstocks.

PLUM
C HÖRSTMANN* - Breeding of Japanese plums for commercial and emerging farmers.

APRICOT
C HÖRSTMANN* - Breeding of apricot cultivars for commercial and emerging farmers.

APPLE
K SOEKER - Phase II evaluation of apple cultivars.

PEAR
K SOEKER - Phase II evaluation of pears in the Western Cape

PEACH
C SMITH - Phase 2 evaluations of peach and nectarine cultivars in the Winter rainfall region.

PLUM
C SMITH - Phase 2 evaluations of plum cultivars in the Winter rainfall region.

APRICOT
C SMITH - Phase 2 evaluations of apricot cultivars in the Winter rainfall region.

PLUM, PEACH, APRICOT
I MEINTJIES - Evaluation of stone fruit in the Summer rainfall area.

APPLE, PEAR, PLUM, PEACH, APRICOT
W PIETERSE - Planting and maintenance of germplasm of pome fruit, stone fruit and alternative deciduous fruit crops

PLUM
J DE KLERK † & C SMITH - Determination of cross pollinators for plum varieties.

PLUM, PEACH, APRICOT
S BOOI - Evaluation of newly bred stone fruit rootstock hybrids.

APPLE, PEAR, PLUM, PEACH, APRICOT
E LOTZ - Cold storage characteristics of new cultivars and selections.

*Carl Horstmann left in August 2016 and plum and apricot breeding will be managed by Werner Pieterse until the new project leader is appointed.
† Jannie de Klerk passed away in February 2016.

BREEDING HIGH QUALITY DISEASE RESISTANT APPLES FOR FIRST AND SECOND ECONOMIES

J Kriel

Objectives & Rationale
ARC Infruitec-Nietvoorbij's apple breeding programme aims to provide South African growers with a range of cultivars that are easy to grow and easy to sell on the home market and overseas, i.e. that are well adapted, reliably cropping, and disease-resistant with excellent appearance and eating quality and good storage ability.

Methods
The breeding involves maintaining gene-banks, hybridizing parents with desirable traits, screening and selecting Phase 1 seedlings from large populations and promoting the best to Phase 2 – and is underpinned by appropriate complementary genetic studies and student training.

Key Results
Budwood of thirteen selections from Phase 1 orchards at Drostersnes short-listed in 2015 was provided to SAPO to raise trees for Phase 2. Nearly 3,500 seedlings in Phase 1 were assessed for crop, visual appeal, and season and seven were harvested for assessment of storage performance; only one full red selection was short-listed for promotion to Phase 2. Thirty cross-pollinations were made e.g. to combine fruit quality with lower chilling requirement or to raise progenies for genetic studies e.g. into scab and woolly aphid resistance; about 9,000 of the resulting 15,000 seeds were sown. Based on microsatellite fingerprinting data produced earlier in 2014/15, a dendrogram was generated which indicated that approximately 200 of the ARC Infruitec-Nietvoorbij's pome fruit accessions matched those of the same name at the UK's National Apple Collection at Brogdale, whereas there were discrepancies for about 40 of the ARC accessions and another 70 were not held at Brogdale. Furthermore, the characterisation of apple cultivars with respect to the ACS1 gene involved in ethylene production allowed the breeding programme to choose parents that will yield seedlings homozygous for the recessive allele associated with long storage. Two students are continuing with their Ph.D. studies.

Conclusion / Discussion
The refocusing of the programme is continuing and particular attention needs to be paid to the enhancement of the genebanks and the application of molecular markers.

BREEDING OF PEAR CULTIVARS

T Human

Objectives & Rationale
The aim of this project is to provide the South African pear industry with new, locally adapted cultivars especially with blushed skin.

Methods
The project uses conventional breeding techniques to generate genetic variation, establish these seedlings in evaluation blocks and, once they start bearing, select the best selections for further evaluation in Phase 2.

Key Results
Budwood of 13 Phase 1 selections and one Inter-Phase selection promoted for further evaluation the previous year were supplied to SAPO. Seventeen new selections were selected in Phase 1 orchards at Drostersnes. Small fruit samples of each selection were harvested, cold stored for eight weeks and evaluated. One selection was earmarked by Culdevco for further evaluation and all the other selections were discarded. This best selection, P16-16, had blushed fruit, harvested on 2 March, with good appearance and attractive colour, good texture and taste, scoring 20/30. Cross pollinations produced 2 083 seeds, comprising 73% for blush, 0.1% for green and 26% for future genetic studies. About 2 792 seedlings generated last year will be kept in plastic bags under shade netting for future plantings. Using seedling progenies at Drostersnes for his study on mapping the blush trait, Solomon Ntladi, a PhD student, is busy completing his thesis for the Stellenbosch University.

Conclusion / Discussion
A total of 17 new selections were initially selected in Phase 1 (nine blush, five green/yellow and three fully red) and, in conjunction with Culdevco, one selection was promoted for further evaluation.

BREEDING OF PEACHES AND NECTARINES FOR COMMERCIAL AND EMERGING FARMERS

W Pieterse

Objectives & 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
Crosses are made and seedlings selected, mostly on the basis of fruit quality.

Key Results
Seven peach and seven nectarine selections identified in 2014 were propagated. The breeding programme is in a transition phase and has experienced trying times and no new selections were made in the period under review. Seeds were collected from two open pollinations and ~ 170 seedlings were raised. Pollen of eight accessions was received from CRA-FRU, Italy and will be used in crosses. The PhD project of Mr Pieterse on the characterisation of stone-fruit genotypes in terms of carotenoid profiles and associated fruit quality traits is ongoing and fruit samples are being analysed with techniques adapted from methods developed by Prof M. Vivier's laboratory.

Conclusion / 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.

BREEDING OF NEW PEACH ROOTSTOCKS FOR THE FIRST AND SECOND ECONOMY

S Booi

Objectives & Rationale
This project aims to provide the South African Stone-Fruit Industry with new, low-chill stone-fruit rootstocks resistant/tolerant to various stresses. The objectives for the current study were to screen for resistance to a combination of ring nematode (*Criconemoide xenoplax*) and root-knot (*Meloidogyne javanica*) under glasshouse conditions and to perform hand cross pollinations.

Methods
In May 2015, cuttings from 16 ARC-bred hybrids and nine commercial rootstock cultivars were rooted for resistance screening trials in 2016 under standard nursery conditions at Bien Donné Research Farm. Eight ARC-bred stone-fruit rootstock selections, mostly plums, peach and interspecies plus six commercial rootstock cultivars were screened for nematode resistance in the Nematode Glasshouse at Bien Donné Research Farm along with a progeny from a controlled cross from Soldonne x Supergold (apricot) with 64 seedlings. Controlled hand pollinations to raise at least 1000 new seedlings for screening were performed.

Key Results
From 16 ARC-bred selections, 457 cuttings were rooted and from nine commercial rootstock cultivars, 267 cuttings were rooted, resulting in a total of 724 cuttings. About 247 rooted cuttings from ARC-bred selections and 140 rooted cuttings from commercial cultivars were recovered. A total of eight ARC-bred selections and six commercial rootstocks were successfully screened for resistance to a combination of ring and root-knot nematodes. A progeny with a total of 68 seedlings was also screened for resistance to both nematodes to select resistant seedlings. Two cross combinations were performed, resulting in 780 flowers pollinated and 340 fruits were harvested from the trees.

Conclusion / Discussion
From the eight ARC-bred selections screened, six were found to be resistant to root-knot nematodes, one tolerant and one susceptible. For ARC-bred rootstock selections and commercial rootstock cultivars inoculated with ring nematodes, very low ring nematode populations were observed in the soil, which suggests that the soil environment or soil temperature around the roots was not suitable for the ring nematode population to increase. This was evident in our positive host rootstock cultivar 'Atlas', which had the lowest average ring nematode counts of all the plants in that screening trial. 'Guardian', the standard commercial rootstock which is known to be tolerant to ring nematodes had the highest average ring nematode counts in the soil.

BREEDING JAPANESE PLUMS FOR COMMERCIAL AND EMERGING FARMERS

C Hörstmann

Objectives & Rationale
This project aims to breed yellow, red, and black Japanese plums to extend the range and season of cultivars, that are easy to grow and sell, supported by staying abreast of the latest developments in breeding and molecular genetics of stone-fruit research.

Methods
Traditional breeding practices and genebank maintenance are complemented by THRIP-funded molecular marker work to fingerprint germplasm and move towards marker-assisted selection.

Key Results
Budwood from the six promising selections of the previous season was collected and provided to SAPO for propagation; however, the poor quality of the budwood available from Bien Donné reduced the success of propagation. Due to the same poor conditions that affected the quality of the budwood, no selections could be made from Phase I confidently during the 2015/2016 season. Hand pollinations and open pollinated sources yielded 1894 embryos. As part of the complementary THRIP project, fingerprinting and S-allele genotyping of the gene bank and certain advanced selections is near to completion. The breeder made several presentations on the plum breeding programme, including to the XI Southern African Plant Breeders Association Symposium.

Conclusion / Discussion
Due to the various constraints experienced during the 2015/2016 season, no progress could be made in evaluating and selecting from Phase I orchards. Several crosses were successfully performed and the seedlings generated according to the breeding objectives of the programme. The THRIP funded research has progressed well and will bring significant benefits to the breeding programme.

BREEDING APRICOT CULTIVARS FOR COMMERCIAL AND EMERGING FARMERS

C Hörstmann

Objectives & Rationale
This project aims to breed yellow and blushed apricots to extend the range and season of cultivars, that are easy to grow and sell, while staying abreast of the latest developments in breeding and molecular genetics of stone-fruit research.

Methods
Traditional breeding practices and genebank maintenance are complemented by THRIP-funded molecular marker work to fingerprint germplasm and move towards marker-assisted selection.

Key Results
Budwood from the 13 promising selections of the previous season was collected and provided to SAPO for propagation; however the poor quality of the budwood available from Bien Donné may impact the success of

propagation for some of the selections. Due to the same poor conditions that affected the quality of the budwood, no selections could be made from Phase I with confidence during the 2015/2016 season. Hand pollinations and open pollinated sources have yielded 1107 embryos. As part of the complementary THRIP project, fingerprinting and S-allele genotyping of the gene bank and certain advanced selections is in the final stages of completion. The breeder made several presentations on the apricot breeding programme at, among others, the XI Southern African Plant Breeders Association Symposium.

Conclusion / Discussion

Due to the many constraints experienced during the 2015/2016 season, no significant progress could be made in evaluating and selecting from Phase I orchards. Several crosses were successfully performed and seedlings were generated according to the breeding objectives of the programme. The THRIP funded research has progressed well and will bring significant benefits to the breeding programme.

PHASE II EVALUATION OF APPLES IN THE WESTERN CAPE

M Soeker

Objectives & 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 market places, 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 33 selections were harvested from Phase 2 orchards at Elgin Experimental Farm and evaluated and tested for cold storage ability at the Post-Harvest Division at ARC Infruitec-Nietvoorbij. Of these, seven stored well, nine showed average storage ability, nine were below average, seven had no storage potential and one needed to be re-evaluated due to decay. The best selections, after quality assessment, from each category were: 4-68-34, striped, 57%; 4-63-66R, bi-colour, 79%; 4-13-23R, full red, 72% and 4-61-35, low chill, 81%. Fifty-eight ARC bred selections were identified for removal after the 2016 season, as they had been evaluated for four years but were not good enough to be promoted to Phase 3. Twelve new selections were planted at Elgin in September 2015. Design and optimisation of Malic acid markers are underway and are yielding promising results. Once they are fully optimised, most promising Phase 2 selections as well as the germplasm will be genotyped.

Conclusion / Discussion

Feedback from industry contacts during orchard walks and exhibitions identified selections to be closely watched in the coming seasons. Selection 4-57-69 has been fast tracked and trees have been propagated for planting later this year. Industry consultants also provided valuable information on orchard management practices which are being implemented to improve the overall productivity of Elgin Research Farm.

PHASE II EVALUATION OF PEARS IN THE WESTERN CAPE

M Soeker

Objectives & 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 56 selections and cultivars were harvested from Phase II plots and evaluated and tested for cold storage ability at the Post-Harvest Division at ARC-Infruitec Nietvoorbij after eight weeks in cold storage. Of these, 13 selections stored well, 28 did not store well, four were below average, seven were average and 4 need to be re-evaluated. The best selections for each of the product types were as follows: P07-3, blush, scoring 84% for consumer traits; P05-12, full red, scoring 73%; P07-28, green, scoring 69%; and P05-17, green/yellow, 74%. Thirteen selections were sent for canning during the season, none of which made it to final evaluation. Three selections made it to the final drying evaluation, and P06-4 scored 75% with good drying ability. Thirty entries scored low marks (<60%) in the past season during quality assessments of fresh produce and, after comparison of evaluation data of the last five years, 15 of these will be discarded. Twenty new Phase 2 selections were planted at Elgin Experimental Farm in 2015.

Conclusion / Discussion

Feedback from industry contacts during orchard walks and exhibitions has been very informative and early input on new pear selections has been positive. P07-3 shows the most promise after three years of evaluation and will be closely monitored in subsequent evaluations. Bud-wood was collected and delivered to SAPO in early 2015 to make 400 trees which will be planted in semi-commercial trials by different growers in 2016.

PHASE 2 EVALUATIONS OF PEACH AND NECTARINE CULTIVARS IN THE WINTER RAINFALL REGION

W Smith

Objectives & Rationale

The project evaluates locally-bred ARC 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 2015 to February 2016 at Bien Donné and Robertson Research Farms. No selections were added to the evaluation site on Uitkomst, a commercial farm in Ceres, due to down scaling on the farm. 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
Nine peach and ten nectarine selections scored ≥80% (cut-off point) in the cold storage evaluation. One 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 96 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. Continuous support was given to the second economy projects in the Crop Development Division.

Conclusion / Discussion
Post-harvest and horticultural evaluations as well as the fruit exhibitions will continue in 2016/17. 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 Donné and Robertson Research Farms. Approximately 377 peach and nectarine selections have been identified for removal during the winter of 2016.

PHASE 2 EVALUATIONS OF PLUM CULTIVARS IN THE WINTER RAINFALL REGION

C Smith

Objectives & 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 2015 to February 2016 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 data base.

Key Results
Four red skin and no yellow skin selections scored ≥80% (cut-off point) in either the single or double temperature regimes or both in the cold storage evaluation. Two 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 96 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 / Discussion
Horticultural and post-harvest evaluations as well as the fruit exhibitions will continue in 2016/17, although at a smaller scale because a large numbers of selections have been removed from evaluation due to poor performance. If available, new selections will be planted at the three evaluation sites. Selections not performing well after three years of evaluation will be removed from the evaluation blocks at Bien Donné and Robertson Research Farms. Approximately 67 selections have been identified for removal during the winter of 2016.

Postscript
This report is in honour Mr Jannie de Klerk who passed away on 15th February 2016. Jannie was an integral part of the phase 2 stone fruit Evaluation projects for almost ten years, as well as project leader of the Plum Pollination project, 000206-Y5 – he will be missed by all. May you rest in peace.

PHASE 2 EVALUATIONS OF APRICOT CULTIVARS IN THE WINTER RAINFALL REGION

C Smith

Objectives & 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 2015 to February 2016 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 also collected to evaluate their external and internal traits and the data captured on the MS Access data base.

Key Results
Three selections scored ≥80% (cut-off point) in the cold storage evaluation. None of the selections submitted for canning evaluation scored 70% (cut-off percentage). No selection obtained more than 70% in the drying evaluation. At the request of Culdevco, several promising selections were given special attention regarding their horticultural traits. One fruit exhibition was held at ARC Infruitec-Nietvoorbij and was attended by approximately 61 people from the fruit industry. 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 / Discussion
Post-harvest and horticultural evaluations as well as the fruit exhibitions will continue in 2016/17. If available, new selections will be planted at only two evaluation sites at BD and RB. Selections not performing well after three years of evaluation will be removed from the evaluation blocks at Bien Donné and Robertson Research Farms. The evaluation site at Uitkomst in Ceres will be evaluated for the last time in 2016/17.

EVALUATION OF STONE-FRUIT IN THE SUMMER RAINFALL AREA

I Meintjies

Objectives & 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 season.

Methods

Fruit samples were harvested weekly from October to January at the three trial sites in Mookghopong (Limpopo), Bufland Farm, and Pro-Plum Farm, and Groblersdal, (Mpumalanga), Collette Farm, and subjected to horticultural evaluation, whereafter the data were captured on a MS Access database.

Key Results

Observations were conducted on 532 Phase 2 selections at the three evaluation sites at Groblersdal Collette Farm, at Mookghopong Bufland Farm and at Mookghopong, Pro-Plum Farm and 117 peach and 103 nectarine harvested and evaluated. Currently there are 19 promising selections (11 peach, 8 nectarine) which will be re-evaluated in the 2016 season. Possible promotion to Phase 3 will be discussed in collaboration with Culdevco. A further seven newly identified selections (six peach and one nectarine) from the ARC breeding programme were planted in the Phase 2 evaluation trial blocks at Modimole, Ginger Gypsy Farm, and at Mookghopong, Bufland Farm. Technology transfer was provided in terms of presentations to students at the Potchefstroom College of Agriculture on the 9th of April, Tshwane University of Technology on the 8th of May and Unisa on the 26th of August 2015. A talk on promising stone fruit selections for the summer rainfall region was broadcast via radio bulletin over RSG – Elsenburg forum on Saturday 19 September 2015.

Conclusion / 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 19 promising selections in order to create a short list for possible cultivar 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.

PLANTING AND MAINTENANCE OF EXISTING AND NEW GERMPLASM OF POME FRUIT AND STONE FRUIT

W Pieterse

Objectives & 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 are maintained in field genebanks at Bien Donné, Drostersnes and Elgin Research Farms, typically two or three trees per accession.

Key Results

The plantings were maintained and three new additions to the pear genebank, were planted, i.e. 'Celina', an early blush cultivar bred in Sweden, 'Kent (VK-RF)' reported to have dull red fruit and red leaves, and *P. regelii* a species new to South Africa. Several apple crosses made to raise progenies for novel genetic studies were repeated in spring 2015 and include those made for combining different ACS and ACO allelotypes for future marker-assisted selection. The accessions in the pome and stone fruit genebanks are being fingerprinted.

Conclusion / Discussion

The fingerprinting of the stone fruit genebanks is nearing completion, and the data generated should yield valuable information to the breeders when planning crosses for genetic studies and cultivar development. Interesting, new additions were made to the pear genebank with a view to future research and genetic studies; the novel traits of *P. regelii* should be further explored for possible introgression into the existing pear germplasm.

STUDENTSHIPS TO APPLY MOLECULAR MARKERS TO THE POME-FRUIT AND STONE-FRUIT BREEDING PROGRAMMES – ESPECIALLY, TO VERIFY AND CHARACTERISE GERMPLASM

K Tobutt

Objectives & Rationale

The aim of this project was to use molecular markers for verifying and characterising the ARC tree-fruit germplasm collections. This will greatly enhance the efficiency of these programmes and their likelihood of delivering improved new cultivars that are easy to grow and easy to sell – and it will aid the integration of molecular tools into the breeding programmes. The work was formulated as three projects to be undertaken by research students, registered at Stellenbosch University, who were trained in the application of molecular markers to the genetic improvement of tree-fruit.

Methods

DNA was extracted from young leaves of accessions in the apple, pear, apricot, plum, peach and almond collections. Samples were amplified with about 10 microsatellite primer pairs per crop to generate fingerprints which were used to check for trueness to type. Primers for the ACS1 locus in apple, involved in ripening, the S incompatibility locus in apricot and plum, and the endoPG locus in peach, determining flesh texture and stem adhesion, were re-designed and used to establish the genotypes at these loci.

Key Results
Some 500 apples, 200 pears, 120 apricots, 70 plums, 210 peaches and 30 almonds in the ARC collections were fingerprinted. In addition, the apples were genotyped for the ACS1 gene, the apricots and plums for the S gene and the peaches for the endoPG gene. The data are being incorporated into the breeding programmes.

Conclusion / Discussion
The fingerprinting of the ARC tree-fruit collections allows the false accessions to be grubbed and costly mistakes in the use of incorrect material to be avoided in future. Knowledge of triploids in the case of pome-fruit, which rarely set viable seed, will allow the breeders to avoid unproductive crosses. The genotyping with respect to the agronomic genes will help the breeders design appropriate crosses for the industry sponsored breeding programmes and, along with the primers, pave the way for marker-assisted selection which is increasingly being adopted by breeding programmes overseas. All in all this project has helped bring the ARC tree-fruit breeding programmes into the marker-assisted age – enhancing the quality of the germplasm collections and developing markers that will be useful for screening progenies.

However, it should be noted that the fingerprinting and molecular characterisation of the tree-fruit gene-banks is not a 'one off'. New accessions are added from time to time, the collections are re-propagated periodically and primers for 'new' traits become available.

Khethani Mhelembe completed his MSc on the fingerprinting and characterizing of the pome-fruit genebanks and has now commenced a PhD on mapping a novel trait in apple. Carl Horstmann transferred from his PhD studentship to the post of apricot and plum breeder. Thembeka Nyawo and Lawrence Kwalimba are about to submit their dissertations on stone-fruit. So ARC, in collaboration with Stellenbosch University, has helped train the next generation of geneticists. Very sadly Fetsang Moima passed away in May 2013.

The fingerprinting methodology and some of the reference data have already been used to check the identity of various rootstocks for the industry.

DETERMINATION OF CROSS POLLINATORS FOR PLUM VARIETIES

J de Klerk

Objectives & Rationale
The goal of this project is to test the pollination requirements (cross- and/or self-pollination) of promising ARC bred Japanese plum selections in Phase 3, as well as newly released cultivars in order to update the existing plum cross-pollination chart with the new information obtained.

Methods
The commercial cultivar 'Songold' was tested as a possible cross pollinator for the selection PR06-30 (PBR and VL application cv Flavour Star), by placing bouquets in adjacent trees. The circumference of both trees was measured before the trial started.

Key Results
Visible fruit set was observed, but due to unanticipated events accurate data were not captured and the suitability of 'Songold' as compatible cross pollinator for PR06-30 (Flavour Star) could not be determined conclusively.

Conclusion / Discussion
It is recommended that the cross-pollination trial with the selection PR06-30 should be repeated with the cultivar 'Songold' as pollinator or/and with other cultivars known to be compatible by molecular techniques that bloom at the same time.

It also recommended that due to personnel change, all further research as from 2017/2018 be performed under Project 000197 – Breeding of Japanese plums.

Postscript
This report is in honour Mr Jannie de Klerk who passed away on 15th February 2016. Jannie was an integral part of the phase 2 stone fruit Evaluation projects for almost ten years, as well as project leader of the Plum Pollination project, 000206-Y5 – he will be missed by all. May you rest in peace.

EVALUATION OF NEWLY BRED STONE FRUIT ROOTSTOCK HYBRIDS FOR FIRST AND SECOND ECONOMY

S Booi

Objectives & Rationale
The objective of the project is to access ARC-bred rootstock selections for rooting ability under nursery conditions and to evaluate rootstock selections planted under field conditions at Bien Donné Research Farm.

Methods
In May 2015, cuttings from 10 ARC-bred hybrids and 3 commercial rootstock cultivars were assessed for rooting ability under standard nursery conditions at Bien Donné Research Farm. A third harvest from a field trial planted at Bien Donné Research Farm in 2011 was evaluated for its production potential in late 2015.

Key Results
Seven out of the 10 ARC-bred rootstock selections had more than 70% rooting ability after two rooting tests. For three harvest seasons, 'Pioneer' plum trees on two of the ARC-bred rootstock selections (peach x almond hybrids) showed good production potential but were not significatly better than the standard commercial plum rootstock 'Marianna'.

Conclusion / Discussion
Two peach x almond hybrid rootstock selections performed very well with the 'Pioneer' plum scion variety and may be expected to do well with peach and nectarine scion varieties also. Additionally, ARC-bred rootstock selections that were promoted from the Phase I breeding programme to Phase II for having multiple resistances and good rooting ability are available for trialling with plum and peach scion varieties under field conditions to evaluate their production potential in comparison with commercial rootstocks

COLD STORAGE CHARACTERISTICS OF NEW CULTIVARS AND SELECTIONS

E Lotz

Objectives & Rationale

Good cold storage ability is a pre-requisite for all South African export fruit cultivars. New selections from the ARC Breeding programme are evaluated for cold storage ability during the evaluation phase of these new selections.

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. Data (for example harvesting maturity, maturity after storage, quality defects and general comments, etc.) are stored in MS Excel. Data is also integrated into the database of the Cultivar Development programme together with production data of new selections. Photographs of fruit at final evaluation are also recorded.

Key Results

Fruit were received from 27 October 2015 to 15 March 2016. A total number of 223 fruit samples were received for cold storage during the 2015/16 season. Data and recommendations were compiled in MS Excel datasheets and shared with Cultivar Development researchers. Feedback aimed at improving production practices (decay, insect damage and harvesting maturity) were also shared. The incidence of decay was lower than the previous few seasons. This can be attributed to lower than normal rainfall experienced in the Western Cape.

Conclusion / Discussion

Storage data and recommendations on the cold storage ability of 223 samples were made to the relevant researchers of the Crop Development division of ARC Infruitec-Nietvoorbij.

DETERMINATION OF APPLE SCAB RACES OCCURRING IN SOUTH AFRICAN APPLE GROWING REGIONS TO UNDERPIN BREEDING FOR RESISTANCE

T Koopman

Objectives & Rationale

We sought to determine which races of apple scab (*Venturia inaequalis*) occur in the different apple growing regions of South Africa and also investigate the population genetic structure and the pathogenicity and virulence of the pathogen on different apple cultivars.

Methods

Apple differential cultivars with different resistance genes against apple scab have been imported. Apple scab samples were collected from four different apple growing regions. Single spored cultures were established and the differential cultivars were inoculated with mixed inoculum to determine the races. Fingerprinting of apple scab isolates was undertaken with seven SSR markers to determine differences between isolates from the different apple growing regions.

Key Results

Apple scab samples were collected from the Koue Bokkeveld, Elgin, and Lower and Upper Langkloof regions during the 2014/15 and 2015/16 growing seasons for race identification. Ten differential cultivars were inoculated with mixed inoculum and it was found that the Rvi1 and Rvi12 resistance genes are overcome by the South African isolates. The Rvi10 gene was overcome by the 2015/16 Koue Bokkeveld isolates. Apple scab isolates were genotyped in 2012/13 and 2013/14 with six and seven SSR markers. Genotyping results were the same for both growing seasons and indicated that minor population differences exist between the Ceres and Langkloof populations and moderate differences between the Elgin and other populations. Thus the Ceres and the Langkloof populations are more closely related to each other. Migration of apple scab isolates occurs between regions. Four different haplotypes were found in the fungal isolates for the barcoding sequence ITS and six for the ABC2 virulence factor.

Conclusion / Discussion

Inoculation of differential apple cultivars with apple scab isolates from the four growing regions showed that the Rvi1 and Rvi12 resistant genes are ineffective in all four regions and the Rvi10 in the Koue Bokkeveld. Single spore isolates also showed differences in virulence and could only infect certain cultivars, consistent with research work reported in Europe. Collection of the apple scab samples from the four apple growing regions enabled a population genetic study which indicated differences in the apple scab fungal populations between the different climatic regions and also indicated that the fungus adapted to the regions over time. Differences in the ABC 2 gene region of the fungus could be associated with variation in virulence.

CROP PRODUCTION

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 build capacity and conduct research for 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, farming efficiency (of which rootstocks, plant quality and orchard efficiency are key components) as well as water- and climate-related research are the strategic priorities of this programme.

CROP PRODUCTION

Prof Wiehann Steyn

PROFILE

Wiehann is the Crop Production Programme Manager at HORTGRO Science and holds an extraordinary appointment within the Department of Horticultural Science at Stellenbosch University.

- *7 Themes*
- *Orchard of the Future*
- *Rootstock evaluation*
- *Completed research*

The Crop Production research programme is structured into seven themes namely; Dormancy, Farming efficiency, Irrigation and Nutrition, Rootstocks and Nursery tree quality, Soil Health, Summer Climate, and Yield. Research strategy for each theme is determined by a workgroup (a workgroup per theme) consisting out 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 that may jeopardise our profitability.

What does the future hold for research within the Crop Production programme in 2016/17? In line with our Orchard of the Future priorities, HORTGRO Science, with input from the Crop Production TAC, has identified two new projects. The effects (benefits and negatives) of nets on plums will be assessed with the aim to increase fruit quality and decrease heat-induced disorders while the second project will assess the effect of the lack of winter chill on fruit maturity and quality. We are also funding three new pear rootstock evaluation plantings as well as co-funding two stone fruit rootstock plantings that are aimed at commercial evaluation of ARC-bred, potentially nematode tolerant rootstocks. We foresee that nursery tree quality as a key determinant of the success of the Orchard of the Future will receive much more attention in future. Screening of rootstocks will be stepped up. A set of key rootstock parameters were determined and the new cost effective and much more focussed rootstock evaluation strategy that was drafted in 2015/16 will now be implemented. Irrigation and climate-related research will remain a focus.

In terms of completed research, the most interesting finding was the peak in white root growth that Dr Elmi Lötze observed in mature apple orchards in both Elgin, Grabouw, Vyeboom, and Villiersdorp (EGVV) and Ceres. Convention had it that root flushes in apple occur prior to bud break in spring and again after harvest in autumn. Four years ago, Tulbagh growers during a HORTGRO Science visit to the area, lamented the absence of a chemical thinning agent for stone fruit. Prof Karen Theron's results indicate that ACC is a very effective thinning agent for plums and also for some peach cultivars. Based on Karen's research, Philagro is currently registering ACC for use in chemical thinning in South Africa. Laura Allderman studied the dormancy progression patterns of commercial stone fruit rootstocks and have found considerable differences in when the rootstocks become dormant, how much chilling they may require and also when they exit dormancy. This has considerable implication for choice of scion and rootstock combinations in different areas in terms of synchronicity between scion and rootstock growth activity.

CROP PRODUCTION

Project List

FINAL PROJECT REPORTS

Received in 2016

APPLE
WILLIE KOTZE - Establish the effect of rest breaking agents on vegetative and reproductive development of apples in the Koue Bokkeveld/ Witzenberg valley.

PLUM, PEACH, APRICOT
LAURA ALLDERMAN - Determining the chill requirement of important stone fruit rootstocks available to the South African fruit industry.

APPLE, PEAR
KAREN THERON - Mechanical thinning of pome fruit.

APPLE
ELMI LÖTZE - Apple root dynamics.

PLUM, PEACH, NECTARINE, APRICOT
PIET STASSEN - Tolerance and susceptibility of commercial stone fruit rootstocks for plant parasitic nematodes.

PLUM
MARIANA JOOSTE - The effect of climate on split pit in plums.

PLUM, PEACH, NECTARINE
KAREN THERON - Chemical thinning of stone fruit.

FINAL PROJECT REPORTS

Due 2017

APPLE
CARLO COSTA - Screening of apple rootstocks for resistance to Woolly Apple Aphid

PLUM
WIEHANN STEYN - Heat stress in plums.

APPLE, PEAR
WIEHANN STEYN - Water relations and sunburn in pome fruit.

PEACH, NECTARINE
NICKY TAYLOR - Stone fruit phenology and physiology in the Northern Province as related to orchard practices and productivity.

APPLE, PEAR
XOLANI SIBOZA - NAA and Ethephon to increase return bloom in apples and pears.

APPLE
XOLANI SIBOZA - Chemical thinning of apples.

PEAR
XOLANI SIBOZA - Chemical thinning of pears.

RUNNING REPORTS

* Note that Soil health projects have been moved to the Crop Protection Programme

APPLE
ESMÉ LOUW - Using the shoot assay to screen combinations and sequential application of existing and possible new rest breaking agents in apples.

APPLE
ESMÉ LOUW - Physiological dynamics of dormancy in apple buds grown in areas with insufficient cold.

APPLE
XOLANI SIBOZA - Rest breaking programmes for warm winter regions

APPLE
ESMÉ LOUW/ LAURA ALLDERMAN - Investigating the effects of different autumn temperatures on endodormancy progression.

APPLE
ESMÉ LOUW/ LAURA ALLDERMAN - Determining the dormancy progression of commercial apple cultivars and clones available to the South African industry.

APPLE
SEBINAZI DZIKITI - Quantifying water use of high performing commercial apple orchards in the winter rainfall area of South Africa.

APPLE
STEPHANIE MIDGLEY - Establishing quantitative relationships between water relations, growth, yield and quality of high performing apple orchards

APPLE
EDUARD HOFFMAN/JOHAN VAN ZYL - Effect of irrigation on the performance of young apple trees in newly established orchards

APPLE
THERESA VOLSCHENK - Evaporation of high performance apple tree orchards.

APPLE
XOLANI SIBOZA - Apple rootstock evaluation at Paardekloof, Witzenberg Valley.

APPLE
XOLANI SIBOZA - Apple rootstock evaluation at Helderwater, Langkloof.

APPLE

XOLANI SIBOZA - Apple rootstock evaluation at Oak Valley Estate, Grabouw.

APPLE

XOLANI SIBOZA - Apple rootstock evaluation at Breëvlei, Grabouw.

PLUM

PIET STASSEN - Evaluation of plum rootstocks

PEACH, NECTARINE

PIET STASSEN - Evaluation of peach rootstocks.

APRICOT

PIET STASSEN - Evaluation of apricot rootstocks.

APPLE

PETRUS VERMEULEN - Apple replant rootstock trials for determining a screening technique

APPLE

JOHAN FOURIE - *Effect of different cover crop management practices on the soil and performance of apple trees.

APPLE

SHEILA STOREY - *Nematode community structure and function as a bio-indicator of the effects of soil amendments on soil health.

APPLE

ANDRÉ MEYER - *Validation of an enzyme-based soil alteration index for testing soil health in local apple orchard soils.

APPLE

STEPHANIE MIDGLEY - Acclimation of apple peel to light and temperature and the effect thereof on red colour development and tolerance to sunburn.

NEW PROJECTS

Approved for 2017

APPLE

E LOUW - Quantifying the impact of insufficient winter chill on apple dormancy and production.

PEAR

XOLANI SIBOZA - Pear rootstock evaluation in Wolseley: Cheeky at La Plaisante.

PEAR

XOLANI SIBOZA - Pear rootstock evaluation in Wolseley: Forelle at La Plaisante.

PEAR

XOLANI SIBOZA - Pear rootstock evaluation in Vyeboom: Packham's Triumph.

PLUM

IWAN LABUSCHAGNE - Evaluation of plum rootstocks for the South African fruit industry in association with IP owners at Simondium.

PEACH, NECTARINE

IWAN LABUSCHAGNE - Evaluation of peach and nectarine rootstocks for the South African fruit industry in association with IP owners at Vaalwater

PLUM

KAREN THERON - Effect of nets on growth, yield and fruit quality as well economic feasibility in plums.

ESTABLISHING THE EFFECT OF REST BREAKING AGENTS ON VEGETATIVE AND REPRODUCTIVE DEVELOPMENT OF APPLES IN THE KOUE BOKKEVELD AND WITZENBERG VALLEY

W Kotze

Objectives & Rationale

The objectives of this project were to establish the effect of rest breaking agents on the duration of bud break and flowering, effectiveness of chemical thinning, variance in fruit harvest maturity and long term yield of 'Golden Delicious' and 'Cripps' Pink' apples in the Koue Bokkeveld and Witzenberg Valley.

Methods

The following rest breaking treatments were applied to the same 'Cripps' Pink' and 'Golden Delicious' apple trees from winter 2011 through to winter 2013: 3% oil, 6% oil, 4% Lift and, 0.5% Dormex + 4% oil. Rest breaking treatments were compared to an untreated control in terms of vegetative and reproductive bud break, bloom duration, yield, fruit maturity and fruit quality.

Key Results

Richardson chill units (May-Aug) exceeded 1600 in all three years and would therefore be considered to be sufficient for apple production without the need for rest breaking application

2011: 0.5% Dormex in combination with 4% oil condensed both vegetative and reproductive bud break in both cultivars. Yield data could unfortunately not be assessed.

2012: Lift at 4% seemed to increase and condense vegetative bud break in 'Cripps' Pink', while 3% and 6% oil were able to condense flowering. Production was not affected by treatments. No treatment effects were observed on Golden Delicious.

2013: 4% Lift advanced the onset, condensed and increased vegetative bud break. 0.5% Dormex + 4% Oil and 6% oil also increased final vegetative bud break compared to the control. 0.5% Dormex + 4% oil seemed to advance the onset of flowering compared to 3% oil and 4% Lift. 6% oil increased yield and yield efficiency compared to 4% Lift and the control. 3% oil also increased yield efficiency compared to the control. Treatments did not significantly affect cumulative yield over the 2013 and 2014 harvests. Fruit size was not affected while effects on maturity were slight. Treatments did not affect the flower cluster density in 2014.

4% Lift and 0.5% Dormex + 4% oil advanced the onset of vegetative bud break in 'Golden Delicious'. Lift also increased bud break and decreased the percentage latent buds. 3% oil increased yield and yield efficiency compared to the control. Treatments did not significantly affect cumulative yield over the 2013 and 2014 harvests. Trees that received 4% Lift as well as 0.5% Dormex and 4% oil over the preceding three years showed increased flower cluster density in 2014 compared to other treatments.

Conclusion / Discussion

Despite accumulation of >1,600 Richardson chill units, rest breaking treatment improved bud break in all three years in 'Cripps' Pink' and in two years in 'Golden Delicious'. Not all rest breaking agents where equally effective – 0.5% Dormex plus 4% oil was effective in 2011 and 2013 while 4% Lift was effective in 2012 and 2013. The cumulative effect of treatments over the three years started having a positive effect on yield in 2013/14, possibly by increasing bearing positions. Based on these results, we recommend that Koue Bokkeveld growers seriously consider the application of rest breaking agents.

DETERMINING THE CHILL REQUIREMENT OF IMPORTANT STONE FRUIT ROOTSTOCKS AVAILABLE TO THE SOUTH AFRICAN FRUIT INDUSTRY

L Allderman

Objectives & Rationale

The dormancy progression and chill requirements of stone fruit rootstocks were assessed to better understand their depth and patterns of dormancy. This information is vital when choosing rootstock /scion combinations best suited to the low chill and varied growing conditions prevalent in South Africa.

Methods

Fifty nine dormancy progressions and 15 chill requirement (CR) calculations were generated over 2 years from 2 different locations using standard forcing laboratory procedures.
A 2-line model was fitted to each of the dormancy progressions and nine variables, identified from the estimated regression parameters, were used in a discriminant analysis (DA). The discriminant plot factors from the DA were then clustered using Ward's Agglomerative hierarchical clustering (AHC). Univariate clustering was also performed on the means of the individual variables (criteria) for each rootstock. The 2 locations were analysed separately.

Key Results

Dormancy progressions varied tremendously between rootstocks. Rootstocks entered and exited dormancy over an extended period of time and the depth of dormancy varied from 26 to 112 days to bud break. Three distinct dormancy patterns were identified viz. rapid entrance/slow exit, slow entrance/rapid exit and equal entrance and exit. The different dormancy patterns were used to distinguish between high and low chill rootstocks. High chill rootstocks enter dormancy early, go into deep dormancy and exit dormancy late. The opposite is true of low chill rootstocks. The DA, AHC and Univariate clustering were also used to cluster rootstocks into high and low chill. Where rootstocks were present at both locations, they always fell into the same cluster pattern. Maridon, SAPO778, Viking, GF677, Atlas, Tetra, Garnem, Cadaman, Kuban86, Krymsk6, Krymsk7 and Tsukuba clustered into the higher chill group while Kakamas, Marianna, Flordaguard, Felinem, Monegro, Chuche Picudo, Guardian and Penta clustered into the lower group. Many of the rootstocks that showed early exit from dormancy did not cluster into the lowest maximum dormancy cluster. Caution must therefore be observed when categorising a variety as high or low chill solely on blossom or bud break date. High chill rootstocks increased the chill requirement of low chill scions. Suckering or poor growth and chlorosis occurs when exit from dormancy of the rootstock and scion are not synchronised.

The majority of calculated CRs seemed rather irrational. Under South African climatic conditions, determination of maximum dormancy for shoot collection proved difficult. Furthermore, the variability of maximum dormancy between locations and seasons as well as certain methodology constraints prevented accurate CR calculation.

Conclusion / Discussion

Under conditions of inadequate chill, the method widely used to determine CR as an absolute value is neither accurate nor reliable. The dormancy of rootstocks must rather be assessed generally using both Dormancy Progression and CR data over numerous locations and seasons before rootstocks are categorised as low or high chill.

MECHANICAL THINNING OF POME FRUIT

K Theron

Objectives & Rationale

Thinning is an important practice in pome fruit production which aims to ensure an optimal yield of high quality, large sized fruit as well as an adequate return bloom. In South Africa, pome fruit thinning is generally done by means of chemicals, with follow-up hand thinning. When thinning is effective, set and thus the hand thinning requirement should be reduced. This is important as labour cost associated with hand thinning is high and continually rising. Chemical thinning is weather dependent and can be environmentally harmful, which has led to a shift towards environmentally acceptable methods of thinning such as mechanical thinning.

Methods

From 2013 until 2015 the mechanical string thinners, viz. Darwin 300™, BAUM, and Bloom Bandit™, were evaluated. These machines are used to thin trees during full bloom and reduce the number of flowers before fruit set. The aim of the trials was to reduce fruit set and therefore hand thinning requirement, while increasing fruit size and quality, maintaining yield and return bloom. A range of tractor speeds and rotational rates were evaluated with the Darwin 300™ on 'Forelle' pears and 'Cripps' Pink' apples, while the BAUM was evaluated only on 'Cripps' Pink' apples. The hand-held Bloom Bandit™ was evaluated on 'Forelle', 'Cripps' Pink', 'Fuji' and 'Cripps' Red'. Thinning intensities of 25%, 50% and 75% of clusters or flowers was applied to mature 'Forelle' and 'Cripps' Red' trees during full bloom.

Key Results

The tractor-driven mechanical thinning devices gave erratic results. The most consistent results on 'Forelle' were obtained using the Darwin 300™ at 5.2 km·h-1 and 300 rpm, while the BAUM gave no consistent results. The unreliability of results were due to South African pome fruit orchards currently being unsuitable for tractor-driven mechanical thinning machines. The 'Forelle' orchard trained to a Palmette system was the most suited for thinning, which is reflected in the more positive results obtained, but further improvements are possible. The Bloom Bandit™ effectively thinned pear and apple trees and increased fruit size without a decrease in yield or return bloom. More time is spent on thinning with the device compared to tractor-driven machines and this should be taken into account when considering using the Bloom Bandit™. Variable effects were seen on fruit set, yield was reduced to acceptable levels, while fruit size was improved in 'Forelle' but not 'Cripps' Red'. Results showed that when thinning mechanically, the aim should be to remove between 25% and 50% of flowers clusters in 'Forelle' and 50% of flowers clusters in 'Cripps' Red'. These levels of thinning gave the best results in terms of the remaining hand thinning requirements and improved return bloom in 'Forelle'. We, however, only evaluated full cluster thinning and not within cluster thinning, which might also occur during mechanical thinning.

Conclusion / Discussion

Variable results were obtained with tractor driven thinning machines due to orchards not well adapted to mechanisation. The Bloom Bandit™ gave promising results and can be an alternative to chemical thinning.

APPLE ROOT DYNAMICS

E Lötze

Objectives & Rationale

Root growth of deciduous fruit trees occurs in two main growth flushes per season according to literature – typically during spring and autumn. The timing and duration of these flushes can be influenced by various factors, e.g. soil environment, irrigation, rootstock, tree age and climate. No root studies to quantify the timing and duration of root flushes of apple trees under local, commercial conditions are available. In this study we quantified white root dynamics for mature, bearing trees ('Golden Delicious', Cripps' Pink'), young, bearing trees ('Fuji' on M793), and a young, non-bearing 'Corder Gala' orchard on M7 in the EGVV area. The 'Cripps Pink' and 'Corder Gala' orchards were on lighter, sandy soils and the other orchards on heavier, clayey soils. The second objective was to determine the effect of cover crops on white root growth in the young, non-bearing 'Corder Gala' orchard. The third objective comprised quantifying root growth of a young, non-bearing and mature, bearing orchard (both 'Golden Delicious') in the Koue Bokkeveld with special attention to the 2015/16 winter flush.

Methods

Root growth dynamics were quantified using a mini-rhizotron approach. Acrylic butyrate tubes (1.05 m) were installed parallel to the tree row, 40 cm from the base of individual trees at an angle of approximately 45°. A root scanner (CI-600, CID Bioscience, Inc, WA USA) was used to obtain images of root growth in four segments/windows per tube. In the EGVV area, the phenological phases were also recorded. Yield (two seasons) and photosynthesis (one season) was recorded for 'Golden Delicious', and photosynthesis for one season for 'Corder Gala' orchards and related to white root peaks. Continuous logging capacitance probes were installed in these sites to quantify soil temperatures and moisture.

Key Results

The timing of root growth flushes was distinctly periodic and similar for the bearing orchards, irrespective of the different scions and soil types, but the duration and magnitude of the flushes differed. The main peak of white roots occurred in winter, with a smaller peak early summer. The white root growth pattern of the young, non-bearing orchard clearly differed from the mature orchards in that roots were produced in various quantities throughout the growing season with no consistent white root growth during winter. Minimum winter soil temperatures, especially at 60 cm soil depth (5 - 12°C), are conducive to root growth and

is reflected in a peak growth period from May to August in the bearing trees. As the establishment of the cover crops only occurred late during 2015, the effect of cover crops on white root development was never observed. Ceres data confirmed white root growth during winter for both young and bearing trees.

Conclusion / Discussion

The winter white root growth peak in EGVV and Ceres is unique and differs from literature. Soil temperatures at these sites were conducive to continuous white root growth during May to August. The effect of this energy requiring activity should be investigated further with reference to possible impact on dormancy release and nutrient application.

TOLERANCE AND SUSCEPTIBILITY OF COMMERCIAL STONE FRUIT ROOTSTOCKS FOR PLANT-PARASITIC NEMATODES

P Stassen

Objectives & Rationale

We evaluated high potential stone fruit rootstocks for their host status to ring (*Criconemoides xenoplax*) and root-knot (*Meloidogne spp.*) nematodes.

Methods

We evaluated different pot sizes, inoculation periods as well as different potting mediums. The best results were achieved using 2400 ml pots, steam sterilised 2:1 fine bark to medium textured sand. Inoculated trees must stay in a glass house at 25°C for at least 6 months. We have also compared the results in pots to results in a commercial orchard situation where ring nematodes occur.

Key Results

From the results it is clear that all rootstocks used sustain high numbers of ring nematodes. The rootstocks Marianna, Flordaguard, Atlas and Garnem have statistically significant higher numbers of ring nematodes than the other rootstocks used, except Guardian. The rootstocks GF 677, Maridon, 5A-5-34, 7B-25-21 and Viking are in the 50% range when Marianna is defined as 100%. The rootstock GF 677 is significantly more sensitive than Kakamas seedling to root-knot nematodes. Both GF 677 and Kakamas seedling rootstocks are more sensitive for root-knot nematodes than Marianna, Maridon, Flordaguard, 5A-5-34, 7B-25-21, Garnem and Viking. To correlate these results with field data, soil samples were taken in a plum orchard with several rootstocks, during 2008 (after plant), 2012 and 2014. During 2014 the ring nematode numbers in the root zone of Marianna was significantly higher than those in the root zone of other rootstocks. There was a high increasing tendency in ring numbers from 2012 to 2014 in the root zones of Marianna, Maridon, Tsukuba 5 as well as GF 677 whilst the rootstocks Chuche-Picudo, Atlas and Flordaguard showed a decrease. Ring nematode numbers in the root zone of Viking, SAPO 778 clonal and seedling never increased above the 500 ring nematodes/300cm³ described as damaging. Results from California indicate that the rootstocks Flordaguard, Cadaman and Atlas have a higher than 100% (Nemaguard defined as 100%) rating with Garnem also showing a tendency to be high.

Conclusion / Discussion

It is clear that there is no commercial rootstock that can be described as resistant to ring nematodes. All results agree that the rootstock Marianna is a good host to ring nematodes and others like Maridon, Flordaguard, Cadaman, Atlas and Garnem must also be suspected to fall in the higher host status group. The rootstocks Kakamas seedling and GF 677 are good hosts to root-knot nematodes, Guardian and Atlas are resistant with Marianna, Maridon, Flordaguard, Garnem and Viking resistant/immune to root-knot nematodes. Correctly performed pot experiments can provide valuable results about the host status of stone fruit rootstocks to ring and root-knot nematodes. To evaluate the influence of rootstocks on the performance of the scion (yield, fruit weight), long term field experiments are necessary. Such results from field trials (not shown here) indicate that Marianna, Maridon, GF 677 and Flordaguard are negatively affected if ring nematode numbers are higher than 500/300 cm³. Performances of trees on Atlas, Garnem and Cadaman are less affected.

A STUDY OF BROKEN STONES IN JAPANESE PLUMS

M Jooste

Objectives & Rationale

The effect of growing area and season on the incidence of broken stones, why cultivars differ in their susceptibility to broken stones, and if calcium and silicate treatments can reduce stone breakage in Japanese plums were studied.

Methods

'Best' subset regressions were performed to determine if the incidence of broken stones at harvest could be predicted in 'Laetitia'. CT scans were performed on 'Laetitia' and 'Songold' fruit from 21 days after full bloom (dafb) until stone hardening was completed. A randomised complete block design with eight blocks per treatment were used to determine the effect of $Ca(NO_3)2$ and K_2O_3Si on broken stones compared to a control.

Key Results

Growing area did not affect broken stones, but seasonal climatic factors had an important influence on broken stone incidence. Generally lower temperatures during early spring cause less competition between the growing plant organs and aid in the development of larger fruit, which are more vulnerable to stone breakage. Rapid lengthwise fruit growth during the early parts of the stone hardening period pulls the stone apart at the interface between the parts of the stone that have started to lignify and the parts that are still 'soft'. Also, stones with higher moisture content (due to wet conditions early in the season) tend to be more susceptible to breaks, especially if this is coupled with increased growth of the mesocarp, which was observed in terms of lengthwise fruit growth. However, data from more seasons are needed to accurately predict the incidence of broken stones at harvest.

CT scans indicated that the tip of the stone at the stylar end started to lignify first for all the tested cultivars. It seems that 'Laetitia' and 'Sapphire' (susceptible to stone breakage) form more endocarp cells in warmer springs which causes the stones to be more rigid and more susceptible to stone breakage

if coupled with rapid radial fruit growth before the stone has hardened completely. 'Songold' (less susceptible to broken stones) forms a complete endocarp irrespective of spring temperatures. However, the enzymes responsible for lignification are influenced by spring temperatures. Hence, the cultivar has a more flexible stone, resisting stone breakage in a warmer spring when lignification is less pronounced and forms a much more rigid stone in a cooler spring when lignification is upregulated. Hence, susceptible cultivars will have more broken stones after warm springs, but less after cool springs while non-susceptible cultivars will have broken stone incidence after a cool spring with negligible levels after a warm spring.

Neither foliar $Ca(NO_3)_2$ and K_2O_3Si, post-harvest $Ca(NO_3)_2$, nor root K_2O_3Si applications had an effect on the incidence of broken stones.

Conclusion / Discussion

Data from more seasons and/or farms are needed to accurately predict the incidence of broken stones at harvest. Higher spring temperatures cause greater endocarp density in susceptible cultivars, and, if coupled with rapid radial fruit growth, will lead to a higher incidence of broken stones. Neither calcium nor silicate treatments can currently be recommended to reduce broken stones in plums.

CHEMICAL THINNING OF STONE FRUIT

K Theron

Objectives & Rationale

Thinning of stone fruit, just as in any other deciduous fruit crop, plays an important role in producing fruit of the right size and quality. Hand thinning is highly labour intensive and time consuming, thus an alternative method of thinning is important to the industry. Chemical and mechanical thinning either alone or in combination could be the alternative.

Methods

Two chemicals, 1-aminocyclopropane-1-carboxylic acid (ACC) and 6-benzyladenine (6-BA) were evaluated on Japanese plums, cling peaches and nectarines. In addition, the Darwin 300™, a mechanical string thinner, was also included in trials on early maturing 'Alpine' nectarine and 'African Rose™' plum. In all trials the objective was to reduce the required hand thinning during commercial hand thinning without compromising on yield and fruit quality.

Key Results

In Japanese plums we reduced the hand thinning requirement significantly with both the ACC thinning and mechanical thinning strategies. Regarding ACC, cultivars differed in their sensitivity to the chemical and the recommended rate will differ for cultivars. ACC consistently reduced the required hand thinning linearly with increasing rate. The recommended rate of ACC for 'African Rose™' is 600 µl.L-1 and for 'Laetitia' 400 µl.L-1. For 'Fortune' a recommended rate could not be determined at this stage, thus further trials should be conducted. The Darwin 300™ reduced hand thinning significantly without reducing the yield significantly. Combining the Darwin 300™ with ACC 600 µl.L-1 in 'African Rose™' gave promising results with regard to hand thinning requirement and fruit size, without reducing yield efficiency significantly. No leaf drop was observed on Japanese plums, except in the pilot trial when applications were made at high temperatures, which should therefore be avoided.

ACC was effective as thinning agent in cling peaches. In 'Keisie', the results were positive during both seasons, and ACC reduced the hand thinning requirement without reducing yield efficiency. The recommended rate of ACC for 'Keisie' is 600 µl.L-1. Slight leaf drop was observed. In 'Sandvliet', there was a significant reduction in fruit set, without reducing the required hand thinning. The reduction in fruit set led to a significant reduction in yield. Severe leaf drop was observed, indicating that cultivars differ in sensitivity to ACC.

In nectarines, ACC only thinned 'Turquoise' but not 'Alpine' or 'August Red' at the rates and phenological stage used, again indicating cultivar differences in sensitivity. In 'Turquoise', the highest ACC rate (500 µl.L-1) reduced fruit set per tagged shoot, as well as the hand thinning requirement, but this rate also reduced the total yield. The Darwin 300™ evaluated on 'Alpine' reduced fruit set significantly and the hand thinning requirement without reducing yield efficiency, indicating that mechanical thinning is a viable option in nectarines. Slight leaf drop was observed in all nectarine trials.

Conclusion / Discussion

ACC was successful in thinning plums and 'Keisie' peach but would not currently be recommended for 'Sandvliet' or on nectarines. The reason for the differences observed in response to ACC between cling peaches and plums on the one hand, and nectarines on the other, cannot currently be explained.

SCREENING OF APPLE ROOTSTOCKS FOR RESISTANCE TO WOOLLY APPLE APHID

C Costa

Objectives & Rationale

The objective of this year's work was to obtain and prepare the remainder of the range of Geneva and standard apple rootstocks via micro-propagation for pot trials under controlled conditions in order to determine their comparative resistance and/or tolerance to woolly apple aphid (WAA).

Methods

Methodology entails the bulking up of plants via micropropagation from mother plants, rooting of genotypes, establishment and hardening off under greenhouse conditions, then transplanting into larger bags and transferring to netted shade-house for inoculation with WAA samples collected in specific orchards. Trees at least 40 cm high are inoculated with WAA to ensure accurate measure of resistance and tolerance.

Key Results

To date we have succeeded in establishing the originally selected 24 genotypes in vitro, two of which are recalcitrant and still in the

proliferation stage, while 22 have passed the rooting stage and 21 have been transplanted into planting bags for inoculation with WAA in spring 2016. Three important rootstock selections, CG5087, CG007 and CG5935, were found to be contaminated by bacteria while in the rooting phase under micro-propagation but could be cleaned up. Autumn inoculation below ground in 2015 was found to be unsuccessful, whereas above-ground inoculation has risks of attack by parasitic wasp.

Conclusion / Discussion

The work plan has already been extended by two years because of difficulty in propagating some of the selections. Another six months will be required to complete the work (screening of the 21 selections). A final report will be submitted in 2017.

USING THE SHOOT ASSAY TO SCREEN COMBINATIONS AND SEQUENTIAL APPLICATION OF EXISTING AND POSSIBLE NEW REST BREAKING AGENTS IN APPLES

E Louw

Objectives & Rationale

The use of rest breaking agents (RBA) is essential for successful budburst in areas with insufficient winter chill. Dormex and oil, the current industry standard, is coming under scrutiny for its hazardous effects on man and environment. The first objective of the study is to investigate the use of growth enhancing compounds to restore the vigour of apple shoots after treatment with Dormex and oil. Secondly we aim to determine the rest breaking capabilities of nitric oxide in the presence of oil as Dormex alternative.

Methods

We used a laboratory shoot assay to test the efficacy of a range of vigour enhancing compounds (hormones and N-containing) through visual assessment after exposing treated shoots to forcing conditions. Similarly, the budbreak ability of alternative RBA that produce NO will be assessed.

Key Results

The vigour enhancing compounds that were tested showed budbreak percentages ranging from 52-98%, outperforming the commercial standard (50%) and shoots that received no RBA (20%). The top performers were 100mg/L Promalin, 50g/L Urea and 100mg/l Maxcel. $NaNO_2$+AsA and KNO_3 tested statistically similar to the commercial standard. $NaNO_2$ treatment showed a noticeable dose response.

Conclusion / Discussion

All the growth enhancing compounds performed equally or better than the fully chilled shoots. We recommend that 100mg/L Maxcel, 100mg/L Promalin and 50g/L Urea or variations thereof are used in whole tree trials in 2017. We furthermore recommend that 1M KNO_3, 1mM $NaNO_2$+AsA and 0.4M $NaNO_2$ or variations thereof are considered in whole tree trials in 2017.

PHYSIOLOGICAL DYNAMICS OF DORMANCY IN APPLE BUDS GROWN IN AREAS WITH INSUFFICIENT COLD

E Louw

Objectives & Rationale

We are investigating three physiological aspects (respiration, oxidative stress and hormone concentration) of apple buds produced under inadequate winter chilling to gain fundamental knowledge on the changes brought about by such typical South African conditions.

Methods

Dormant apple buds from two contrasting climatic regions, Elgin (insufficient winter chill) and Koue Bokkeveld (sufficient winter chill) are compared in terms of their respiration rate and four different respiration pathways throughout the winter period. Similar testing is also done during the commercial application of RBAs to investigate the mechanisms of rest breaking. Method development is underway to describe differences in the oxidative stress, hormone concentrations and movement and membrane content of such buds.

Key Results

Buds from Elgin lack an increase in the TCA cycle after bud swell but increase the PPP and ALT pathways compared to buds from Koue Bokkeveld. This pattern is mimicked when RBA is used - untreated shoots continue to lack in TCA cycle capacity while increasing PPP and ALT. The lipid analysis method was optimised to assist with the membrane studies that have been added to the project and sample processing is current under way. The hormone studies have not yet produced a reliable protocol and we are currently looking at improving the recovery from the extraction process.

Conclusion / Discussion

The 2015 respiration results show that the respiration pathway preference of the buds from Elgin and Koue Bokkeveld are significantly different after bud swell.

EVALUATE REST BREAKING PROGRAMMES FOR WARM WINTER REGIONS

X Siboza

Objectives & Rationale

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

Methods

The following rest breaking treatments were applied in 2015.

Fuji:

1. 3% Dormex
2. 0.5 % Dormex + 3% Oil
3. 1% Dormex & 7 days later with 5%

Oil:

1. 0.5% Lift + 1% Oil + 1% KNO_3 + 0.5% Dormex
2. 2% LB Urea + 2% KNO_3 & 7 days later

with 0.5% Dormex + 3% Oil

Reinders Golden Delicious:

1. 1% Dormex + 4% Oil
2. 3% Dormex
3. 1% Dormex & 7 days later with 0.5% Dormex + 4% Oil
4. 0.5% Lift + 1.5% Oil + 1% KNO_3 + 0.5% Dormex

Key Results

The different rest breaking treatments were equally effective in terms of bud break and did not affect yield in Fuji. 3% Dormex had a slight negative effect on fruit size. Effects on fruit maturity were not of horticultural significance.

Bud break was generally poor and not differentially affected by the different rest breaking applications in Golden Delicious Reinders. Treatments did not differ in yield and fruit maturity, but fruit from the treatment containing 0.5% Lift and 1% KNO_3 seemed to be slightly greener in peel colour.

Conclusion / Discussion

Rest breaking application were equally effective in Fuji and apparently equally ineffective in improving bud break in Golden Delicious Reinders in 2015.

INVESTIGATING THE EFFECTS OF DIFFERENT AUTUMN TEMPERATURES ON ENDODORMANCY PROGRESSION

E Louw & L Allderman

Objectives & Rationale

In this study we are exploring the induction of endodormancy by exposing Elgin and Koue Bokkeveld buds to low temperatures for various time periods and monitoring their endodormancy progression. We also investigate the effect of short term exposure to harsh environmental conditions by simulating a heat wave, a cold front and sudden sub-zero conditions. Information from this aims to increase our understanding of how temperature influences induction of dormancy.

Methods

Shoots from 'Royal Beaut' trees grown in two different climatic areas were collected weekly and exposed to temperatures varying from 4 to14°C for different time periods (1 – 14 days) and then forced (25°C, continues light) to grow while monitoring the budbreak pattern. The effect of harsh environmental conditions were tested by exposing 'Cripps Pink' shoots to 1 day of either 4°C, 30°C or -4°C before exposing them to forcing conditions.

Key Results

Data generation and analysis was not yet complete at time of reporting. Buds from Elgin reacted to low temperatures in week 8 compared to the buds from the Koue Bokkeveld that started to go endodormant in week 5. The Elgin buds reacted to low temperature up to week 16 whilst the Koue Bokkeveld went endodormant without any additional cold. Both Elgin and Koue Bokkeveld buds showed decreasing endodormancy levels in response to heatwave and sub-zero conditions but increasing the levels once exposed to the cold front treatment.

Conclusion / Discussion

It is still too early to make any conclusions based on this preliminary data.

DETERMINING THE DORMANCY PROGRESSION OF COMMERCIAL APPLE CULTIVARS AND CLONES AVAILABLE TO THE SOUTH AFRICAN INDUSTRY

E Louw & L Allderman

Objectives & Rationale

Plotting the dormancy progressive curves of some of the commercial apple cultivars, all in one season, can provide very useful information to producers considering new plantings, especially if matched to the dormancy levels of the rootstock (study already completed). Comparing the performance in two climatically different areas also adds to the pool of knowledge of the way scions react to chill accumulation.

Methods

Shoots from 22 different apple clones (10 different cultivars) were collected every 14 days from two climatic areas (Elgin and Koue Bokkeveld) starting in Feb 2016. The samples were exposed to standard forcing conditions (25°C, continues light) and monitored until 50% budbreak. From this dormancy progression curves were constructed. The data generation is ongoing.

Key Results

The (very) preliminary data shows that the scions from Elgin have a significantly lower endodormancy level compared to their counterparts grown in the Koue Bokkeveld. The maximum dormancy levels recorded to date confirm that some cultivars, 'Golden Delicious' and 'Granny Smith', tend to have a shallower endodormacy compared to 'Galas' and 'Fuji', irrespective of the climatic area.

Conclusion / Discussion

The shoot collection needed for the construction of dormancy curves typically runs until end of September and shoot monitoring deep into October, thus at the time of the submission of this report the data generation was not complete and therefor no discussion or conclusions can be presented.

QUANTIFYING WATER USE OF HIGH PERFORMING COMMERCIAL APPLE ORCHARDS IN THE WINTER RAINFALL AREA OF SOUTH AFRICA

S Dzikiti

Objectives & Rationale

Apple production in South Africa is entirely dependent on irrigation. In recent years, orchards yielding up to 120 t/ha are becoming common. There is also no

information on water use by young, non-bearing apple orchards. This study seeks to close this information gap by quantifying the water use of high yielding apple orchards from planting to full-bearing.

Methods

The actual amount of water transpired by apple orchards was measured in the EGVV region during the 2015/16 season. Two non-bearing 'Cripps' Red' and 'Golden Delicious' orchards as well as two high yielding full-bearing 'Golden Delicious' and 'Cripps' Pink' orchards were used. Tree transpiration was measured using sap flow gauges. Orchard evapotranspiration (ET) was monitored using three methods namely; 1) the open path eddy covariance, 2) soil water balance, and 3) high resolution remote sensing data from Fruitlook.

Key Results

The full-bearing 'Golden Delicious' orchard transpired 7 660 m3/ha/season compared with 6 550 m3/ha/season for 'Cripps' Pink'. The non-bearing 'Cripps' Red' orchard transpired 1 330 compared to 1 550 m3/ha/season for non-bearing 'Golden Delicious'. Daily orchard scale ET peaked close to 9.0 mm for full-bearing 'Golden Delicious' compared to less than 6.0 mm/d in non-bearing 'Cripps' Red'. Model ET predictions were within 10% of the seasonal ET estimates from Fruitlook for the full-bearing orchards although substantial deviations were observed for the non-bearing orchards.

Conclusion / Discussion

Water use rates were strongly related to canopy size. The full-bearing orchards in EGVV used similar amounts of water to those in Koue Bokkeveld.

ESTABLISHING QUANTITATIVE RELATIONSHIPS BETWEEN WATER RELATIONS, GROWTH, YIELD AND QUALITY OF HIGH PERFORMING COMMERCIAL APPLE ORCHARDS

S Midgley

Objectives & Rationale

In this study we are exploring the induction of endodormancy by exposing Elgin and Koue Bokkeveld buds to low temperatures for various time periods and monitoring their endodormancy progression. We also investigate the effect of short term exposure to harsh environmental conditions by simulating a heat wave, a cold front and sudden sub-zero conditions. Information from this aims to increase our understanding of how temperature influences induction of dormancy.

Methods

We established combined treatments of two crop loads and three irrigation volumes in a high-yielding 'Golden Delicious' orchard. Measurements were performed from December-March of midday stem water potential (SWP), leaf gas exchange, stem and fruit diameter fluctuations, and fruit, shoot and root growth. Fruit number, yield, and fruit quality and maturity were determined at harvest.

Key Results

High crop loads led to lower SWP later in the season. Photosynthesis, stomatal conductance and root growth increased while transpiration rate decreased after harvest. Post-harvest stomatal conductance remained high in the afternoon. Before harvest, medium crop load stimulated higher root growth, but after harvest the high crop load treatment showed stronger root growth. Trees under low irrigation had stronger root growth after harvest.

Conclusion / Discussion

High crop load appears to use more water - further analysis required. Water loss through transpiration decreases after harvest. A strong fruit sink inhibits root growth. A medium fruit sink allows more root growth pre-harvest (as well as more shoot growth, especially under high irrigation) but a lesser root response after harvest. Low irrigation volume resulted in higher post-harvest root growth based on excess available carbohydrates used towards seeking water.

THE EFFECT OF IRRIGATION ON THE PERFORMANCE OF YOUNG APPLE TREES IN NEWLY ESTABLISHED ORCHARDS

J van Zyl & E Hoffman

Objectives & 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 well-prepared gravelly soil (to be planted October 2016) has been identified at Oak Valley Estate, Grabouw. The soil has been surveyed and classified after which samples were taken for physical and chemical analyses. An irrigation system has been designed and will be installed shortly for watering the fifteen plots of the field trial. Equipment for the measurement of soil water content and soil temperature was ordered and is currently being calibrated before installation.

Key Results

The Kroonstad soil of the trial site is spatially uniform and matches the requirements specified for the experiment. Further work such as soil analyses and instrument calibration is still in progress while irrigation treatments will only start in October 2016.

Conclusion / Discussion

All preparatory work to create the necessary infrastructure for the irrigation trial is on time, within budget and according to specification at the moment. Treatments and the concomitant monitoring of soil water status, soil temperature, root growth and plant response will only start in October 2016.

EVAPOTRANSPIRATION OF HIGH PERFORMANCE APPLE TREE ORCHARDS

T Volschenk

Objectives & Rationale
Information on orchard water use is crucial for irrigation scheduling and on-farm water. The WRC/HORTGRO study proposes a multi-disciplinary approach to establish water use by high performing orchards and orchards at different growth stages and to develop models to extrapolate the results of the study to other apple cultivars and growing regions.

Methods
Determine soil physical properties (texture, chemical status, soil water retention curves) of four orchards. Install and calibrate soil water content sensors, monitor soil water content throughout the season and calculate evapotranspiration according to a soil water balance for unstressed young non-bearing 'Cripps Red' (CR) and full-bearing 'Golden Delicious' (GD) apple orchards in EGVV.

Key Results
CR and GD orchard ET reached a maximum of c. 7.6 and c. 9.2 mm/d, respectively, on sandy loam soils. In GD, maximum tree and work row ET amounted to c. 7.3 mm/d and 2.6 mm/d, respectively. Maximum ET in the ridged CR tree row was c. 7.4 mm/d, 1.6 mm/d in the non-irrigated work row (cover crop) and 1.4 mm/d in the bare non-irrigated area. Excessively wet conditions at the GD orchard during midsummer, or water deficit during December and January at the CR orchard may have decreased ET below the optimum for these periods.

Conclusion / Discussion
Means to address problems with evapotranspiration estimates using the daily soil water balance need to be researched. Soil water status should be taken into account in interpretation and reporting of tree physiological and yield responses and/ or evapotranspiration data collected through eddy covariance and sap flow techniques.

APPLE ROOTSTOCK EVALUATION IN THE WITZENBERG VALLEY

X Siboza

Objectives & Rationale
The objective of this trial is to assess various new dwarfing, semi-dwarfing and semi-vigorous apple rootstocks from the GENEVA® range against the industry standards M793, M7, M25 and MM109. The performance of different M9 sub-clones is also assessed.

Methods
Trees grafted to Rosy Glow were planted during December 2010 at Paardekloof, Witzenberg Valley. Dwarfing and semi-vigorous rootstocks were grouped together in two adjacent plots that are managed separately. Cepiland, G222, CG3007, Lancep, M793, M7, MM106, MM109/M9 and M9 RN29 were planted in 5 blocks at 4 x 1.25 m spacing as the more dwarfing site while G222, G228, G778, CG934, M25, M793, Maruba and MM109 were planted in 6 blocks at 4 x 1.5 m spacing as the more vigorous site.

Key Results
MM109/M9 and G778 trees appear more yield efficient than would be expected for their size. However, on a cautionary note, the scion diameter of the MM109/M9 trees is measured higher above the ground compared to other rootstocks. In winter 2017, we will measure the diameter of all trees at the same height as MM109/M9. M9 RN29 seems to be most yield efficient of the most dwarfing rootstocks while Lancep trees are stunted and underperforming. Pink colour development and fruit maturity generally decreased with increasing rootstock vigour.

Conclusion / Discussion
G778 gives trees that are of similar size as MM109 but seems more productive. G228 also appears to be an improvement over the similarly-sized to slightly larger M793. In this trial, M793 and MM109 show comparatively poor performance.

EVALUATION OF NEW APPLE ROOTSTOCKS AND INTERSTEM COMBINATIONS IN THE LANGKLOOF (HELDERWATER)

X Siboza

Objectives & 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
More dwarfing (M9 Emla, M9 Nic29, G222, M7, MM109/M9, MM109/G222, M793/M9, M793/G222, G778/M9, and G778/G222) and more vigorous rootstocks (M7, G202, G778, M793, MM109, and G228) were grouped together in two adjacent, but separate plantings. Trees were planted during spring 2013 using randomised complete block designs for both plantings.

Key Results
Our data show that M9 Emla, G778/M9, MM109/M9, M9 Nic 29, G228 and G202 rootstocks are precocious and yield efficient. However, it should be noted that these are preliminary findings. The expected negative relationship between tree size, as indicated by scion diameter, and precocity was observed.

Conclusion / Discussion
The trial has been harvested for the first time and it is still too early to make solid conclusions.

EVALUATION OF NEW APPLE ROOTSTOCKS AND INTERSTEM COMBINATIONS IN GRABOUW (OAK VALLEY)

X Siboza

Objectives & Rationale
The objective of this project is to assess various new apple rootstocks (mostly from the 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
More dwarfing (M9 Emla, M9 Nic29, GA222, M7, MM109/M9, MM109/G222, M793/M9, M793/G222, G778/M9, G778/G222) and more vigorous rootstocks (M7, G202, G778, M793, MM109, G228) were grouped together in two adjacent, but separate plantings. With hindsight, G202 should have formed part of the more dwarfing planting. 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
These results are based on the first harvest (3rd leaf). Trees on all rootstocks have grown well with about 30 cm separating the tallest and the shortest trees in both the more dwarfing and the more vigorous planting. The first yield has been very good and fruit quality was excellent. The expected negative relationship between tree size and yield efficiency was observed. The industry standard M793, MM109 and M7 rootstocks seem to be of lower precocity than some of the Geneva rootstocks of comparable size and also compared to more dwarfing rootstocks. Interstem trees on G778 also seem to be more productive than expected for their size.

Conclusion / Discussion
This was the first yield of these trees and therefore too early for any conclusions.

EVALUATION OF NEW APPLE ROOTSTOCKS AND INTERSTEM COMBINATIONS IN GRABOUW (BREËVLEI)

X Siboza

Objectives & 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
More dwarfing (M9 Emla, NIC29, G222, M7, MM109/M9, MM109/G222, M793/M9, M793/G222, G778/M9, and G778/G222) and more vigorous rootstocks (M7, G202, G778, M793, MM109, and G228) were grouped together in two adjacent, but separate plantings. Trees were planted during spring 2013 using randomised complete block designs for both plantings. Trunk diameter and height increases were assessed as a measure of tree growth during winter 2016.

Key Results
Trees have shown relatively good growth. The trend of Geneva rootstocks being thinner than M-range rootstocks of the same height continued in 2015/16. M7 seems to impart more vigour amongst trees in the more dwarfing planting.

Conclusion / Discussion
The trial will be harvested for the first time in 2016/17 (4th leaf). It is still too early to make any conclusions.

EVALUATION OF PLUM ROOTSTOCKS

P Stassen

Objectives & 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 in single tree plots.

Key Results
On calcareous sandy soil with high numbers of ring nematodes, 'African Delight' on Atlas performs well in terms of yield, fruit weight and yield efficiency, but not significantly better than trees on GF 677 in terms of fruit weight. Cadaman is less yield efficient. Fruit weight of trees on Marianna and Maridon suffers because of the high ring nematode numbers.

On high potential soil with a pH (KCl) of 7.2 and ring, spiral and root-lesion nematodes, 'African Rose' on GF 677, Atlas, Marianna and Viking perform well in terms of yield and fruit weight, whilst no significant difference occurs between Atlas, Marianna and Viking for yield efficiency. Over a three-year period, 'Laetitia' on Viking and SAPO 778 performed well in terms of yield, fruit weight and yield efficiency on high potential soil with high numbers of ring nematodes.

Conclusion / Discussion
On calcareous sandy soil with high numbers of ring nematodes, trees on GF 677, Atlas and Cadaman perform the best. On high potential soil with moderate numbers of several nematodes, trees on GF 677, Viking, Atlas and Marianna perform well in terms of yield, fruit weight and yield efficiency.

EVALUATION OF PEACH ROOTSTOCKS

P Stassen

Objectives & Rationale
The main objective of this project is to evaluate high potential imported and local 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
On high potential calcareous soils, the effect of nematodes, especially ring, is less damaging. No significant differences in terms of yield and fruit weight occur between Alpine trees on Cademan, Garnem, Atlas, GF 677 and Viking.

On high potential soil with low nematode numbers, Artic Star trees on Atlas, Cadaman, Viking and Garnem had the highest cumulative yield over four harvest seasons.

On high potential, non-calcareous soil where high numbers (600/300 ml soil) of ring nematodes occur, no significant differences were found between Cascade trees on Garnem, Atlas, Cademan and Kakamas seedling in terms of yield and fruit weight.

On high potential soil with low ring (193/300 ml soil), root-lesion nematodes, no significant differences occur between Summersun trees on Atlas, SAPO 788 clonal and seedling, Guardian and Viking in terms of yield, fruit weight and yield efficiency.

High risk (95.3%) sandy soil with rising water tables in winter, containing ring (106), root-lesion (169) and spiral (169) nematodes/300 ml soil, Summertime trees had a high % dieback due to *Leucostoma* and *Botryosphaeria* infections.

Conclusion / 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.

EVALUATION OF APRICOT ROOTSTOCKS

P Stassen

Objectives & Rationale

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

Methods

Two trials using a randomised block design were planted in McGregor and Bonnievale during 2013. Rustic trees on Atlas, Viking, Cadaman, GF 677, SAPO 778, Guardian, Marianna, Maridon and Tsukuba 4 with a Royal interstem are evaluated against Royal seedling.

Key Results

Three years after planting the trees at Tevrede, Bonnievale show no significant difference in trunk circumference between trees on Royal seedling as standard and on Atlas, Viking, Cadaman and GF 677 with a Royal interstem. Analysis show low to moderate numbers of root-lesion nematodes in these soils.

At Thornvilla, trees on Royal seedling, Atlas, Viking, Cadaman, Guardian, GF 677 and SAPO 778 (all with a Royal interstems) do not differ significantly in trunk circumference from each other. No signs of breakage at the bud-union occur thus far. High numbers of ring nematodes occur in this soil.

Conclusion / Discussion

Due to pollination problems that was experience with Rustic in commercial orchards during 2014, cross-pollinators and flower bouquets was introduced in these orchards. No fruit-set occurred during the 2015 season.

APPLE REPLANT ROOTSTOCK TRIALS FOR DETERMINING A SCREENING TECHNIQUE

P Vermeulen

Objectives & Rationale

The objective of this study is to quantify the variation in apple rootstock genotypes regarding resistance/tolerance to ARD.

Methods

Rootstocks from the Cornell Geneva range (CG3007, G778, G202) and standard industry rootstocks (M793, M7, MM109) were investigated under ARD conditions in field trials in Elgin.

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 ARD 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 ARD conditions in the field.

Conclusion / Discussion

It is clear that rootstock tolerance is site specific. MM109 seemed to be most susceptible to ARD at both sites, but was the only rootstock that consistently showed tolerance to ARD in previous field trials (2010-2012. Soil chemical and nutrient status was similar for the various rootstocks, therefore not affecting plant growth. Lesion nematode counts were highest for G222 and MM109 (Vergelegen), the more susceptible rootstocks at this site. Parasitic nematodes were indicated to have a site specific role as part of the ARD complex.

ACCLIMATION OF APPLE PEEL TO LIGHT AND TEMPERATURE AND THE EFFECT THEREOF

S Midgley

Objectives & Rationale

As for 2015, with the addition of assessing sun-exposed and shaded canopy positions. We also aimed to determine whether peel acclimation to low temperature decreases the colour response at harvest.

Methods

Shaded or sun-exposed canopy position was added in the light/heat stress trials. Peel discs from 'Rosy Glow' on nine rootstocks were exposed to six temperature treatments under moderately high light, and colour changes measured over a 72-hour period. Evaporative cooling was conducted on 'Cripps' Pink' at temperatures above 28°C for different periods from mid-summer to harvest, and colour development assessed.

Key Results

As in 2015, there were no rootstock effects on on-tree physiological parameters. Duration of stress exposure, the recovery period, and canopy position all influenced photostress and visible peel damage in both cultivars. 'Rosy Glow' showed lower sensitivity to peel damage on CG3007 and higher sensitivity on 'Rosy Glow' own roots, M793 and CG778. In covered 'Golden Delicious' peels stressed for one hour, shade fruit were more sensitive than sun-exposed fruit on CG228 and CG778. Innate ability to develop red colour increased from 16°C to 25°C, but remained high at 31°C in CG222, CG3007 and M793. Cepiland, MM109, MM109/M9 and RN29 had low colour development.

CROP PROTECTION

The Crop Protection research programme was very productive in the past season. A variety of basic and applied research in the fields of nematology, plant pathology and entomology was undertaken. Of interest is the changing environment with respect to the crop protection research programme.

CROP PROTECTION

Matthew Addison

PROFILE

Matthew is the Crop Protection Manager at HORTGRO Science

- *Phytosanitary issues*
- *Soil health*
- *Plant pathology*
- *Biological control agents*

Concerns regarding phytosanitary issues in countries importing South African fruit are a reality and a number of industry funded research projects are aimed at mitigating the threat. For example, false codling moth has received at lot of attention in Europe and other importing countries. The research includes work on genetic, cultivar susceptibility and control measures. Strategically the research programme must allow growers to access markets of their choice, thus the risk of exporting false codling moth must be reduced to a minimum. The same basic principles can be applied to the invasive fruit fly, *Bactrocera dorsalis*. While the fly has yet to reach our major production area it is expected to do so. Current research has allowed us to answer some critical questions regarding the fly's ecology.

Another rapidly changing field of research is soil health and orchard floor management. There is a growing awareness of the importance of soil health internationally. Local research is progressing well and a number of projects have yielded significant results. In addition, an externally funded cooperative research programme has been established to look at soil health issues in deciduous fruit orchards. The integrated nature of the research is fascinating and orchard floor management is expected to become a critical aspect of sustainable fruit production.

A number of important plant pathology projects are underway or complete. They include research on apple scab and stem cankers. The development of more integrated disease management in orchards is seen as a priority and the current research is aimed at addressing this. The apple scab research supplements previous research on the non-chemical control of apple scab. This research will allow for the use of the latest generation of predictive disease management models. Research on nematodes is critical from both the biological control and pathology perspectives. A number of research projects on the use of entomopathogenic nematodes as biological control agents are underway, in addition the use of entomopathogenic fungi in conjunction with the nematodes is being investigated.

The reports on the current and new projects are herewith included. Please contact me should you require any additional information.

CROP PROTECTION

Project List

FINAL PROJECT REPORTS

Received in 2016

APPLE, PEAR, PLUM, PEACH APRICOT, NECTARINE
SHEILA STOREY - Nematode community structure and function as a bio-indicator of the effects of soil amendments on soil health in deciduous fruit orchards

PLUM, PEACH, APRICOT
ELLEUNORAH ALLSOPP - Investigating the use of semiochemicals for integrated management of western flower thrips on stone fruit and table grapes.

APPLE, PEAR, PLUM, PEACH APRICOT, NECTARINE
SHEILA STOREY - Development of monitoring methods and optimisation of a pheromone lure for the grain chinch bug, *Macchiademus diplopterus*.

APPLE, PEAR, PLUM, PEACH APRICOT, NECTARINE
PIA ADDISON - Forecasting *Bactrocera dorsalis* invasion potential using trait-based modelling approaches.

APPLE, PEAR, PLUM, PEACH APRICOT, NECTARINE
JOHN TERBLANCHE - Thermal physiology and population dynamics of bollworm (*Helicoverpa armigera*) in South African fruit orchards.

APPLE
ADELE MCLEOD - Determining the rain fastness of mancozeb on apple leaves and the development of a benchmark spray deposition model for apple scab.

APPLE, PEAR
CHERYL LENNOX - Development of a fungicide sensitivity monitoring service for SA pome fruit pathogens.

PLUM, PEACH, APRICOT
JOHN TERBLANCHE - High temperature disinfestation of false codling moth larvae

FINAL PROJECT REPORTS

Due 2017

APPLE
LIZEL MOSTERT - Survey of stem cankers and dieback symptoms of young apple trees and possible inoculum sources

PLUM, PEACH, APRICOT
ANTOINETTE MALAN - Ring nematode (*Criconemoides xenoplax*) distribution, characterisation and culture

APPLE
ADELE MCLEOD - Management of apple replant disease using phosphonates

PEACH, NECTARINE
PIA ADDISON - Integration of GIS and spatial analysis with monitoring data of major pests for the purposes of area-wide management.

APPLE, PEAR
PIA ADDISON - Biological control of fruit flies using entomopathogenic fungi and nematodes as well as parasitic wasps.

RUNNING REPORTS

APPLE, PEAR
ANTOINETTE MALAN - Incorporating entomopathogenic nematodes and fungi in an integrated pest management system for the control of codling moth.

APPLE, PEAR, PLUM, PEACH APRICOT, NECTARINE
SHELLEY JOHNSON - Grain chinch bug (*Macchiademus diplopterus*) thermal biology and the implications for post-harvest control measures.

PLUM, PEACH, APRICOT
SHELLEY JOHNSON - CATTS as a post-harvest treatment for chill sensitive plum cultivars and associated phytosanitary insect pests.

APPLE, PEAR, PLUM, PEACH APRICOT, NECTARINE
SHELLEY JOHNSON - Investigating the potential of ethyl formate fumigation for phytosanitary control of the grain chinch bug on pome and stone fruit.

APPLE, PEAR, PLUM, PEACH APRICOT, NECTARINE
PIA ADDISON - Using biological control against two sporadic pests in vineyards and orchards.

APPLE, PEAR
MATTHEW ADDISON - Pest and disease monitoring in orchards under shade net.

APPLE, PEAR, PLUM, PEACH APRICOT, NECTARINE
CHRIS WELDON - Dispersal capacity of *Bactrocera dorsalis*

NEW PROJECTS

Approved for 2017

APPLE, PEAR

LENÉ VAN DER WALT - A survey to determine the *Pratylenchus spp.* present in South African apple orchards

PEAR

MARELIZE DE VILLIERS - Phytosanitary status of false codling moth, *Thaumatotibia leucotreta* (Meyrick) (Lepidoptera: Tortricidae) on pears.

PLUM, PEACH, APRICOT

DALENE STEENEKAMP - Control of false codling moth, *Thaumatotibia leucotreta*, on stone fruit with mating disruption.

APPLE, PEAR, PLUM, PEACH APRICOT, NECTARINE

PIA ADDISON - Integrated management of the control of false codling moth, *Thaumatotibia leucotreta*, on deciduous fruit, with focus on biological control.

APPLE

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

NEMATODE COMMUNITY STRUCTURE AND FUNCTION AS A BIO-INDICATOR OF THE EFFECTS OF SOIL AMENDMENTS ON SOIL HEALTH IN DECIDUOUS FRUIT ORCHARDS

S Storey (NEMLAB)

Objectives & Rationale

Nematodes were extracted from soil samples collected from each treatment in the work and tree row at the Vyeboom trial site. These nematodes were used to determine the changes in population density and biodiversity due to cover crop management practices.

Methods

Nematodes were quantified by extracting them from 50 plots comprised of the 5 different treatments and 5 repetitions per treatment for the tree and work rows. Nematodes were identified to family level and data interpreted using various indices.

Key Results

The soil health status has essentially remained unchanged from 2015 and is currently experiencing stressed conditions with nutrient depletion in the soil food web. The condition of the soil food web is similar for the work row and tree row. Bacterial feeding nematodes from the family Cephalobidae are still the most abundant. Fungal-feeding nematodes have increased leading to better structure of the soil food web. There is a significant number of economically damaging plant-parasitic lesion nematodes (*Pratylenchus sp.*) present in the tree row. Levels need to be monitored in order to ensure the economic threshold level is not exceeded and no crop losses or death of young trees occurs.

Conclusion / Discussion

Clear responses in the nematode community have been established owing to changes in the soil environment due to the cover crops and management thereof implemented in this orchard. The orchard should be vigilantly monitored for the presence of plant-parasitic nematodes from the families Pratylenchidae (lesion nematodes). At present the soil food web is degraded and stressed but the system seems to be recovering. Future monitoring will determine this trend.

INVESTIGATING THE USE OF SEMIOCHEMICALS FOR INTEGRATED MANAGEMENT OF WESTERN FLOWER THRIPS ON STONE FRUIT AND TABLE GRAPES

E Allsopp (Arc Infruitec-Nietvoorbij)

Objectives & Rationale

This research aimed to investigate the feasibility of using semiochemicals to modify thrips behaviour in order to minimize economic thrips damage, whilst reducing the need for toxic pesticides. The ultimate aim is to develop an effective, environmentally sustainable integrated management strategy for western flower thrips (WFT) on deciduous fruit crops by using a push-pull system. Three plant essential oils (methyl-salicylate, thymol and carvacrol) were identified from literature as potential oviposition deterrents. Research objectives:

1. Test efficacy of methyl-salicylate, thymol and carvacrol to reduce WFT egg-laying in plum blossoms in laboratory bioassays.
2. Test efficacy of methyl-salicylate, thymol and carvacrol to reduce WFT egg-laying in plum blossoms in screen-house trials with potted plum trees.
3. Collect plum and clover flower volatiles by means of air entrainment.
4. Determine potential of clover as a trap crop for WFT: test attractiveness of with plum and clover flower volatiles by means of olfactometer trials.
5. Test push-pull system with semiochemicals and trap crop in field trials.

Key Results

Laboratory bioassays showed that all three essential oils reduced the oviposition rate of WFT on plum blossoms, but methyl salicylate and carvacrol showed most promise because the lower concentrations of these oils (0.1%, 0.5%, 1%) reduced oviposition rates significantly without causing phytotoxic damage. This study is the first to show that these essential oils are effective in reducing WFT oviposition when applied to fragrant plum flowers. The inability of the wetting agents (Triton X-100 and Citrex® mineral oil) to keep the essential oils in stable suspensions was identified as a problem and this was confirmed by the lack of significant results in the screen-house and insectary trials using potted plum trees. Plum blossoms and clover flower volatiles were successfully captured by means of air entrainment. Olfactometer studies showed that clover flower and plum blossom volatiles are highly attractive to WFT. This means that clover has potential as a trap crop for WFT, but it will only be effective if used in conjunction with an oviposition deterrent. The high level of attraction to WFT demonstrated for plum blossoms means that this holds true for any other potential trap crop. Equipment procured and training received in air entrainment techniques during this study meant that Porapak

Q tubes for air entrainment could be prepared and processed locally, instead of having to be obtained from and sent overseas for processing at significant costs. ARC Infruitec-Nietvoorbij is now also able to do air entrainment and prepare and process Porapak Q tubes for air entrainment as a service to other local researchers.

Conclusion / Discussion

In conclusion, methyl salicylate and carvacrol show promise as oviposition deterrents for WFT on plum blossoms and clover would be suitable as a trap crop. At present, the lack of a suitable formulation for the oviposition deterrents is a limiting factor. However, if research on microencapsulation of essential oils is successful in providing a stable formulation with sustained release of behaviourally effective essential oil concentrations, implementation of a push-pull strategy to manage WFT in plum and other fruit orchards appears to be attainable.

DEVELOPMENT OF MONITORING METHODS AND OPTIMISATION OF A PHEROMONE LURE FOR THE GRAIN CHINCH BUG, *MACCHIADEMUS DIPLOPTERUS*

S Johnson (Stellenbosch University)

Objectives & Rationale

We investigated the chemical ecology and orientation behaviour of shelter-seeking grain chinch bugs, *Macchiademus diplopterus*, to evaluate the use of pheromones and profiles in monitoring and trapping methods for grain chinch bugs.

Methods

Headspace volatile compounds were identified from active bugs through gas chromatography-mass spectrometry analysis. The efficacy of synthetic lures using previously identified aggregation pheromone components, and sex pheromone volatile components (identified in present study) was studied in combination with modified traps using rubber septa dispensers in field trials. Also, behavioural responses of grain chinch bugs to visual objects (shapes – rectangle, circle, triangle and square; and colours – red, black, green and yellow) were carried out under laboratory conditions.

Key Results

There was no significant difference ($P > 0.05$) between insects caught in the sex pheromone baited traps and the aggregation pheromone baited traps. Traps caught low numbers of bugs compared to the level of orchard infestation indicated by the amount of bugs that were found sheltering in corrugated cardboard bands tied around tree trunks. The corrugated cardboard bands showed a significant difference in the number of bugs sheltering between bands placed at bottom and top positions on the trees. More bugs were found in bottom bands. Behavioural responses of grain chinch bugs to different shapes presented in their visual space indicated that there was a significant difference ($P = 0.0001$) in the choice of shape. Vertical/upright rectangular shapes had the highest number of grain chinch bug visits. Grain chinch bugs responded to upright rectangles of different colours. Black and red rectangles were not significantly different ($P > 0.05$) from each other but were both significantly different ($P = 0.0001$) from green and yellow rectangles.

Conclusion / Discussion

The study has provided new information on the constituents of pheromones produced by grain chinch bugs, but use of these pheromones as lures in trapping systems for the grain chinch bug requires additional work. Grain chinch bugs have a preference with regard to the shape and colour of profiles in its field of view. This preference must be taken into consideration and used in combination with effective lures, when developing traps to attract grain chinch bugs.

FORECASTING *BACTROCERA DORSALIS* INVASION POTENTIAL USING TRAIT-BASED MODELLING APPROACHES

P Addison (Stellenbosch University)

Objectives & Rationale

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

Methods

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

Key Results

There were no statistically significant differences between the total numbers of eggs produced by *B dorsalis* on nectarine and plum over 90 days, but *B. dorsalis* produced significantly more eggs during the 24 h test period on plum than on peach. When the adults of the two species competed for oviposition, *B. dorsalis* out-competed *C. capitata* in most instances; but when the larvae of the two species competed to complete their life cycles in one fruit, *C. capitata* was more successful than *B. dorsalis* in most instances. The eggs of *B. dorsalis* were the life stage most resistant to the high (42.7°C) and low (-6.5°C) discriminating temperatures. We found that adult *B. dorsalis* heat-hardened at 37°C and 39°C, but a brief 2 h cold exposure at a mild (non-lethal) temperature did not result in statistically significant increased survival at the low discriminating temperature of -6.5°C

Conclusion / Discussion

Bactrocera dorsalis is a robust fly that will be able to reproduce successfully on the deciduous and stone fruit crops produced in the Western Cape. The distribution might be restricted by cold temperatures.

THERMAL PHYSIOLOGY AND POPULATION DYNAMICS OF BOLLWORM (*HELICOVERPA ARMIGERA*) IN SOUTH AFRICAN FRUIT ORCHARDS

J Terblanche (Stellenbosch University)

Objectives & Rationale

Predicting how climate affects pest insects such as the Bollworm (*Helicoverpa armigera*) requires an understanding of the environments to which they are exposed, and so we plan to develop a mechanistic model to translate broad-scale meteorological datasets into their microclimatic conditions. We will then run model simulations, at different spatial resolutions, across deciduous fruit growing regions within South Africa. These results will provide an indication of the spatial scale at which future studies focusing on Bollworm, and on insect pests in general, should be conducted. These models will also provide a first indication of likely climate change impacts of Bollworm in South African agricultural landscapes.

Methods

Over the past three years we have made considerable progress in understanding how climate and topography affect the performance and survival of the African Bollworm (*Helicoverpa armigera*). We have developed a biophysical model that translates spatially explicit data of climate and terrain into the microclimates encountered by the different life-history stages of the Bollworm on its host apple tree. Once conditions in the Bollworm's immediate environment are determined, the model calculates the animal's core-body temperature, and then draws on established datasets to ascertain its capacity to develop and survive.

Key Results

Model simulations across the Western Cape province (centering on Villiersdorp) and found that, as well as climate, local topographic variation has significant impacts on the Bollworm's population dynamics (voltinism), phenology and exposure to thermal stress. More specifically, individuals on northern facing slopes were predicted to have significantly warmer body temperatures, reduced thermal stress, and a greater number of completed generations. As such, the fitness of Bollworm may vary considerably between adjacent orchards that differ only in topography. These findings have been published in an international journal, Austral Entomology, and have received considerable interest from researchers in the field. In a second study, we ran model simulations across local (Western Cape) and global extents at three spatial resolutions (0.5km, 1km and 1.5km grid cells) to ascertain how spatial scale affects our predictions of Bollworm's core-body temperature and fitness. We found significant interactions between elevation of the site and model resolution such that the coarse scale under-, and then over-predicted core-body temperature (in comparison to the fine-scale model) as elevation increased.

Conclusion / Discussion

These systematic discrepancies in our body-temperature predictions, and associated fitness traits, were detected across local and global extents. Our findings help explain why many previous studies detect either larger or smaller distributions when comparing model outputs that have been run at multiple resolutions.

DETERMINING THE RAIN FASTNESS OF MANCOZEB ON APPLE LEAVES AND THE DEVELOPMENT OF A BENCHMARK SPRAY DEPOSITION MODEL FOR APPLE SCAB

A McLeod (Stellenbosch University)

Objectives & Rationale

The contact fungicide mancozeb forms an integral part of apple scab (*Venturia inaequalis*) management in South Africa. Effective fungicide spray deposition is required for optimal disease management. It is important to link spray deposition to biological efficacy by developing a spray deposition benchmark model. Rainfall is an important factor that influences disease control by foliar applied pesticides. The projects objectives are to (i) determine if a yellow fluorescent pigment is a suitable tracer for mancozeb formulations, (ii) develop a mancozeb spray deposition benchmark model for apple scab and (ii) determine the rain fastness of different mancozeb treatments (Dithane M-45 800 WP NT, Ventum 800 WP, and Ventum 800 WP combined with a sticker-spreader adjuvant Nu-Film P).

Methods

The rain fastness of the three mancozeb treatments was studied by quantifying the percentage fluorescent pigment loss using macorphotography, fluorometry and image analyses and the percentage loss in mancozeb residues (manganese ions). Benchmark development involved apple seedling leaves being treated with a concentration range of mancozeb and fluorescent pigment (0, 0.15 ×, 0.3 ×, 0.45 ×, 0.6 × and 1.0 ×), followed by inoculation with conidia. *Venturia inaequalis* control was assessed using a basic fuschin based staining technique and visual assessment. The in vitro production of *V. inaequalis* conidia was investigated using a cellophane technique.

Key Results

A yellow fluorescent pigment was shown to be a suitable tracer for five different mancozeb formulations. Simulated rain applied to apple seedlings at a constant rainfall intensity of 5 mm/h at five different rainfall volumes (0, 1, 5, 10 and 15 mm) resulted in no significant differences between the three mancozeb treatments. Although a good correlation (r = 0.726 to 0.783) existed between FPC% and Mn-ions, the response of FPC% and Mn-ion differed somewhat as was evident from the slopes of exponential regression models. A significant loss (11.95%) in mancozeb residue occurred after applying 1mm of rain, but no significant differences in losses (26.32 to 31.67%) occurred after applying 5 to 15mm of rain. The benchmark model development work showed that the staining technique was useful for quantifying *V. inaequalis* infection within 6 days, but it underestimated percentage control relative to the visual assessment of lesions after 3-4 weeks. Complete control was observed for all mancozeb concentrations based on visual lesion assessment. No function could thus be fitted to deposition quantity data versus disease control. The cellophane agar plate technique was optimized for the in vitro production of *V. inaequalis* conidium inoculum.

Conclusion / Discussion

The study provided valuable information for the assessment of mancozeb deposition,

mancozeb rainfastness, and benchmark model development. The yellow fluorescent pigment can be used as an excellent cost effective tracer for mancozeb deposition on apple seedling leaves, and will also be helpful for identifying trends on the effect of rain on the persistence of mancozeb. Mancozeb is relative rain fast following the application of 5 to 15mm rainfall at moderate intensity. Although a benchmark model could not be developed, a rapid staining technique for quantification of *V. inaequalis* disease severity was identified that can be optimized further.

DEVELOPMENT OF A FUNGICIDE SENSITIVITY MONITORING SERVICE FOR SA POME FRUIT PATHOGENS

C Lennox (Stellenbosch University)

Objectives & Rationale

Several pome fruit fungicides are at risk for fungicide resistance development due to the nature of the pathogen and the site directed activity of the chemicals. Monitoring of shifts in fungicide sensitivity requires prior knowledge of sensitivity in fungal pathogen populations. Baseline fungicide sensitivity of *Botrytis cinerea* (causing pear grey mould) and *Venturia inaequalis* (causing apple scab) was tested.

Methods

Botrytis cinerea baseline fungicide sensitivities were compared to fungal isolates from pear trees previously exposed to botryticides from three orchards, which were tested for fungicide sensitivity to benomyl, fludioxonil, iprodione, and pyrimethanil at discriminatory doses (N=45). *Venturia inaequalis* isolates (N= 42) were tested for sensitivity to cyprodinil, dodine and mancozeb.

Key Results

Botrytis cinerea baseline sensitivity for pyrimethanil was found to be at EC50= 0.18 ug ml-1 (range 0.09-0.40 ug ml-1). Significant shifts towards resistance were identified in *B. cinerea* isolates towards pyrimethanil when tested at the discriminatory dose (29% resistant). At the discriminatory dose mycelial growth was inhibited in 93 % isolates with benomyl, 99.4 % with fludioxonil, and 95% with iprodione. *Venturia inaequalis* isolates from an abandoned orchard (baseline population) had a mean EC50 of 0.88 ug ml-1 for cyprodinil (range 0.06-3.90 ug ml-1), and 0.08 ug ml-1 for dodine (range 0.01- 0.58 ug ml-1).

Conclusion / Discussion

Results suggest that pyrimethanil sensitivity levels in *B. cinerea* have shifted towards resistance and that botryticides involving dicarboximides, or phenylpyrrole group fungicides could effectively control grey mould on pears. The tested *V. inaequalis* population was found to be sensitive to cyprodinil, dodine and mancozeb.

HIGH TEMPERATURE DISINFESTATION OF FALSE CODLING MOTH LARVAE

J Terblanche (Stellenbosch University)

Objectives & Rationale

The factors affecting thermal limits of insects are of central importance to predicting the influence of changing environmental conditions on their distribution and abundance, which has significant implications for pest management strategies. For holometabolous insects, it is of particular importance to establish the life-stage-related variation in acute critical thermal limits to activity and survival.

We aimed to fill the crucial knowledge gap of thermal tolerance limits in adult and larval false codling moth (FCM), *Thaumatotibia leucotreta* by examining thermal tolerance (upper and lower thermal limits) using a variety of different tolerance measures. We investigated the effect of different rates of heating and cooling on critical thermal limits as well as rapid heat hardening (acute plasticity) and survival assays across the different life stages. We specifically tested the prediction, generated from dynamic ramping assays, that a life-stage with a strong positive association between thermal tolerance estimates and ramping rate show less pronounced hardening responses.

Methods

Using a suite of standard lab thermal tolerance assays we tested the ability of FCM larvae and adults to survive and remain active across a diverse range of thermal conditions.

Key Results

Final-instar larvae are generally more tolerant to a broader range of thermal conditions than adults (lethal temperature range: larvae 61.2°C vs. adults 49.2°C following 2 h exposure). Larvae show a stronger positive effect of ramping rate on critical thermal estimates than adults, but adults were more thermally plastic, supporting the aforementioned hypothesis. The difference in basal and plastic thermal tolerance between life-stages suggests there are trade-offs between these in T. *leucotreta*, indicating that hardening effects and their variation among life-stages could play a role in predicting the impact of ramping rate variation under natural conditions.

Conclusion / Discussion

Larvae of FCM are able to survive a much broader thermal range of conditions than adults. This has significant implications for population dynamics modelling and post-harvest fruit disinfestation. Although larvae are more tolerant to a wider range of acute thermal conditions, adults are more plastic (able to adjust to novel conditions). It is critical that any attempt to forecast or predict mortality owing to thermal stress considers life-stage related variation, and is mindful of both basal and inducible forms of tolerance depending on the time-scales under consideration.

SURVEY OF STEM CANKERS AND DIEBACK SYMPTOMS OF YOUNG APPLE TREES AND POSSIBLE INOCULUM SOURCES

L Mostert (Stellenbosch University)

Objectives & Rationale

The occurrence of canker/ dieback pathogens was assessed on plants sampled from rootstock mother layer blocks as well as visually healthy nursery apple trees. Also, the sampling of one-year-old commercial orchards was completed.

Methods

Asymptomatic shoots from rootstock layers blocks and shoots with cankers (if present) were sampled and isolations made. Certified, healthy nursery trees were collected from

four nurseries. Isolations were made from the scion shoot, bud union, pruning wound on the rootstock and rootstock. The fungal taxa were identified with DNA sequencing and comparisons with an international sequence database. One-year-old trees showing symptoms of dieback or cankers were collected from young orchards and analysed in a similar way.

Key Results

Young orchards

Forty percent of the 130 trees evaluated harboured canker causing pathogens. Cankers were mostly observed on the scion shoot of the trees, but also on the pruning wound, rootstock, and the bud union. *Didymosphaeria sp.* was the most predominant fungus isolated followed by *Diplodia seriata* and *Eutypella citricola*. Soil analyses revealed high phosphor levels and in the majority of orchards too low pH, indicative of suboptimal soil conditions.

Rootstock mother material

Of the asymptomatic shoots (405) in layer blocks 21% had infections. *Didymellacaea spp.* was the most predominant fungal taxa isolated followed by *Truncutella angustata*. In blocks with transplanted rootstocks, 87 shoots with cankers were sampled and 41% had canker causing pathogens. The most predominant pathogens from the shoots with cankers were *Diplodia seriata*, followed by *Valsa malicola*. The shoots with cankers also had fruiting bodies of canker causing pathogens.

Nursery plants

In total 480 visually healthy nursery trees were analysed. The majority of the pruning wounds and the bud unions had vascular discoloration. The infection levels of the nurseries ranged from 51% to 71%. Sixty-five percent of the nursery trees evaluated harboured canker or wood rot pathogens. Dieback causing pathogens were mostly isolated from the bud union and the pruning wound on the rootstock. *Didymosphaeria sp.* was the most predominant fungus isolated. Fungal taxa in the Botryosphaeriaceae, Basidiomycetes, Diatrypaceae, Diaporthales, Coniochaetales and species of Phaeoacremonium, all known canker or wood rot pathogens of fruit trees were isolated as well.

Conclusion / Discussion

The high infection percentage of the bud unions and pruning wounds indicate that aerial inoculum is present at the time these wounds are made in the nurseries. The protection of pruning wounds is necessary and budding practices needs to be improved. The removal of rootstock plants with cankers.

RING NEMATODE (*CRICONEMOIDES XENOPLAX*), DISTRIBUTION, CHARACTERIZATION AND CULTURE

A Malan (Stellenbosch University)

Objectives & Rationale

Codling moth (CM), *Cydia pomonella* (L.), is the most important pest of apples and pears in South Africa. Currently, mating disruption and chemical control is a standard practice, while the use of parasitic wasps and of entomopathogenic nematodes (EPNs) for the control of CM is still in the experimental phase.

The use of entomopathogenic fungi (EPF) as an additional biological tool for the control of CM has not yet been exploited in South Africa. Further research into the use of EPNs under suboptimal environmental field conditions, and into the use of EPF in an integrated pest management (IPM) system, is required.

The success of EPF in controlling a wide range of insect pests indicates the method to be a biological control option for the control of CM. Several EPF, including *Beauveria spp.*, and *Metarrhizium spp.*, have been found to attack CM.

Furthermore, the issues relating to the use of EPN during the winter months under suboptimal conditions, and to the inconsistent results found in field trials aimed at the control of the diapausing winter larval population for future commercial application, have still to be resolved. Some of the previous field trials gave disappointing results with commercially available nematode formulations, in comparison to those that were obtained with our local nematode isolates.

This project will be aimed at building on previous research that has been undertaken with CM and EPNs. A second tool for use in IPM would be to incorporate EPN and EPF individually, and in combination, into an IPM system directed towards the effective control of autumn, winter and spring diapausing CM population.

MANAGEMENT OF APPLE REPLANT DISEASE USING PHOSPHONATES

A McLeod (Stellenbosch University)

Objectives & Rationale

The major apple replant disease (ARD) pathogens in South Africa consist of oomycetes, with plant parasitic nematodes also sometimes being involved. The first aim for this reporting period is 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 will be to determine the best time and method of application for phosphonate treatment of non-bearing apple trees, and whether oomycete replant pathogens are sensitive to phosphite.

The efficacy of ARD management with semi-selective chemicals on fumigated and non-fumigated soil were evaluated in four orchards using tree growth performance and pathogen quantifications. Of the semi-selective chemicals, phenylamide, fenamiphos and imidacloprid were only applied at planting as a soil drench, whereas phosphonates were applied annually. The effect of timing (winter versus summer) and application method (soil drench, stem spray, stem paint and foliar sprays) on phosphonate translocation to roots were evaluated in two orchards on non-bearing apple trees by measuring root phosphite concentrations. The sensitivity of different oomycete ARD pathogens to phosphite will be determined in vitro and in root-bioassays.

Based on the results of four ARD orchard trials, two in their second and two in their third year of growth, the application of semi-selective chemicals show potential for managing ARD in orchards planted on non-fumigated soil, since similar tree growth responses were observed as on fumigated soils. However, at one orchard trial the semi-selective only treatment tended to be less effective than some, but not all, of the fumigant treatments. The application of semi-selective chemicals to trees grown on fumigated soil did not improve tree growth relative to the fumigated only treatments. The evaluation of different times and methods of phosphonate applications showed that in both trials, the best application method was stem painting since it yielded the highest and most persistent root phosphite concentrations. Following summer applications, root phosphite concentrations declined rapidly. The decline in root phosphite concentrations were somewhat less following winter applications, but this differed in the two trials.

Semi-selective chemicals may have potential for managing ARD, but continued tree growth and yield measurements are required in the four experimental orchards. Characterization and quantification of the pathogen complex will also be important, and must still be conducted. The highest root phosphite concentrations in non-bearing apple trees can be obtained by stem paint application. Since root phosphite concentrations decline over time, especially in summer, a winter and summer application is likely required

INTEGRATION OF GIS AND SPATIAL ANALYSIS WITH MONITORING DATA OF MAJOR PESTS FOR THE PURPOSES OF AREA-WIDE MANAGEMENT

P Addison (Stellenbosch University)

Objectives & Rationale

1. Incorporate fruit fly, false codling moth and codling moth monitoring data from Fruit Fly Africa, XSIT and Elgin producers, respectively, into a geo-database. Together with corresponding environmental variables in order to spatially analyse the monitoring data.
2. Investigate the variation in the spatial patterns of Mediterranean Fruit fly (Medfly).
3. Which variables are most influential in determining these spatial patterns.

Methods

1. Incorporate monitoring data into a Geographic Information System (Data management procedure).
2. Optimized hotspot analysis (ArcGIS 10.3.1) 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 set milestones for objective two to four have been achieved. All necessary monitoring data have been incorporated into a Geographic Information System with the relevant ecological data. Analysis of the Fruit Fly data have been done in the EGVV area. The results show that Medfly distribution is aggregated in the early season (November and December). The areas where the aggregations occur are strongly associated with citrus fruits. Moreover, according to the long term monitoring data for Medfly in the EGVV area, the Villiersdorp and eastern Vyeboom areas tend to have clustering of high trap catches in general. Classification and regression tree (CART) analysis was performed to explain the spatial variation in fruit fly trap catches throughout the season in the EGVV area making use of various explanatory variables. These variables could only explain the long term spatial variation in fruit fly trap catches and not the weekly/seasonal spatial variation in the trap catches.

Conclusion / Discussion

Following the optimized hotpot analysis performed on the data, our attention was focussed on citrus and the winter and spring (population build up period) time periods. This time period and the areas associated with citrus seem to play a major role in the population size in the fruiting season (Myburgh 1956). Other possible explanatory variables that might explain the weekly/seasonal variation in the trap catch data will be investigated further.

BIOLOGICAL CONTROL OF FRUIT FLIES USING ENTOMOPATHOGENIC FUNGI AND NEMATODES AS WELL AS PARASITIC WASPS

P Addison (Stellenbosch University)

Objectives & 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 commencement of this project, fieldwork has been conducted to collect soil in order to isolate entomopathogens. Several have been isolated using wax moth larvae and meal worms and then preserved.

Several local known EPN species along with one isolate obtained during the soil surveys has been screened against late instar larvae of *C. capitata* by exposing the larvae to 100IJs/50µL in bioassay plates. Known EPF species will soon be screened using the immersion/dipping method.

Fieldwork has been conducted to sample fruit fly infested fruit to rear out associated parasitoids. These natural enemies will be removed, dried (using Critical Drying Point method), mounted

and catalogued before being digitally imaged and identified.

Key Results

No new isolates of fungi or nematodes have been isolated from soil surveys yet, but one potential EPN (*Heterorhabditis zealandica*) was used in screening experiments. Screening of EPNs has yielded promising results, with *C. capitata* larval mortality ranging from 50-100% for each species. Further statistical analyses are in progress to identify the most virulent EPN. Fruit fly infested apples, pears, plums, peaches, kei apples and grapes have been sampled and several parasitoids have been reared. Identification of these specimens are in progress in collaboration with Simon van Noort. Parasitoids reared from tropical fruit in Limpopo by Tertia Grove have also been mounted and are in the process of being imaged and identified.

Conclusion / Discussion

Many more, and potentially new, entomopathogenic isolates are expected from the soil sampling that will take place during the coming season (2016/17). Use of EPNs against *C. capitata* is showing great potential from initial screening efforts. Contribution of parasitoid knowledge (and images) is on-going, and a greater sampling effort will take place also during the coming season.

INCORPORATING ENTOMOPATHOGENIC NEMATODES AND FUNGI IN AN INTEGRATED PEST MANAGEMENT SYSTEM FOR THE CONTROL OF CODLING MOTH

A Malan (Stellenbosch University)

Objectives & Rationale

Codling moth (CM), *Cydia pomonella* (L.), is the most important pest of apples and pears in South Africa. Currently, mating disruption and chemical control is a standard practice, while the use of parasitic wasps and of entomopathogenic nematodes (EPNs) for the control of CM is still in the experimental phase. The use of entomopathogenic fungi (EPF) as an additional biological tool for the control of CM has not yet been exploited in South Africa. Further research into the use of EPNs under suboptimal environmental field conditions, and into the use of EPF in an integrated pest management (IPM) system, is required.

The success of EPF in controlling a wide range of insect pests indicates the method to be a biological control option for the control of CM. Several EPF, including *Beauveria spp.*, and *Metarrhizium spp.*, have been found to attack CM. Furthermore, the issues relating to the use of EPN during the winter months under suboptimal conditions, and to the inconsistent results found in field trials aimed at the control of the diapausing winter larval population for future commercial application, have still to be resolved. Some of the previous field trials gave disappointing results with commercially available nematode formulations, in comparison to those that were obtained with our local nematode isolates.

This project will be aimed at building on previous research that has been undertaken with CM and EPNs. A second tool for use in IPM would be to incorporate EPN and EPF individually, and in combination, into an IPM system directed towards the effective control of autumn, winter and spring diapausing CM population.

GRAIN CHINCH BUG (*MACCHIADEMUS DIPLOPTERUS*) THERMAL BIOLOGY AND THE IMPLICATIONS FOR POST-HARVEST CONTROL MEASURES

P Addison (Stellenbosch University)

Objectives & Rationale

In order to better understand the thermal biology of *Macchiademus diplopterus*, grain chinch bug, the changes in thermal tolerance, the effect of different modified controlled atmospheres on thermal tolerances and the cold tolerance strategy of aestivating and active grain chinch bugs were investigated.

Methods

Critical thermal minima and maxima were determined for bugs collected during mid aestivation, late aestivation and the active reproductive period. This was done under regular air (RA) and four different modified controlled atmospheres: high CO_2 and low O_2 (4%CO_2 + 4%O_2), the CATTS mixture of high CO_2 and low O_2 at 15% CO_2 & 1% O_2, high CO_2 (4%CO_2) and low O_2 (4%O_2). Supercooling points and lower lethal temperatures of insects collected in each period were determined.

Key Results

Results indicate that grain chinch bugs become more thermal tolerant further into aestivation. However, the application of modified atmospheres reduces both cold and heat tolerance in grain chinch bugs. Grain chinch bugs are extremely cold tolerant, but are freeze intolerant.

Conclusion / Discussion

Since grain chinch bugs become more thermal tolerant further into aestivation, the development of temperature-based postharvest treatments must be focused on late aestivating bugs. Since modified atmospheric conditions reduce grain chinch bug thermal tolerance combination treatments or pre-treatments with modified atmospheres will improve efficacy of temperature treatments.

CATTS AS A POSTHARVEST TREATMENT FOR CHILL-SENSITIVE PLUM CULTIVARS AND ASSOCIATED PHYTOSANITARY INSECT PESTS

S Johnson (Stellenbosch University)

Objectives & Rationale

Postharvest mitigation treatment is necessary to disinfest export fruit of phytosanitary pests, to minimize the risk of consignments being

rejected. Cold temperature as a phytosanitary treatment is effective against a variety of pests, but some stone fruit cultivars are chill-sensitive and therefore cannot be exported using the current cold sterilization regimes. The use of CATTS (Controlled Atmosphere Temperature Treatment System) was investigated as potential postharvest mitigation treatments.

Methods

The use of CATTS as a chemical free new technology incorporating heat and atmospheric stress to control key phytosanitary pests, grain chinch bug (*Macchiadermus diplopterus*), banded fruit weevil (*Phlyctinus callosus*) and false codling moth (*Thaumatotibia leucotreta*) larvae on chill-sensitive Japanese plum cultivars (*Prunus salicina Lindl.*) was investigated. The use of ethyl formate as a fumigant to control the grain chinch bug on selected stone and pome fruit cultivars was also investigated. With regards to CATTS, different temperature treatments in combination with controlled atmosphere were cold stored using two different cold storage regimes, namely cold sterilization and intermittent warming, to examine the effectiveness of the CATTS treatments and cold storage as phytosanitary pest control while maintaining fruit quality. Fruit quality was evaluated after application of treatments, after storage and after cold storage plus shelf life simulation.

Key Results

The grain chinch bugs have proved to be the most difficult in attaining a 100% mortality rate with the selected treatments while still maintaining fruit quality. The banded fruit weevil required lower temperatures with shorter treatment durations to obtain 100% mortality compared to the false codling moth or the grain chinch bug. Both of the latter required more stresses to increase the mortality rate resulting in a decrease in fruit quality in some cases. The impact of the treatments on the physiology of the fruit with regards to quality parameters (hue angle, flesh firmness, internal and external quality etc.), heat shock proteins and phospholipid fatty acid content was also assessed.

Conclusion / Discussion

Depending on the insect pest that requires phytosanitary control, CATTS technology in combination with different cold storage regimes could be used to provide phytosanitary security for chill-sensitive Japanese plums and expand market accessibility.

INVESTIGATING THE POTENTIAL OF ETHYL FORMATE FUMIGATION FOR PHYTOSANITARY CONTROL OF THE GRAIN CHINCH BUG ON POME AND STONE FRUIT

S Johnson (Stellenbosch University)

Objectives & Rationale

Due to the lack of postharvest mitigation treatments for the grain chinch bug, a cold hardy external phytosanitary pest of South African export fruit, and the need for alternatives to methyl bromide fumigation, the efficacy of ethyl formate fumigation against grain chinch bug was assessed. Ethyl formate (EF) is considered to be the most promising fumigant to replace methyl bromide.

Methods

Efficacy trials. To investigate the effect of fumigation with ethyl formate on the mortality of grain chinch bug, as well as the effect of fumigation on fruit quality, selected plum, nectarine and pear cultivars ('Songold' plums, 'August Red' nectarines, 'Russet Gold Bosc' and 'Forelle' pears) were treated together with live adult grain chinch bugs. Three concentrations of EF were applied (50, 100 and 150 g/m3) t to examine its effectiveness after 1 h of fumigation to control grain chinch bug.

Central composite design model trial. To determine optimum dose, duration and treatment temperature to achieve 100% mortality of the grain chinch bug with no phytotoxic effect on 'Russet Gold Bosc' pears, a central composite design (CCD) model was used. A CCD model was compiled for three different pulp temperatures (0, 10 and 23°C) to determine if the product's temperature at time of treatment play a role in its susceptibility to damage.

Key Results

Ethyl formate achieved a 100% mortality of grain chinch bug with the dose range of 50 - 150 g/m3 after 1-hour exposure without decreasing fruit quality significantly.
The CCD model was able to provide guidelines with regards to dose range and duration which yielded no phytotoxic effect after cold storage plus shelf-life simulation.

Conclusion / Discussion

Ethyl formate was successful in controlling grain chinch bug without phytotoxic effect. This knowledge needs to be expanded to enable commercial application of ethyl formate/ VapormateTM for external pests. The development of successful treatments will not only help maintain current markets which are constrained by available mitigation options, but will also allow for market expansion and growth of the industry.

USING BIOLOGICAL CONTROL AGAINST TWO SPORADIC PESTS IN VINEYARDS AND ORCHARDS

P Addison (Stellenbosch University)

Objectives & Rationale

The common method of controlling banded fruit weevil (BFW), *Phlyctinus callosus* (*Coleoptera: Curculionidae*) involves the use of pyrethroids applied on the tree trunks and on foliage. Entomopathogenic nematodes (EPNs) from two families (Heterorhabditidae and Steinernematidae) can be incorporated in an integrated pest management system to control *P. callosus* which is a key pest of grapes, apples and nectarines in South Africa. Due to the sporadic nature of katydids in vineyards, no chemical pesticides have been registered for this pest and current chemical control measures are mostly ineffective. However, previous research has identified possible biological control agents, including entomopathogenic fungi (EPFs) and parasitic wasps, which can be incorporated into an IPM program.

Methods

An "Entomopathogenic Fungi for Insect Pathology" workshop was attended to develop the necessary skills required for testing EPFs against both insect pests. Two EPNs were evaluated for their virulence and their ability to suppress populations of *P. callosus* last instar larvae. The two EPNs were compared in dose–response bioassays by exposing the larvae to six infective juvenile (IJ) concentrations (0, 25, 50, 100, 200 and 400). In the assays, *S. yingalemense* was more virulent than *H.*

noenieputensis. The LC50 values were 25 and 50 IJs/insect for *S. yingalemense* and *H. noenieputensis*, respectively.

Conclusion / Discussion

S. yingalemense shows good control against *P. callosus* in preliminary laboratory trials at 100IJs/insect. However, more EPNs must be tried before the pathogen can be incorporated into an integrated pest management system to improve the control of *P. callosus*. Trials against katydids will commence early in the growing season as soon as immatures are monitored in the field.

PEST AND DISEASE MONITORING IN ORCHARDS UNDER SHADE NET

M Addison (Stellenbosch University)

Objectives & 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 assess where possible.

Methods

Orchard A23 on Oak Valley Estate in Elgin was selected for the purpose. The orchard is fully enclosed with 20% white shade cloth effectively decreasing sunlight by 8%. The orchard is 2.45 ha in extent and is planted to Granny Smith on a range of rootstocks (CG 222, M7, M9, M109). The orchard was planted in 2012 and extended in 2013. The orchard is contiguous and an untreated (trees without nets) area is not 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 / 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.

DISPERSAL CAPACITY OF *BACTROCERA DORSALIS*

C Weldon (Stellenbosch University)

Objectives & Rationale

The key outcome of this project is to establish the dispersal capacity of the invasive fruit fly, *Bactrocera invadens*, with regard to environmental and physiological variables. It is now recognised that *B. invadens* is a synonym for the Oriental fruit fly, *Bactrocera dorsalis*.

Methods

Sterile *B. dorsalis* were used in mark-release-recapture experiments to determine the effects of fly maturity, sex and availability of host fruit on dispersal. To explore the physiological basis for field dispersal results, the PhD student assigned to the project, Mrs Louisa Makumbe, has determined the influence of temperature on locomotor activity.

Key Results

Three of four releases of sterile *B. dorsalis* have been completed. Results to date suggest 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. One more release is scheduled for October 2016. *Bactrocera dorsalis* is largely inactive at temperatures lower than 20°C. The frequency and duration of walking and flight increases between 24-32°C. At a temperature of 36°C, the duration of resting begins to increase, which may indicate the onset of thermal stress.

Conclusion / 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, higher dispersal ability of younger flies may result from higher numbers of short flights when temperatures are suitable.

POST HARVEST

The essence of this programme is to support and enhance the processes across the supply-chain to ensure that intrinsic product integrity is maintained. The latest Postharvest Innovation (PHI) programme comes to an end with final reports due on 31 December 2016.

POST HARVEST

Richard Hurndall

PROFILE

Richard is the Research and Development Manager at HORTGRO Science and also manages the Postharvest Programme for the organisation.

- *Stone fruit*
- *Postharvest biocontrol*
- *Internal browning*
- *RA/CA storage*

STONE FRUIT

Stone fruit projects conducted by Experico included:

- Forced Air Cooling (FAC) and Field Heat Removal (FHR) on plums and apricots
- Investigate maximum temperature at loading of plums up to 3.0 °C
- Testing a 7 mm plunger as a tool to determine flesh firmness of nectarines at harvest
- Measuring pulp temperatures of plums in Quest shipping containers
- Treating dual-temperature plums with SmartFresh^{SM}, with and without a warming period, to overcome the cold-sterilisation treatment

The Horticulture Department looked at the water vapour peel permeance of plums in relation to shrivel, and attempting to reduce shrivel with various liner bags.

In addition, a postharvest biocontrol project on stone fruit (PHI) is being conducted by the Stellenbosch University Process Engineering Department (Prof Kim Clarke), as well as a container optimisation logistics project, motivated via the Packhouse Action Group, by Mr Koos Bouwer.

POME FRUIT

Internal browning is receiving attention in Rosy Glow (SU), and Fuji (Experico). An extensive Forelle research programme, including Forelle Early Market Access (FEMA), is underway, as follows:

- Position of fruit on the tree in relation to mealiness (SU), and by Experico:
- The study into the sugar/acid ratio of Forelle, as an additional maturity parameter
- Maximum delay for SmartFresh^{SM} treatment on FEMA Forelle was established as 14 days (current recommendation 7 days) for a storage period of 6 weeks.
- Williams' Bon Chretien pears should only be subjected to a FEMA type programme if it is harvested at an advanced maturity (firmness of 7.4 kg)
- Abate Fetel pears did not adhere to the FEMA programme in terms of crisp and sweet
- Cheeky pears were not crisp enough for FEMA programme
- Survey of Forelle water core

Both Experico and ARC are investigating RA and CA storage of Abate Fetel pears, and Experico is conducting the maturity profiling of Cheeky.

Anti-scald strategies for Packham's Triumph are receiving attention of Experico (Harvista) and ARC (DCA), as are the ARC non-chemical storage technologies for apple.

ACKNOWLEDGEMENTS

The significant contribution of the Postharvest Innovation Programme of the Department of Science and Technology to innovation in the postharvest field is gratefully acknowledged.

POST HARVEST

Project List

FINAL PROJECT REPORTS

Received in 2016

*Funded by Forelle Producer Association levy

PLUM
HANDRÉ VILJOEN - Conducting scanning trials on additional dual-temperature regime plums, to enable successful shipping at a single temperature.

PLUM, PEACH, NECTARINE
IDA WILSON - Investigation of product residue levels, and product efficacy for decay control, of *Monilinia* and *Botrytis*, dependent on method of application, product concentration and spray volume for two registered products.

PLUM
IDA WILSON / STEPHAN FERREIRA- The prevalence of *Botrytis cinerea* in and on plums.

NECTARINE
KAREN THERON - Moisture loss studies in nectarines.

PLUM, PEACH, APRICOT, NECTARINE
KIM CLARKE - Production of antimicrobial lipopeptides by *Bacillus spp* for biological control of postharvest phytopathogens on stone fruit.

APPLE, PEAR, PLUM, PEACH APRICOT, NECTARINE
KOOS BOUWER - Optimisation of cargo freight capacity utilisation in refrigerated shipping containers, and associated logistics.

PEAR
STEPHAN FERREIRA - Detection and quantification of *Botrytis cinerea* on pears.

PEAR
DANIËL VILJOEN - Determine the minimum flesh firmness of Forelle FEMA fruit.*

PEAR
IAN CROUCH - Extended cold storage of Abate Fetel pears.

PEAR
IAN CROUCH - Maturity profiling of Cheeky and Forelle pears to reduce the risk of postharvest disorders.

PEAR
DANIËL VILJOEN - To determine if pear cultivars, other than Forelle, can be successfully cold stored using the FEMA model.

FINAL PROJECT REPORTS

Due 2017

PEAR
ANEL BOTES - Determine the critical minimum dynamic controlled atmosphere (DCA) storage exposure periods to inhibit superficial scald and the effects of CA and RA storage periods following DCA storage on superficial scald development of Packham's Triumph pears.

APPLE, PEAR
ANEL BOTES - Non-chemical storage technologies for apple and pear superficial scald prevention.

APPLE
ELKE CROUCH - Harvest and storage conditions/duration on internal browning of Rosy Glow.

APPLE
HELEEN TAYLER - Physiological profiling on Rosy Glow apples harvested at different maturities, with special reference to internal browning development potential.

RUNNING REPORTS

*Funded by Forelle Producer Association levy

NECTARINES
ARRIE DE KOCK - 7 mm plunger for nectarines.

PLUM
ARRIE DE KOCK - Monitoring Temp and RH in Quest containers.

PLUM
ELMI LOTZE - Moisture loss in plums.

PLUM
KAREN THERON - Peel permeabilities in plums.

PLUM
ARRIE DE KOCK - Revision of temperature tolerance at loading for plums.

PLUM
ARRIE DE KOCK - Optimum cooling and transport temperatures for plums from areas situated far from cooling facilities/depots.

APRICOT
ARRIE DE KOCK - The effect of temperature from orchard to cold store on apricot quality, specific to areas removed from cold storage facilities.

APPLE
ELKE CROUCH - Harvest and storage conditions/duration on internal browning of Rosy Glow.

APPLE
HELEEN TAYLER - Physiological profiling of Rosy Glow harvested at different maturities for internal browning.

APPLE
DANIËL VILJOEN - Internal browning in Fuji.

APPLE, PEAR
ANEL BOTES - Optimum CA storage of Abate Fetel pears.

PEAR

ANEL BOTES - Determine the critical minimum dynamic controlled atmosphere (DCA) storage exposure periods to inhibit superficial scald and the effects of CA and RA storage periods following DCA storage on superficial scald development of Packham's Triumph pears.

PEAR

ANEL BOTES - Optimum CA storage of Abate Fetel pears.

PEAR

IAN CROUCH - Extended cold storage of Abate Fetel pears for EU market.

APPLE

DANIËL VILJOEN - Assessment of accumulation DPA residues throughout storage and packing facilities.

PEAR

IAN CROUCH - Identification of factors involved and control of astringency in pears.

PEAR

ELKE CROUCH - 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.

PEAR

DANIËL VILJOEN - To determine the maximum delay in SmartFresh^{SM} application from harvest to room filling for fruit destined for the FEMA programme.*

APPLE

HELEEN TAYLER - Physiological profiling on Rosy Glow apples harvested at different maturities, with special reference to internal browning development potential.

APPLE

ELKE CROUCH - Harvest and storage conditions duration influencing internal browning and fruit quality of Rosy Glow.

PEAR

DANIËL VILJOEN - 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.*

NEW PROJECTS

Approved for 2017

PLUM

I WILSON / ARRIE DE KOCK - Survey and investigation on the impact of various fungicide application methods and technologies on decay control of plums in the pack-house.

PLUM, NECTARINE

ARRIE DE KOCK - Develop optimum ripening protocol arriving too green or too firm in the market.

PLUM

S FERREIRA / I WILSON - Quantifying the presence of *Botrytis cinerea, Monolinia laxa, Penicillium expansum* before harvest in plums and correlation of relative pathogen presence to decay after shelf-life.

APPLE, PEAR

ANEL BOTES - Effect of DPA on quality of pome fruit.

APPLE

DANIËL VILJOEN / HELEEN TAYLER - Investigate different step down cooling regimes in conjunction with SmartFresh^{SM} for Cripps' Pink to ensure year round supply.

APPLE

ELKE CROUCH - Investigate different step down cooling regimes in conjunction with SmartFresh^{SM} for Cripps' Pink to ensure year round supply

PEAR

DANIËL VILJOEN - Assess IB development potential from high watercore incidence FEMA Forelle

APPLE, PEAR

RICHARD HURNDALL- Development of CA Research facilities

PEAR

ANEL BOTES - Optimisation of RLOS protocol for superficial scald prevention on Packham's Triumph pears

APPLE

STEPHAN FERREIRA - Pre and post-harvest monitoring of *Alternaria spp* in orchards with historically high incidence of dry core rot

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, Experico

Objectives & Rationale

This project was conducted to establish if SmartFresh^{SM} 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.

Methods

Five cultivars were sourced from Franschhoek, Montagu and Stellenbosch over three seasons, 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 5 days at 10 °C.

Key Results

Cultivar differences were evident. Quality maintenance of African Rose, Sapphire, Fortune and Ruby Red plums were best maintained over the 3 seasons of testing, by applying SmartFresh^{SM} during the accumulation period, followed by no warming before shipping [T6] and applying SmartFresh^{SM} during the accumulation period, followed by 3 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^{SM} during the accumulation period, followed by 10 days warming at 7.5°C before shipping [T1] in some of the seasons. Quality maintenance was worst by not applying SmartFresh^{SM} during the accumulation period, followed by no warming or 3 days warming at 20°C before shipping [T7 and T5, respectively].

Conclusion / Discussion

Cultivar differences were evident. Quality maintenance of African Rose, Sapphire, Fortune and Ruby Red plums were best maintained over the 3 seasons of testing, by applying SmartFresh^{SM} during the accumulation period, followed by no warming before shipping [T6] and applying SmartFresh^{SM} during the accumulation period, followed by 3 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^{SM} during the accumulation period, followed by 10 days warming at 7.5°C before shipping [T1] in some of the seasons. Quality maintenance was worst by not applying SmartFresh^{SM} during the accumulation period, followed by no warming or 3 days warming at 20°C before shipping [T7 and T5, respectively].

INVESTIGATION ON PRODUCT RESIDUE LEVELS, AND PRODUCT EFFICACY FOR DECAY CONTROL, OF *MONILINIA* AND *BOTRYTIS*, DEPENDENT ON METHOD OF APPLICATION, PRODUCT CONCENTRATION AND SPRAY VOLUME FOR TWO REGISTERED PRODUCTS ON PLUMS, NECTARINES AND PEACHES

I Wilson, Experico

Objectives & Rationale

Significant post-harvest losses occur in stone fruit as a result of brown rot (*Monilinia laxa*) and grey mould (*Botrytis cinerea*) decay, but only a few products are registered for the control of such decay. Despite the cost and effort of fungicide application, inadequate decay control is regularly experienced. The aim of this study was to investigate fungicide application methods and technologies to elucidate those which are optimal for decay control.

Methods

Plums, nectarines or peaches were injured and inoculated with either *Botrytis cinerea*, or *Monilinia laxa* to induce fungal infection and decay. Different methods (only plums), volumes and dosages were used to apply fungicides "Scholar®" (a.i Fludioxonil), or "Rovral®" (a.i. Iprodione) to fruit. Fruit were cold stored at -0.5°C for 4 weeks, followed by 10 °C for 4 days, to simulate shelf life. Brown rot and grey mould decay in fruit was evaluated, to estimate the efficacy of decay control.

Key Results

The different application methodologies had a marked influence on decay control. In some instances decay observed by dipping plums in fungicide solutions was significantly less than when fungicides were applied with an atomiser, with resultant residues also being notably lower. Volume of application also notably influenced the levels decay control observed.

Conclusion / Discussion

Results from this study indicate that decay control strategies should not solely rely on the use of available products, but that decay control may be optimised by refining and optimising application methods and technologies. Following best practises can be of huge value to the industry.

TO DETERMINE THE EFFECT OF SUGAR / ACID RATIO AND OTHER MATURITY PARAMETERS ON THE EATING QUALITY OF FORELLE PEARS DESTINED FOR THE FEMA PROGRAMME, AS A MEANS OF IMPROVING THE FEMA RELEASE CRITERIA

D Viljoen, Experico

Objectives & 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 2 or 3 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^{SM} within 7 days after harvest and stored for 5 weeks at -0.5°C. Evaluations conducted were maturity at harvest, SmartFresh^{SM} efficacy testing, start of shelf life after 5 weeks cold storage and end of shelf life after a simulated shelf life at 20°C for 7 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 / 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.

TO DETERMINE IF PEAR CULTIVARS OTHER THAN FORELLE CAN BE SUCCESSFULLY COLD STORED USING THE FEMA MODEL BY HARVESTING FRUIT AT A MORE ADVANCED MATURITY AND THEN RETARDING RIPENING THROUGH THE USE OF SMARTFRESH^{SM}

D Viljoen, Experico

Objectives & Rationale

To determine if pear cultivars, other than Forelle can be successfully cold stored using the FEMA model by harvesting fruit at a more advanced maturity and then retarding ripening through the use of SmartFresh^{SM}.

Methods

Williams' Bon Chretien (2014 and 2015), Abate Fetel (2014 – 2016) and Cheeky (2016) pears were harvested at optimum followed by two additional harvests within 2 weeks after release. Pears were subjected to a 600 ppb SmartFresh^{SM} application within 7 days after harvest and stored for 6, 8 and 12 weeks. After storage pears were subjected to a 7 day shelf life at 20°C. Evaluations were conducted after cold storage and at the end of shelf life.

Key Results

2014

Ripening of Williams' Bon Chretien (WBC) and Abate Fetel pears was successfully retarded by the application of SmartFresh^{SM}. Pears subjected to SmartFresh^{SM} exhibited greener fruit, decreased incidence of especially senescent breakdown in WBC pears, and lower internal ethylene levels than untreated control fruit.

2015

Flesh firmness of Williams' Bon Chretien pears dropped from 9.0 kg to 7.4 kg between Harvest 1 and 4. Fruit of the first three harvests treated with SmartFresh^{SM} did not ripen below 6.9 kg after shelf life, regardless of storage time. Only fruit harvested three weeks after optimum (Harvest 4) stored for 8 weeks or longer ripened below 4.0 kg during shelf life. However, these fruit exhibited much higher colour loss.
Firmness' of Abate Fetel pears (two populations) varied between different harvests. Regardless of harvest time and storage time, fruit treated with SmartFresh^{SM} did not ripen to an acceptable firmness below 4.0 kg during shelf life.

2016

Abate Fetel pears advanced in harvest maturity with each progressive harvest. TSS levels however, did not increase as expected. Consumers preferred untreated control fruit from Harvests 1 and 2 according to post-storage taste evaluations. Untreated control fruit for these two harvests were most likely riper, fitting in with the general idea of a soft and juicy pear. Consumers preferred SmartFresh^{SM} treated fruit to untreated fruit from Harvest 3. It is most likely that the untreated fruit were overripe.
Cheeky pears advanced in harvest maturity with each progressive harvest. TSS levels however, did not increase. No trend occurred regarding taste between different harvests or between different storage times.

Conclusion / Discussion

Williams' Bon Chretien pears should only be subjected to a FEMA type programme if it is harvested at an advanced maturity (firmness of 7.4 kg). This firmness was only attained 3 weeks after commercial harvest which could be a risk in terms of fruit drop and green skin colour loss. Abate Fetel pears did not adhere to the FEMA programme in terms of crisp and sweet. Fruit lacked sweetness and were not as juicy. It is therefore not recommended to subject Abate Fetel pears to a FEMA type programme.

Cheeky pears were not crisp enough. Fruit subjected to SmartFresh^{SM} tended to be rubbery and generally more consumers preferred untreated fruit regarding taste. It is therefore not recommended to subject Cheeky fruit to a FEMA type of program without additional research.

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, Agricultural Research Council

Objectives & 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 time 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

Optimum harvested 'Packham's Triumph' pears from the Ceres and Grabouw production areas were used. Fruit were stored at DCA conditions for 5 d, 2 w, 4 w, 8 w, 12 w, 16 w and 20 w and then subjected to additional RA periods for 6 w and 10 w and shelf life periods for 0 and 7 d at 20°C to determine the critical minimum exposure periods to control superficial scald effectively. Intermittent DCA and Initial Low Oxygen Stress treatments followed by CA were also included in the trials. 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 successfully inhibited the development of superficial scald on Packham's Triumph from Grabouw and Ceres production areas for up to 20 w storage followed by 6 w and 10 w simulated shipment with 7 day shelf-life. ILOS+CA controlled superficial scald for 16 w followed by 6 w and 10 w simulated shipment with 7 day shelf-life. The 14 day break in DCA did not influence the control of superficial scald for up to 32 w with 7 day shelf-life. No off-tastes were detected at any of the treatments.

Conclusion / Discussion

DCA and ILOS+CA proved to be a good alternative to the use of DPA to control superficial scald on 'Packham's Triumph' pears from Grabouw and Ceres production areas.

NON-CHEMICAL STORAGE TECHNOLOGIES FOR APPLE AND PEAR SUPERFICIAL SCALD PREVENTION

A Botes. Agricultural Research Council

Objectives & 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, DCA and RA) were applied to optimum harvested Packham's Triumph. Fruit quality evaluations were done after each shelf-life period.

Key Results

RLOS+ULO-CA, RLOS+CA and DCA was effective in preventing superficial scald on pre-optimum and optimum Granny Smith up to 8 months with 14 day shelf-life. Core flush is a problem for the longer storage periods. All treatments resulted in firmer fruit and better skin colour retention, with generally no differences between them. 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, with generally no differences between them. No off-tastes were detected.

Conclusion / Discussion

RLOS and DCA prove to be effective in preventing superficial scald development on Granny Smith for long term storage. RLOS also prohibited superficial scald development on Packham's Triumph. It is however important to take other quality parameters into consideration when storing for 8 or 10 months, such as possible core flush on apples and decay on pears.

HARVEST AND STORAGE CONDITION PLUS DURATION INFLUENCING INTERNAL BROWNING AND FRUIT QUALITY OF 'ROSY GLOW'

E Crouch, Stellenbosch University

Objectives & Rationale

'Rosy Glow' is regarded prone to internal flesh browning. This study investigated tree age, harvest maturity, storage temperature, 1-methylcyclopropene (1-MCP) treatment and storage duration in CA as factors influencing 'Rosy Glow' internal browning.

Methods

Fruit were harvested at <40% and >50% starch breakdown (SB) for the harvest maturity trial (Trial 1) and <40% SB for the storage duration, temperature, 1-MCP (Trial 2) and tree age trial (Trial 3). Trial 1 and 3 fruit were stored for 7 months in CA (1% CO_2 and 1.5% O_2) plus 6 weeks in air at -0.5 °C and 7 days at 20 °C and evaluated after each period. Trial 2 fruit treated with or without 1-MCP, were stored at -0.5 °C or 2 °C and evaluated after 3, 5 and 7 months in CA plus 6 weeks in RA and 7 day shelf-life periods.

Key Results

Diffuse (DB), radial (RB), and combination (CB) as well as CO_2 browning were observed. Optimum harvest fruit was less susceptible to DB and RB. 1-MCP treated fruit had a lower internal browning incidence and no tree age effect was observed (4th and 7th leaf). DB and RB were first observed after 5 months in CA plus 6 weeks RA at -0.5 °C.

Conclusion / Discussion

Diffuse browning was the main type of browning present. Post-harvest maturity (>50% SB) played a significant role in 'Rosy Glow' browning development. Fruit quality was better retained at -0.5 °C than at 2 °C in this season, while 1-MCP treated fruit quality was better maintained than control fruit over time. Orchard influence was observed on 'Rosy Glow' browning and requires further investigation.

EVALUATION OF THE 7MM PENETROMETER PLUNGER TO DETERMINE HARVEST MATURITY IN NECTARINES

A de Kock, Experico

Objectives & Rationale

Flesh firmness as an important harvest maturity parameter is currently determined on nectarines with a penetrometer fitted with an 11 mm plunger. In late cultivars that are harvested relatively firm the use of the 11 mm plunger proved to be problematic since firmness readings are highly variable. The aim of this trial was to determine if 7 mm plungers can be used to provide accurate flesh firmness readings for nectarines.

Methods

Four nectarine cultivars were harvested at regular intervals starting 4 to 7 days prior to the expected commercial harvest date. In total there were 3 harvest maturities for each cultivar. At each harvest the flesh firmness was determined with a penetrometer fitted with plungers of 11 mm and 7 mm in diameter. Fruit from each cultivar was divided into treatments that were pre-ripened to approximately 8 kg in flesh firmness using a 11 mm plunger and treatments that were not pre-ripened. Standard deviations were determined for flesh firmness of each of the harvest maturities to determine the variability in the firmness readings. The fruit was then cold stored for 4 weeks at -0.5°C and evaluated, before and after a shelf life of 5 days at 10°C, for flesh firmness, decay, shrivel and internal quality.

Key Results

Generally the standard deviation in flesh firmness at harvest was higher when the 11 mm plunger was used compared to the 7 mm plunger. This could be an indication that the variation in flesh firmness for fruit harvested at specific sizes or skin colour will be less when the 7 mm plunger is used. For Alpine, August Red, and September Bright nectarines, the fruit from the first harvests generally developed less internal problems and decay compared to fruit from the last harvest. The 7 mm plunger as a tool to determine flesh firmness at harvest could potentially allow producers to harvest early without incurring rejections due to variation in flesh firmness at harvest. Summerfire (non-melting type) did not soften over the harvesting period and remained firmer than the maximum firmness.

Conclusion / Discussion

Flesh firmness exceeding or close to the current maximum flesh firmness of 11.3 kg as measured with an 11 mm plunger varied to a greater extent compared to flesh firmness measured with a 7 mm plunger. When harvesting fruit of a given size or skin colour the margin of error for flesh firmness could therefore be reduced with the 7 mm plunger compared to the 11 mm plunger. Summerfire was identified as a clingstone type for which flesh firmness is generally not a good indicator of maturity. It is suggested that a minimum skin colour for this cultivar at harvest should be established.

MONITORING OF TEMPERATURE AND RELATIVE HUMIDITY LEVELS IN QUEST SHIPPING CONTAINERS

A de Kock, Experico

Objectives & Rationale

The objective of this study was to record delivery air temperature directly next to the cold air inlet and in pallet position 17, as well as relative humidity (RH) and fruit pulp temperatures in two commercial shipping containers. This was done to determine if cold damage to fruit can occur in certain positions in containers and to record RH.

Methods

Air temperature, fruit pulp temperature and RH loggers were installed in two commercial shipping containers. Air temperatures were recorded at the perceived coldest and warmest position in the containers namely at the air inlet (bottom of the first pallet in the container) and at the door (top of the pallets), respectively. RH was determined in the latter position in the container. Fruit pulp temperature was also measured in the middle of the containers.

Key Results

Air temperature dropped below -2.0 °C for 4 hours in the bottom of the first pallet in container 1, and ran at around -1.5 °C for much of the 22 day period in the container. In the same container the RH ranged between 65 and 50%. Pulp temperatures of plums ranged between -0.5 °C and -0.7 °C and declined marginally during the shipping period. In container 2 the air temperatures spiked between 0.5 °C and -1.1 °C. On average the temperature was -0.5 °C. Pulp temperatures were around -0.5 °C and declined marginally during shipping, as was the case in container 1. RH ranged between 70 and 76%.

Conclusion / Discussion

Pulp temperatures measured on plums in the middle of the shipping containers were good, at approximately -0.5°C. In one shipping container the air temperature at the cold air inlet position (pallet position 2) tended to be on the low side at -1.5 °C for much of the containerization period. This could possibly lead to cold damage in certain instances. The RH in shipping containers was generally low and could contribute to the high levels of shrivel in some plum cultivars. Methods to increase RH in plum shipping containers should be investigated.

MOISTURE LOSS STUDIES IN JAPANESE PLUMS (*PRUNUS SALICINA* LINDL.)

E Lötze, Stellenbosch University

Objectives & Rationale - AIM 1

Different packaging solutions (i.e. bags with different sizes and amounts of perforations) were tested to determine whether they could reduce moisture loss during postharvest storage from some South African plum cultivars, while still maintaining internal and external fruit quality.

Methods

Eight different bags, with 6 repetitions per bag were used for each cultivar, namely Laetitia, Songold and African Delight. Internal and external fruit quality as well as the incidence of shrivel were inspected after cold storage and after a simulated shelf-life period. Fruit weight loss during the storage period was determined by weighing the fruit in the bottom tray of 3 reps per treatment, before and after storage.

Key Results

No treatment differences were seen in terms of shrivel, decay, respiration rate, ethylene production, or weight loss for 'Laetitia' or 'Songold'. Significant differences were seen between treatments in shrivel incidence and weight loss with 'African Delight'. The control (shrivel sheet) had the highest incidence of shrivel, followed by HDPE bags with 60 x 5mm perforations. All other treatments (which had fewer and/or smaller perforations) had a lower shrivel incidence.

Conclusion / Discussion

Japanese plum cultivars differ in their susceptibility to post-harvest moisture loss and shrivel manifestation. Thus, packaging solutions to prevent shrivelling will most likely be cultivar specific. The packaging specifications will vary according to the respiration rate of and chilling sensitivity of each cultivar. To obtain the optimal packaging solution to reduce moisture loss and shrivel, more cultivars, over more seasons will have to be evaluated. It needs to be established whether shrivelling is only affected by the amount of moisture lost from the fruit or whether other factors are involved.

Objectives & Rationale - AIM 4

It was investigated whether, and to what extent, open lenticels and/ or stomata contribute to moisture loss of a plum cultivar susceptible (Laetitia) and not susceptible (Songold) to moisture loss.

Methods

Fruit were sampled weekly from 3 weeks before the anticipated optimum harvest date, until one week after the optimum harvest date. On each sampling date the peel water vapour permeance of 100 fruit per cultivar was calculated. Afterwards, 20 fruit per cultivar were stained with methylene blue solution in order to visualise the open lenticels. The percentage of open lenticels per fruit surface area was determined by counting the amount of stained vs unstained lenticels on peel sections taken from each fruit.

Key Results

Peel water vapour permeance of 'Laetitia' remained relatively stable throughout the sampling period, while that of 'Songold' increased significantly between 2 weeks before harvest and the optimum harvest date. 'Songold' had almost threefold the amount of open lenticels per fruit surface area compared to 'Laetitia'. Strong correlations were found between lenticel quantity and peel permeability for 'Songold', but not for 'Laetitia'

Conclusion / Discussion

'Laetitia' is more prone to post-harvest moisture loss compared to 'Songold'. However, 'Songold' had significantly more open lenticels per fruit and showed better correlations between peel permeability and the amount of open lenticels. The lenticels cannot be the only contributors to post-harvest moisture loss from Laetitia and the compositional and structural differences between the cuticles of the two cultivars must be investigated to gain further insight into the occurrence of moisture loss and shrivelling.

PEEL PERMEABILITY, SHRIVEL, MOISTURE LOSS IN JAPANESE PLUMS

K Theron, Stellenbosch University

Objectives & 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'H20) 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'H20 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'H20 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'H20 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'H20 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 / Discussion

Previously it was found that very little difference and correlation over time in overall P'H20 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'H20 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.

REVISION OF TEMPERATURE TOLERANCE AT LOADING FOR PLUMS

A de Kock, Experico

Objectives & Rationale

The effect of temperature during the accumulation phase, prior to loading of plums was tested. Temperatures selected were -0.5 °C as the recommended pulp temperature at loading, 2 °C, which is 0.5 °C higher than the current maximum temperature and 3 °C. Accumulation periods of 3, 7 and 10 days were used. The objective was to determine if maximum temperature at loading of plums can be adjusted upwards without a negative effect on quality.

Methods

African Rose, Fortune, Laetitia, Songold and Sunkiss plums not cooled before packing were obtained from a commercial pack house in Franschhoek. Each cultivar was divided into 9 treatments. The variables were accumulation periods of 3, 7 and 10 days and temperature (-0.5 °C, 2 °C and 3 °C). After the accumulation periods, the plums were stored at dual temperature regimes consisting of 2 days at -0.5 °C, 5 days (African Rose), 7 days (Fortune, Laetitia and Sunkiss) and 9 days (Songold) at 7.5 °C and the balance at -0.5 °C, for a total storage period of 35 days for African Rose, Fortune and Sunkiss, 42 days for Songold and 49 days for Laetitia. The plums were evaluated for flesh firmness, decay, shrivel and internal disorders after cold storage, as well as after 5 days shelf life at 10 °C.

Key Results

Accumulation temperatures of 2 °C and 3°C had no negative effect on African Rose and Songold plums. The effect of temperature on internal disorders and shrivel was also negligible. Laetitia had a similar result but flesh firmness was softer after shelf life for the plums accumulated at 2 °C and 3 °C in comparison to -0.5 °C, especially if accumulated for 10 d. Fortune and Sunkiss were marginally softer at 2.0 °C, compared to -0.5 °C, and were significantly softer at 3 °C than at 2.0 °C. Accumulation period could affect softening, in combination to temperature, with softening increasing as the period is extended at a higher accumulation temperature. Internal disorders and shrivel could also be affected by accumulation temperatures, however, it could have an opposite effect to softening.

Conclusion / Discussion

It is clear that cultivars differ in the extent to which the quality is affected by higher

temperatures during accumulation. The results must be verified using fruit at the lower end of the maturity window and be extended to single temperature cultivars such as African Delight and Angeleno. The results indicated that loading at 3.0 °C may not have a negative effect on some cultivars (African Rose, Songold and possibly Laetitia). This could potentially reduce cooling time but may be cultivar specific. Accumulation at a higher temperature may result in softening after storage of Fortune and Sunkiss.

OPTIMUM COOLING AND TRANSPORT TEMPERATURES FOR PLUMS FROM AREAS SITUATED FAR FROM COOLING FACILITIES/ DEPOTS

A de Kock, Experico

Objectives & Rationale

Temperature profiles of uncooled and forced-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 then 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 profiles of uncooled plums transported in refrigerated trucks, to the cooling/ loading facilities (Paarl area), as well as plums subjected to FAC in the production area (Ladismith) were determined by data collection with loggers, from packing until the end of FAC. Fruit pulp and air temperature were recorded in three commercial pallets during each transport leg. The temperature monitoring was completed in 2015. In 2016, the temperatures profiles established in 2015 were simulated under laboratory conditions and a FHR treatment was added, to ascertain the effect on plum quality.

Key Results

The effect of FAC and FHR on Sapphire and African Delight plums was similar. FAC or FHR within 6 hours after packing, before road transport of plums from areas far from cooling facilities, had a beneficial effect on flesh firmness, reduced shrivel and in the case of Sapphire, reduced over ripeness in comparison to plums transported uncooled. This confirms 2015 results on African Delight plums.

Conclusion / Discussion

Fruit quality data suggest that FAC, as well as FHR, prior to transportation may be beneficial in terms of flesh firmness retention, moisture loss and shrivel control, compared to transporting uncooled plums in refrigerated trucks to a depot for subsequent cooling. This will be confirmed in commercial consignments in 2017 prior to commercial recommendations.

THE EFFECT OF TEMPERATURE FROM ORCHARD TO COLD STORE ON APRICOT QUALITY, SPECIFIC TO AREAS FAR AWAY FROM COLD STORAGE FACILITIES

A de Kock, Experico

Objectives & 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 two 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 forced 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 apricot quality.

Key Results

Pulp temperatures in FAC apricots were maintained during transport but were not reduced in uncooled apricots transported in refrigerated trucks from Ladismith to Paarl. Flesh firmness was similar in FAC apricots, and uncooled apricots transported cold, but were lower in apricots subjected to FHR. There was a trend for less internal disorders in the FAC apricots compared to uncooled apricots and apricots subjected to FHR.

Conclusion / Discussion

Albeit non-significant, fruit quality data suggest that FAC on site and cold transport from Ladismith to Paarl may have a beneficial effect on apricot quality in terms less internal disorders compared to uncooled apricots transported in refrigerated trucks. FHR had a negative effect on flesh firmness compared to FAC and uncooled apricots. This will have to be verified in 2017.

ASSESSMENT OF ACCUMULATIVE DPA RESIDUES THROUGHOUT STORAGE AND PACKING FACILITIES

D Viljoen, Experico

Objectives & Rationale

The aim of this trial was to further assess the potential risk of cross-contamination on untreated fruit by analysing DPA residue levels on fruit at the cold store level, as this area was found in 2013 and 2014 to have the highest risk of cross-contamination.

Methods

Six old cold rooms (stored DPA treated fruit for more than 2 years before 2014) and six

new rooms (first used in 2014, never stored DPA treated fruit) were identified for long term storage. Fruit samples were taken monthly until November (or room opening) and send to three different laboratories.

Key Results

DPA levels generally remained the same for samples of old cold stores analysed from week 23 to 36. Higher levels were measured on samples analysed in weeks 43 and 46 with samples from one room having residue levels above 0.05 ppm. DPA residue levels on fruit samples from new cold rooms followed the same trend as those of old rooms. However, levels were lower with no samples measured with levels higher than 0.05 ppm.

Conclusion / Discussion

According to 2015 results a low risk does exist for fruit to be contaminated by DPA residues when stored in cold stores that previously stored DPA treated fruit. This contamination however, only occurred on fruit samples analysed in week 43. No cross contamination occurred in new cold rooms. However, like with the old rooms, DPA levels increased in samples from week 43.

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

E Crouch, Stellenbosch University

Objectives & Rationale

Preliminary studies show 'Forelle' pear canopy position and TSS relate to mealiness development during ripening. This study explored ripening rates and mealiness development as well as micro-climactic differences within the canopy. This study therefore further aimed to establish whether pollination influences tissue structure and mealiness development.

Methods

Fruit surface temperature and irradiance of five canopy positions were measured. CT scanning was performed to determine tissue density for fruit on all positions before and after ripening (not reported on in this feedback). Fruit of five positions have been harvested at two maturities (optimum and post-optimum) and evaluated after storage (8, 12, 16 weeks at -0.5 °C) and ripening (4, 7, 11 days at 20 °C). Flowers of shoulder height were emasculated and hand cross-pollinated with 'Early Bon Chretien' pollen, while some flowers were only emasculated without receiving any pollen. Maturity indices, ethylene and CO_2 production and tissue density (CT x-ray scanning) were measured after harvest, cold storage at -0.5 °C and ripening at 20 °C.

Key Results

Outside canopy fruit were more mealy, had the highest surface temperature and highest percentage exposure to sunlight. Inside fruit mealiness remained constant for both harvest maturities regardless of cold storage and ripening times. Maximum mealiness differed for outer canopy sides for various storage and ripening times. Diameter of inside fruit of harvest two did not differ significantly from harvest one outside-east fruit, but have significant differences in mealiness. Hand cross-pollinated fruit on the eastern side fruit were significantly less mealy.

Conclusion / Discussion

Outside canopy fruit had the highest surface temperature, sunlight exposure mealiness. Cross-pollination seems to result in lower mealiness incidence. Tissue density processing and correlations will aid in describing these differences further. A second season is required to confirm current findings.

THE MAXIMUM DELAY IN SMARTFRESH^{SM} APPLICATION FROM HARVEST TO ROOM FILLING FOR FRUIT DESTINED FOR THE FEMA PROGRAMME

D Viljoen, Experico

Objectives & 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^{SM} treatment rooms, and the rate of filling of these rooms within the 7 day protocol.

The aim of this study was therefore to determine the maximum delay in SmartFresh^{SM} 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 7, 9, 14 and 21 days after harvest with SmartFresh^{SM} (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 7 days at 20°C.

Key Results

2014

In one of the populations, pears subjected to a SmartFresh^{SM} 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^{SM} 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 / 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^{SM} 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.

SUPPORT STRUCTURES

Advisory Committees

PROFILE

HORTGRO Science is dependent on its extensive support structures that are made up of colleagues and role-players in the deciduous fruit industry who 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. A quick tally of participation in our different work groups shows that we have in the order of 200 different individuals involved in our different work groups:

- ***6 Peer Work Groups***
  34 scientists
- ***5 Technical Advisory Committees***
  66 technical / growers
- ***30 focus workgroups***
  100 scientists / technical / growers

PEER WORK GROUPS (PWG'S)

Objectives of PWG:

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

Breeding & Evaluation:
Richard Hurndall - HORTGRO Science
Hugh Campbell - HORTGRO Science
Prof Wiehann Steyn - HORTGRO Science
Prof Karen Theron - US Horticulture
Dr Leon Von Mollendorff - Culdevco
Dr Willem Botes - US Genetics
Dr Klaus Pakendorf - ARC
Prof Melané Vivier - US Institute of Wine Biotechnology (IWBT)

Horticulture:
Richard Hurndall - HORTGRO Science
Hugh Campbell - HORTGRO Science
Prof Wiehann Steyn - HORTGRO Science
Dr Nigel Cook - Prophyta
Prof Gerard Jacobs - US Horticulture
Prof Karen Theron - US Horticulture
Dr Nicky Taylor - University of Pretoria
Dr Piet Stassen - Consultant

Soil Science:
Richard Hurndall - HORTGRO Science
Hugh Campbell - HORTGRO Science
Prof Wiehann Steyn - HORTGRO Science
Dr Eduard Hoffmann - US Soil Science
Dr Pieter Raath - Bemlab
Dr Nigel Cook - Prophyta
Dr Nicky Taylor - University of Pretoria
Dr Johan Van Zyl - US Soil Science

Entomology & Nematology:
Richard Hurndall - HORTGRO Science
Hugh Campbell - HORTGRO Science
Matthew Addison - HORTGRO Science/ US Entomology
Dr Ken Pringle - HORTGRO Science/ Us Entomology
Dr Brian Barnes - Consultant
Dr Ruan Veldman - SANBI
Welma Pieterse - DAFF
Prof Schalk Louw - University of Free State
Prof Martin Hill - Rhodes University

Pathology:
Richard Hurndall - HORTGRO Science
Hugh Campbell - HORTGRO Science
Lindi Benic - HORTGRO
Matthew Addison - HORTGRO Science/ US Entomology
Prof Lise Korsten - University Of Pretoria
Prof Altus Viljoen - US Pathology
Dr Johan Fourie - Experico
Ferdi Van Zyl - Pro Agri Services (Pty) Ltd

Post Harvest:
Richard Hurndall - HORTGRO Science
Hugh Campbell - HORTGRO Science
Dr Marius Huysamer - Consultant
Prof Karen Theron - US Horticulture
Prof Linus Opara - Research Chair In Post-Harvest technology (US)
Dr Paul Cronje - Citrus Research International
Dr Mariana Jooste - Private consultant

TECHNICAL ADVISORY COMMITTEES (TAC'S)

Objectives of TAC's:

- 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

Production TAC:
Stephen Rabe - Grower/
HORTGRO Science Director (Chairman)
Graeme Krige - Two-A-Day
Anton Müller - Kromco
Tobie Van Rooyen - Inteligro
Peter Dall - Peter Dall Consultancy
Dr Nigel Cook - Prophyta
Pierre Du Plooy - Consultant
Andrew Hacking - Ad Lucem
De Kock Hamman - CFG
Hannes Laubscher - United Fruit Exports
Christo Strydom - Wolfpack Pears
Chris Jurisch - Arbor Tech
Willie Kotze - Dutoit Agri
Prof Wiehann Steyn - HORTGRO Science
Daan Brink - Two-A-Day
Nelius Kapp - Prophyta
Mico Stander - Agrimotion
Louis Reynolds - Fruitful Crop
Xolani Siboza - HORTGRO Science

Fruit Route (Breeding) Advisory Committee:
Prof Bongani Ndimba - ARC
Ken Tobutt - ARC
Dr Leon Von Mollendorff - Culdevco
Hugh Campbell - HORTGRO Science
(Saappa & Saspa)
Dappie Smit - Dfpts
Wiehann Victor - Cfpa
Tarryn Wettergreen - Sati

Crop Protection Tac:
Richard Hurndall - HORTGRO Science (Chairman)
Matthew Addison - HORTGRO Science
Lindi Benic - HORTGRO Science
Anton Muller - Kromco
Bekker Wessels - Procrop Trust
Andrew Hacking - Ad Lucem
Nico Ferreira - Two-A-Day
Dr Ken Pringle - HORTGRO Science/
Us Entomology
Fanie Van Der Merwe - Dow Agrosciences

Post-Harvest TAC:
Grant Smuts - Grower/
HORTGRO Science Director
Charl Stander - Franschhoek Marketing
Richard Hurndall - HORTGRO Science
Jacques Du Preez - HORTGRO
Dr Malcolm Dodd - Consultant
Henk Griessel - Trucape
Jaco Moelich - Fruitways
Angelique Marais - Fruitways
Petro Conradie - Dutoit Agri
Margaret Reineke - Bayer
Karin van Rensburg - Capespan
Elizabeth Downes - Capespan
Pieter Neethling - Two-a-day
Dr Mdunzi Ngcobo - PPECB (now ARC)
Petru du Plessis - Consultant
Anton Gouws - Kromco

Technology Transfer Advisory Committee:
Hugh Campbell - HORTGRO Science (Chairman)
Stephen Rabe - Grower/ Hortgro Science
Adv Council
Elise-Marie Steenkamp - HORTGRO Science
Matthew Addison - HORTGRO Science
Prof Wiehann Steyn - HORTGRO Science
Peter Dall - Peter Dall Consultancy
Keith Bradley - Grower
Linde Du Toit - Grower
Pierre Du Plooy - Consultant
Dr Nigel Cook - Prophyta
Graeme Krige - Two-A-Day
Dr Ian Crouch - Experico
Charl Stander - Franschhoek Marketing
Christo Strydom - Wolfpack
Marinus Van Der Merwe - Future4growers
Tobie Van Rooyen - Inteligro

ADVISORY / FOCUS GROUPS

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

Groupings:
The following advisory and focus groups are in place and are made up of experts in each field (researchers, technical advisors, growers). The list is large – between 90 and 110 individuals. We are indeed indebted to each one of these individuals for their contributions.

Crop Production:
Dormancy
Reproductive Biology
Rootstock Evaluation Committee
Rootstock and Nursery Tree
Growing Season Climate
Irrigation and Nutrition
Farming efficiency
Orchard of the future
Rest breaking and Fruit thinning
Water Availability Committee

Breeding:
Breeding Advisory – Pome fruit
Breeding Advisory – Stone fruit

Crop Protection:
Soil health
IPM Group
Crop Protection Advisory Group (Market Access)
Spraying systems Advisory Group

Post-Harvest:
Physiology / Horticultural Science
Post-Harvest pathology
Packaging and cold chain management
CA Group
Forelle research focus group
DPA focus group

General:
Confronting Climate Change Steering Committee
Pome Fruit Technical Forum
Stone Fruit Technical Forum
Packhouse Action Group
Deciduous Plant Improvement Association

SAFJ PUBLICATIONS LIST

DEC/JAN 2016

FEB/MARCH 2016

APRIL/MAY 2016

SAFJ PUBLICATIONS LIST

JUNE/JULY 2016

AUGUST/SEPTEMBER 2016

OCTOBER/NOVEMBER 2016

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