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THE TECHNOLOGY COLLECTIVE

HORTGRO Science Annual Report

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HORTGRO science

Our purpose (Defined as follows.) 1.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.

In Biology mutualism refers to the way two organisms of different species exist in a relationship in which each individual benefits. In the deciduous fruit industry a similar relationship exists between academia and the growers on the ground. At HORTGRO Science we believe in this beneficial relationship, even though there are future challenges. We endeavour to build human capital; give growers a full return on investment; promote sustainable agriculture and ensure product integrity through the supply chain. HORTGRO Science believes in: *et colet in posterum* - farming for the future.

'ENSURE A SUSTAINABLE, INTERNATIONALLY COMPETITIVE POME AND STONE FRUIT INDUSTRY.'

It is my pleasure to present my first report as Chairman of HORTGRO Science – Advisory Council. This council replaced the HORTGRO Science board as a result of changes that took place with the realignment of the HORTGRO Structures. This in my opinion clarifies the role and function performed by HORTGRO Science within the HORTGRO stable.

The mandate given to HORTGRO Science is to align the research efforts with what is needed to ensure a sustainable, internationally competitive pome and stone fruit industry. Management and the council have implemented the strategy decided upon 2 years ago to ensure closer control of the research effort so that we achieve our mandate.

One of the key success factors in fulfilling levy payers expectations is maintaining and improving communication efforts between HORTGRO Science and producers, with this in mind a permanent appointment was made and Elise-Marie Steenkamp started within this year under review. A concerted, measured effort will be made to ensure we improve this side of our business.

Another effort to bring researchers and producers closer is the Orchard of the Future (OOF) project. Three of these have been planted and they are all generating game-changing data and statistics as well as providing venues for field days to show producers future possibilities. This project has the potential to bring researchers, service providers and producers together in an environment that allows broader interface with the levy payer while achieving HORTGRO Science's mandate.

I would like to thank all the members of the committee for their participation and input in assisting and guiding management. I need to make special mention of the professional input made by Louis von Broembsen in providing a solid sounding board for the many challenging issues that face HORTGRO Science.

On behalf of the Advisory Council and all levy payers my sincere appreciation for the passion and dedication shown by Hugh Campbell and his team. I have no doubt that their unselfish efforts and commitment, add bottom line value to the broader horticultural community and promote our industry as an internationally competitive player.

I am confident that the research effort is in good hands, well managed and forward focused.

Stephen Rabe

HORTGRO SCIENCE: THE PROCESS

HORTGRO SCIENCE
- Facilitates
- Consults
- Round Table

EXPERENTIAL LEARNING
- Uni's
- Research Institutes
- Sustainable growth
- Development
- Knowledge economy

RESEARCH PROJECTS 2014/15
- Total Projects 106 (70 Pome and 36 Stone)
- New Projects 29 (15 Pome and 14 Stone)

ROI • Human Capital • Technology • Knowledge

GDP ANNUALLY • Stone R1,75 billion • Pome R6,9 billion

FARM GATE • Profit • Investment • Sustainable farming • Feeding the world

LEVY • 644 Pome Fruit Growers 0,2% of GDP • 984 Stone Fruit Growers 0,45% of GDP

"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 import. 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

INTRODUCTION

The purpose of HORTGRO Science is defined as follows:
"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."

HORTGRO Science has lived out its tag line of the 'technology collective'. Over 200 experts from across the deciduous fruit industry contribute to the formal research process annually – either by sitting on a peer review panel, a technical advisory group or one of thirty workgroups. In addition to the formal process which includes regional visits to grower groups in the different regions, informal inputs are made by growers in an effort to align the research with the research priorities of the industry.

'ENSURING THE DEVELOPMENT AND RETENTION OF SKILLS.'

One of the greatest challenges of any research system is to be able to demonstrate to its funders that it is adding tangible benefits. Research sometimes generates quantum outputs but mostly research is incremental, fitting pieces to the puzzle over a longer period of time. We have embarked upon a process where we are publishing a series of stories in the South African Fruit Journal that will hopefully enlighten stakeholders in the deciduous fruit industry about the benefits of their investment in research over the past 10 – 15 years. To highlight the first two stories:

Story One: The Forelle Early Market Access (FEMA) programme evolved out of some innovative thinking from Dr Ian Crouch, Research and Development Manager from ExperiCo where he sought "to treat pears like apples". He used a combination of SmartFresh™ technology and harvest maturity to create a product that could fill a particular marketing gap and in the process increased the net return to the grower. The annual net return of FEMA programme for 2014 was over R20 million. This returns R9 annually for the cumulative R1 investment in the research.

Story two: Dr Ken Pringle initiated research on mites on apples which led to bio-control of mites. The annual benefit or impact on the South African apple industry is R12 million – this is equivalent to annual spend on apple research. The total cost of the research was R317 751. The yearly cost benefit is 1:37.

PERSONNEL / MANAGEMENT

The staff of HORTGRO Science is as follows:
Hugh Campbell
- General manager
Richard Hurndall
- Research & Technology Manager
- Programme Manager – Post Harvest
Prof Wiehann Steyn
- Programme Manager Crop Production (extraordinary appointment to the Department of Horticultural Science – Stellenbosch University)
Matthew Addison
- Programme Manager Crop Protection – based at the Department of Entomology and Conservation Ecology – Stellenbosch University
Erin Morkel
- Technology Transfer Manager (up until March 2014)
Elise-Marie Steenkamp
- Communications Specialist (from April 2014)
Theresa Sonnenberg
- Research administrator
Willie Kotze
- Regional fruit production researcher

The staff seconded to Stellenbosch University are the following:
Dr Ken Pringle
- Department of Entomology and Conservation Ecology
Dr Shelly Johnson
- Department of Entomology and Conservation Ecology
Dr Elmi Lotze
- Department of Horticulture Science
Dr Mariana Jooste
- Department of Horticulture Science (5/8 appointment)

Contract positions funded through research projects:
Dr Juanita Heunis
- Department of Entomology and Conservation Ecology
Ms Laura Allderman
- Dormancy Projects

Wiehann Steyn was appointed as an extraordinary associate professor at the Stellenbosch University Department of Horticultural Sciences. We congratulate him on this appointment and recognise his continued input into both undergraduate and post graduated teaching.

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 Programme Manager - Prof Wiehann Steyn.
Crop Protection Programme Manager - Matthew Addison.

3. Product integrity (Post Harvest) - Richard Hurndall. Market Alignment and a Sustainable Supply Chain - Lindi Benić, in her capacity as Manager of Trade and Market Access leads the market alignment programme.

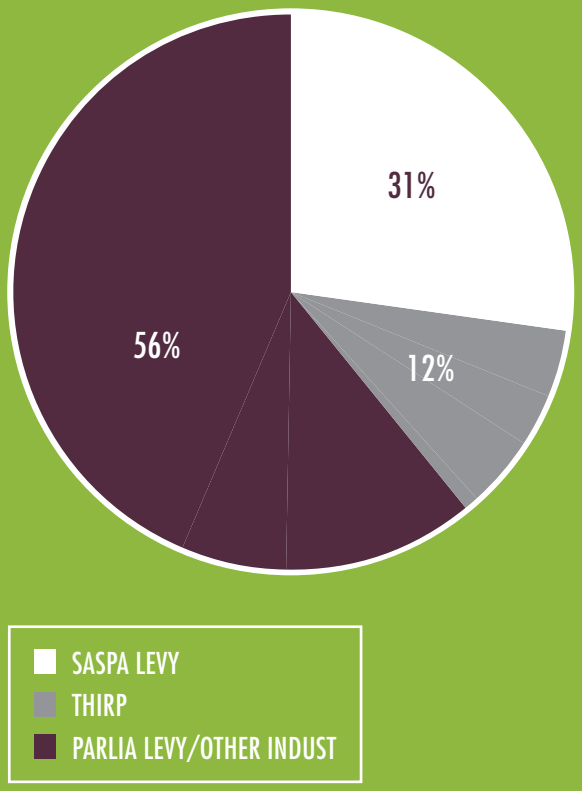
4. The Technology Transfer programme was managed by Erin Morkel up until March 2014. In April 2014 Elise-Marie Steenkamp was appointed as a Communications Expert. This change in portfolio came about after a strategic re-think of the communications and technology transfer function within HORTGRO Science.

RESEARCH PROJECTS / FUNDING

HORTGRO Science receives its primary funding from the grower levy from SAAPPA and SASPA. This funding provides the seed funding to catalyse its research. Fifty percent of the standard levy is channelled to research and development. If one were to include the market development levy then research and development would represent 34% of the total levy that a grower pays. This funding is then used to leverage further funding. Figure 1 below indicated the funding leverage for stone fruit. For every R1 received from the levy R2,2 is leveraged. The main vehicles used are: the Parliamentary Grant channelled through the ARC; co-funding from other industries (mostly pome fruit, stone fruit, dried fruit, canning fruit, as well as the table grape, citrus and wine industry); The Department of Trade and Industry's THRIP (Technology and Human Resources for Industry Programme) which is associated with capacity development as it requires students to be trained at universities.

In addition to the funding alternatives noted above, HORTGRO Science has and continues to benefit from the Post-Harvest Innovation Programme that is funded by the Department of Science and Technology. This programme focuses specifically on innovative post-harvest technology in the fruit and vegetable industries. The Western Cape Department of Agriculture is a core funded of the Confronting Climate Change project. Further co-funders of research are the National Research Fund (NRF) that fund bursaries at the universities and the International Atomic Energy Agency that has funded research on sterile insect release in codling moths. Management is continually on the look-out for additional funding opportunities.

FIGURE 1: 1998/99 FUNDING ALLOCATIONS SASPA 2013/14 FUNDING LEVERAGE



GENERATE AND TRANSFER KNOWLEDGE

Funding shifts over time:
The following two figures (Figure 2 & Figure 3) demonstrate the shift on funding over the past 14 years.

The pie graph below clearly reflects the shifts that have taken place over the past 14 years. It is interesting to note the relative decrease in funding allocation to the ARC. The breeding programme absorbs 70% of the funding allocation to the ARC. One of the noticeable shifts has been towards increasing capacity within HORTGRO Science. This has manifested in an increased control of the programme management activity as well as technology transfer back to the grower. In addition, HORTGRO Science has made a strategic investment in researchers that are critical to the industry.

FIGURE 2: 1998/99 FUNDING ALLOCATIONS

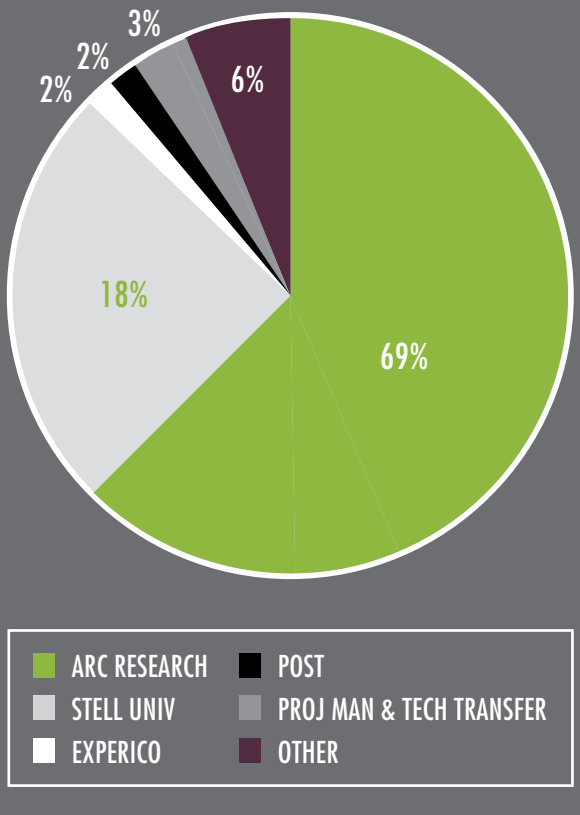
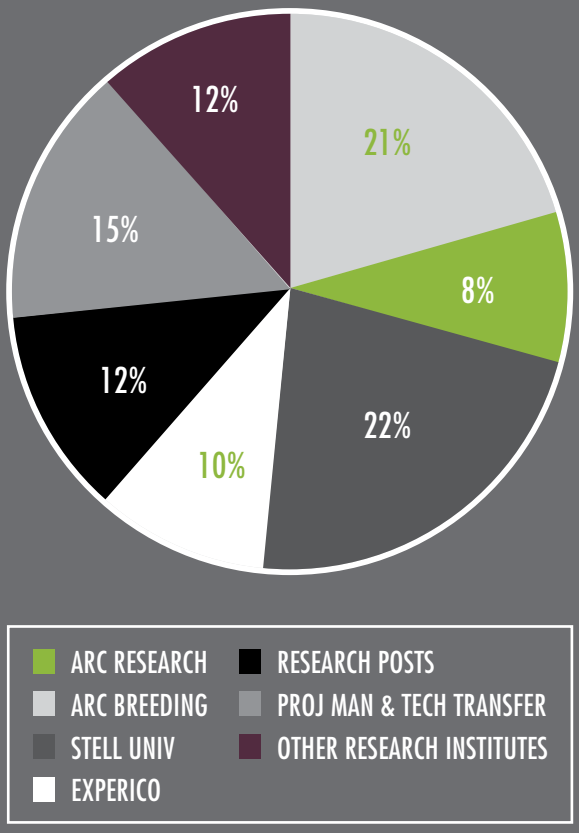


FIGURE 3: 2013/14 FUNDING ALLOCATIONS



Research projects conducted during 2013/14:

TABLE 1: 2013/14 RESEARCH PROJECTS

PROJECTS	TOTAL	POME	STONE
Projects conducted in 2012/2013	120	82	83
Projects completed in 2012/2013	30	21	9
Projects continuing in 2013/2014	90	61	29
New projects initiated in 2013/2014	26	17	9
TOTAL PROJECTS IN 2013/14	**116**	**78**	**38**

Note: 16 projects are co-funded by both pome and stone fruit.

Research institution utilised in 2013/14:
The following table gives an overview of the research institutions utilised in 2013/14:

TABLE 2: 2013/14 RESEARCH PROJECTS PER RESEARCH INSTITUTION

RESEARCH INSTITUTE	PROJECTS 2013/14	PROJECTS 2012/13
ARC Infruitec-Nietvoorbij	**36**	**36**
ARC Breeding	21	21
ARC Research Projects	15	15
Stellenbosch University	**39**	**38**
US – Horticulture	16	15
US – Pathology	5	5
US – Entomology	18	18
HORTGRO Science Technical Services	**20**	**20**
ExperiCo	**16**	**15**
CA Science	**1**	**1**
Nemlab	**1**	**1**
Blue North	**1**	**1**
University of Pretoria	**1**	**1**
CSIR	**1**	**1**
TOTAL PROJECTS	**116**	**114**

FIGURE 4: POME FRUIT 2013/14
INVESTMENT PER RESEARCH INVESTMENT FOCUS AREA

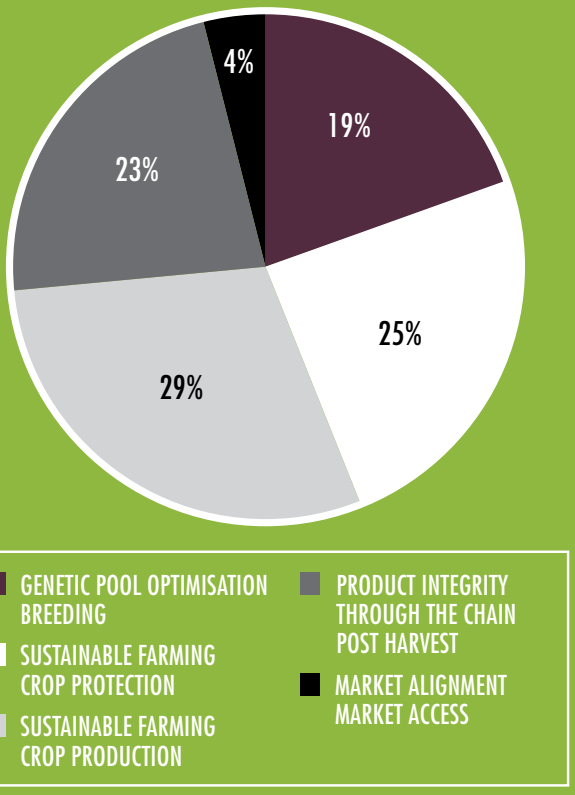
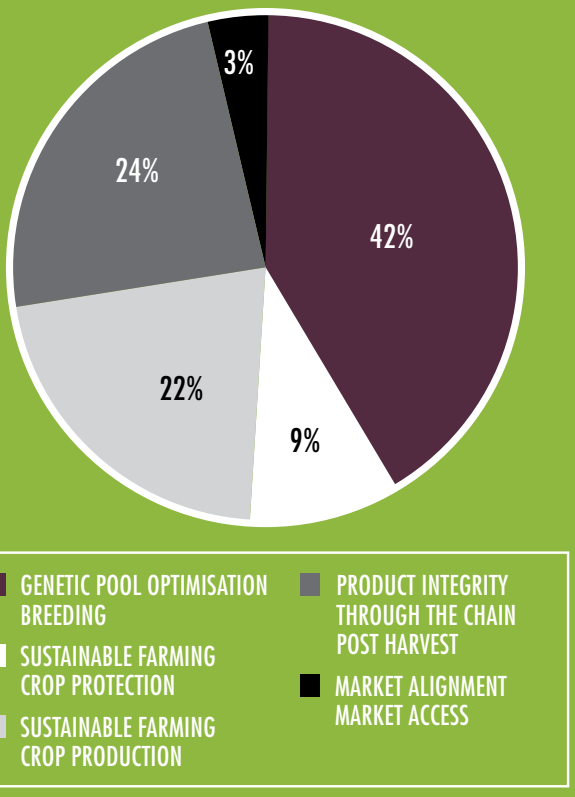


FIGURE 5: STONE FRUIT 2013/14
INVESTMENT PER RESEARCH INVESTMENT FOCUS AREA



Average cost of projects per year:
2000/01 - R68,300 / project
2005/06 - R112,268 / project
2009/10 - R145,597 / project
2011/12 - R127,693 / project
2012/13 – R119,920 / project
2013/14 – R144,196 / project
The average cost per project went up in 2013/14. This is a factor of a number of variables that include the type of projects embarked upon.

Funding allocation per research investment focus area:
The following graphs give a representation of the funding allocation per programme.

Research programmes and projects per investment area:
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 2013/14 financial year.

RESEARCH CAPACITY AND TRANSFORMATION

One of the strategy objectives of HORTGRO Science is to address the research capacity challenge that our industry is facing. It is a perpetual challenge to build the next generation of researchers while ensuring that we maintain the key research capacity that is necessary to meet the current needs of the deciduous fruit industry. In parallel with this, we would like to change the profile of our researchers to better reflect the demographics of the country. Currently 37% of the research projects have a female as the project leader and 13% of the projects have a black project leader, down from 15% last year. What is encouraging is that 35% of our projects involve the training of students at post graduate level and as noted below 40 postgraduate students are currently registered on HORTGRO Science projects. These students are not guaranteed a position within the deciduous fruit industry of South Africa. However, it is very evident that s large number of the technical and research personnel currently employed in the industry were trained through a project that was funded by the industry.

HORTGRO Science interacts with the Deciduous Fruit Development Chamber (DFDC) in order to identify the specific research needs of the emerging growers. The DFDC acts as a vehicle through which to communicate with emerging growers. The DFDC is represented on the HORTGRO Science Board by Joseph Hendricks and William Myburgh. All technology transfer events organized by HORTGRO Science are made available to emerging growers at no cost if facilitated through the DFDC. Currently a technology strategy is being drafted in conjunction with the DFDC. A video series of 35 videos covering all the production aspects of production has been produced specifically focusing on new entrants. Twenty five of the videos have been translated into Afrikaans and Xhosa. A plan is in place to translate the final 10 videos into Afrikaans and Xhosa.
These videos are freely available to all and are housed on http://www.saorchard.co.za

University projects – student cost and availability:
40 post-graduate students are funded through bursaries supplied by research projects. The full value of these bursaries amount to R2 301 863 or 13% of the funding allocated to research projects. This excludes specific bursaries funded through HORTGRO that focus more on undergraduate students. It is also noted that additional funding was leveraged by the universities and research organisation from the Department of Trade and Industries THRIP fund. This fund requires students to be registered at a university in order to match funds put into a project involving students.

TABLE 3: POST GRADUATE STUDENTS WORKING ON PROJECTS FUNDED BY SAAPPA / SASPA.

TOTAL	MSC	PHD	POST DOC	TOTAL BURSARY
40	23	13	4	R2 301 863

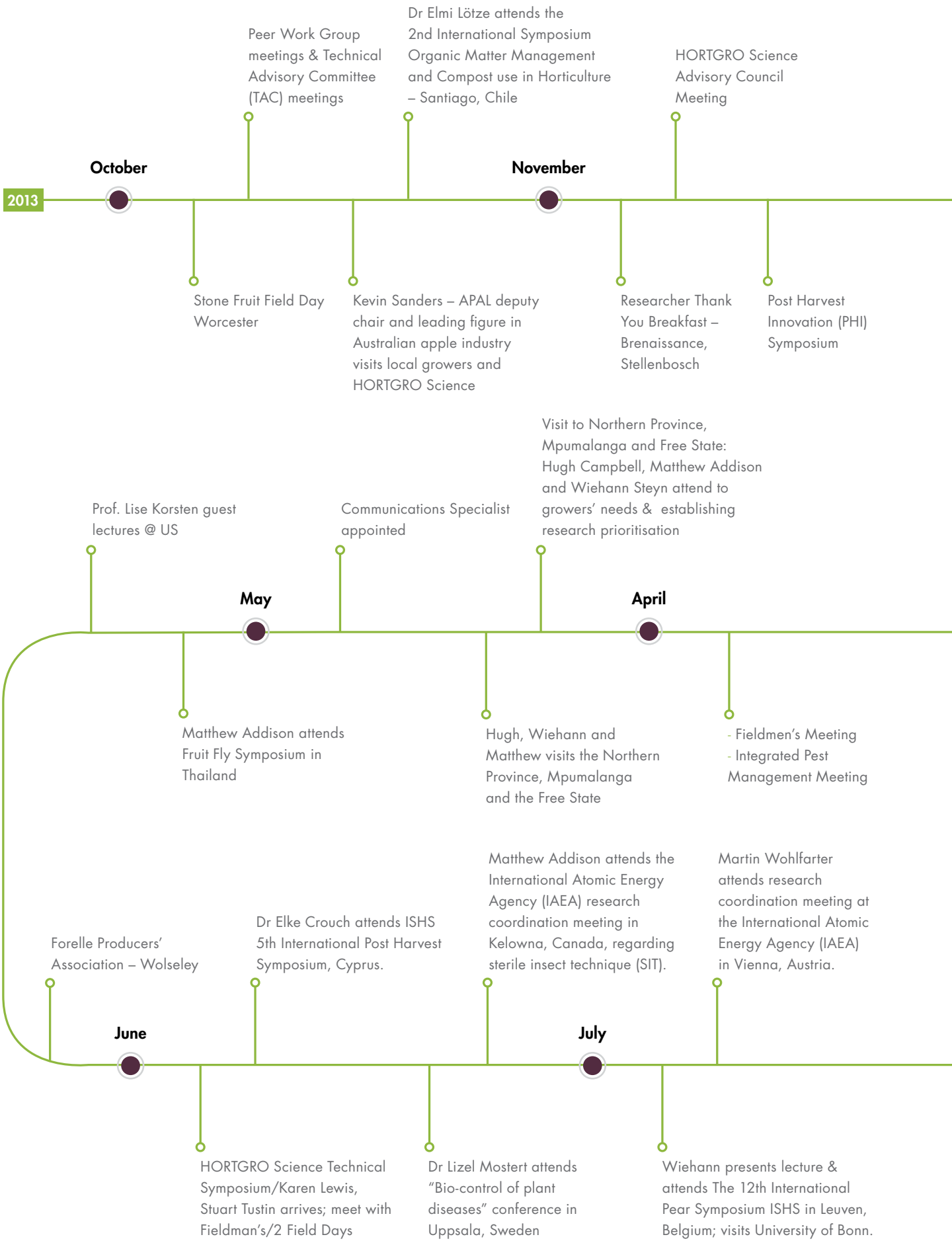
SUPPORT STRUCTURES / ADVISORY COMMITTEES

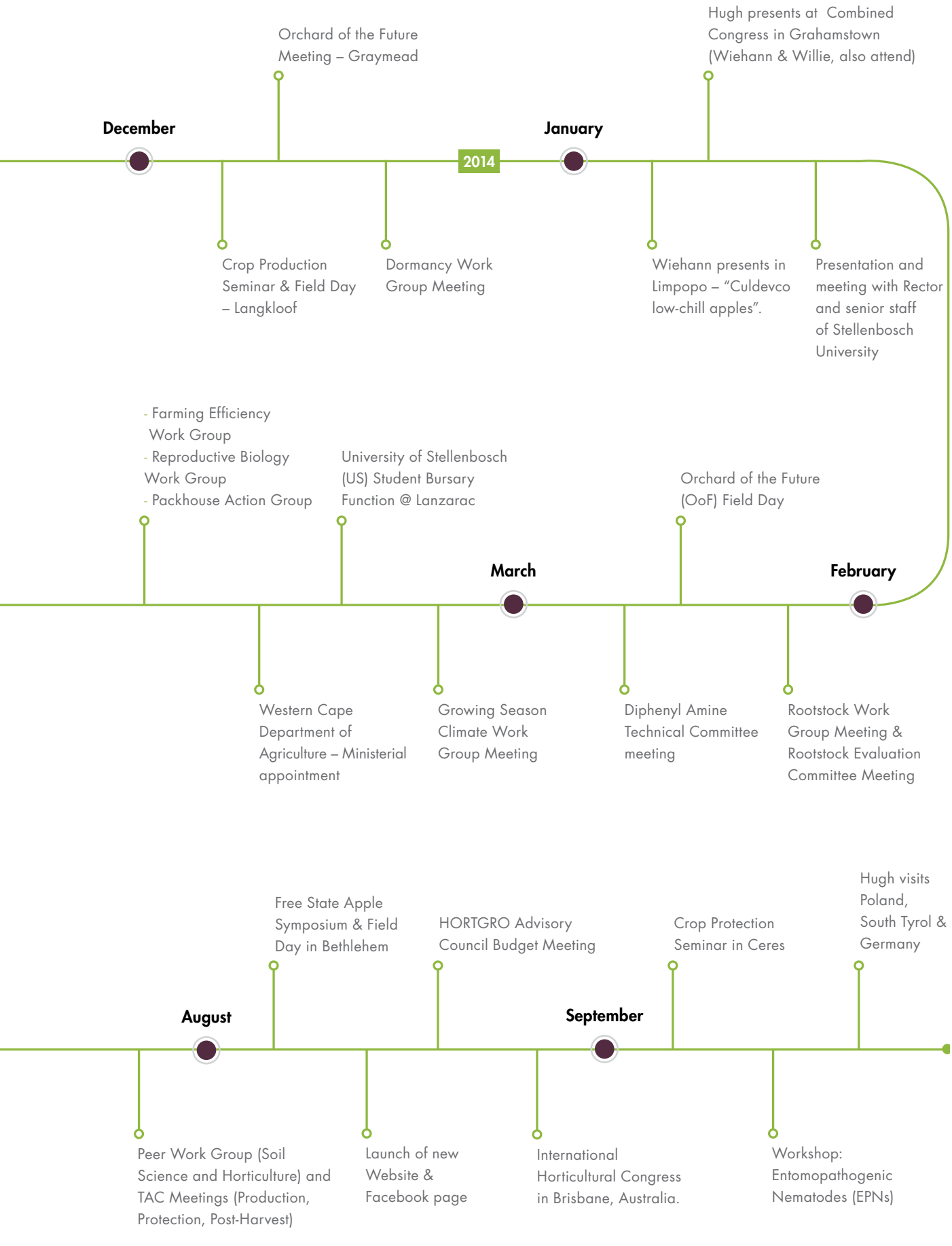
HORTGRO Science is dependent on its extensive support structures that are made up of colleagues and role-players in the deciduous fruit industry who tirelessly give of their time, intellect and passion to serve the needs of the industry. The various committees that service the needs of HORTGRO Science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

See peer work groups (PWG's) on page 87 appendix.

Hugh Campbell


2013
October
Peer Work Group meetings & Technical Advisory Committee (TAC) meetings
Dr Elmi Lötze attends the 2nd International Symposium Organic Matter Management and Compost use in Horticulture – Santiago, Chile
November
HORTGRO Science Advisory Council Meeting
Stone Fruit Field Day Worcester
Kevin Sanders – APAL deputy chair and leading figure in Australian apple industry visits local growers and HORTGRO Science
Researcher Thank You Breakfast – Brenaissance, Stellenbosch
Post Harvest Innovation (PHI) Symposium
Prof. Lise Korsten guest lectures @ US
Communications Specialist appointed
Visit to Northern Province, Mpumalanga and Free State: Hugh Campbell, Matthew Addison and Wiehann Steyn attend to growers' needs & establishing research prioritisation
May
April
Matthew Addison attends Fruit Fly Symposium in Thailand
Hugh, Wiehann and Matthew visits the Northern Province, Mpumalanga and the Free State
- Fieldmen's Meeting
- Integrated Pest Management Meeting
Forelle Producers' Association – Wolseley
Dr Elke Crouch attends ISHS 5th International Post Harvest Symposium, Cyprus.
Matthew Addison attends the International Atomic Energy Agency (IAEA) research coordination meeting in Kelowna, Canada, regarding sterile insect technique (SIT).
Martin Wohlfarter attends research coordination meeting at the International Atomic Energy Agency (IAEA) in Vienna, Austria.
June
July
HORTGRO Science Technical Symposium/Karen Lewis, Stuart Tustin arrives; meet with Fieldman's/2 Field Days
Dr Lizel Mostert attends "Bio-control of plant diseases" conference in Uppsala, Sweden
Wiehann presents lecture & attends The 12th International Pear Symposium ISHS in Leuven, Belgium; visits University of Bonn.

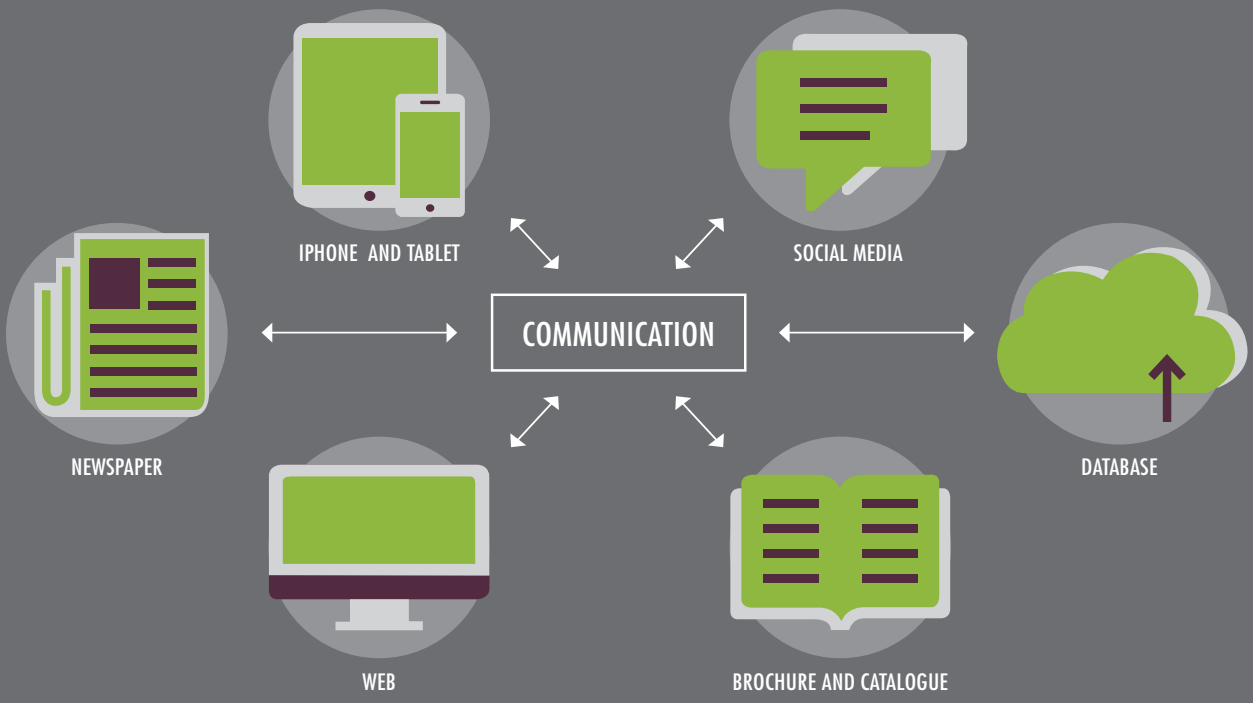

December
Orchard of the Future Meeting – Graymead
Crop Production Seminar & Field Day – Langkloof
Dormancy Work Group Meeting
2014
January
Hugh presents at Combined Congress in Grahamstown (Wiehann & Willie, also attend)
Wiehann presents in Limpopo – "Culdevco low-chill apples".
Presentation and meeting with Rector and senior staff of Stellenbosch University
February
Orchard of the Future (OoF) Field Day
Rootstock Work Group Meeting & Rootstock Evaluation Committee Meeting
March
- Farming Efficiency Work Group
- Reproductive Biology Work Group
- Packhouse Action Group
University of Stellenbosch (US) Student Bursary Function @ Lanzarac
Western Cape Department of Agriculture – Ministerial appointment
Growing Season Climate Work Group Meeting
Diphenyl Amine Technical Committee meeting
August
Free State Apple Symposium & Field Day in Bethlehem
HORTGRO Advisory Council Budget Meeting
Peer Work Group (Soil Science and Horticulture) and TAC Meetings (Production, Protection, Post-Harvest)
Launch of new Website & Facebook page
September
Crop Protection Seminar in Ceres
Hugh visits Poland, South Tyrol & Germany
International Horticultural Congress in Brisbane, Australia.
Workshop: Entomopathogenic Nematodes (EPNs)

'HEALTHY COMMUNICATION PRINCIPLES AND AN INTEGRATED APPROACH'

COMMUNICATIONS

Half-way through the year the Technology Transfer Programme changed quite dramatically when Erin Morkel resigned and Elise-Marie Steenkamp was appointed in a newly created post as a Communications Specialist.

This shift reflects the great demand for strategic communication process – one in which diverse stakeholder needs are addressed, awareness is raised, a strong network is created, information is dispersed in a timely manner and growth can take place. The emphasis is on healthy communication principles and an integrated approach; applying SMART logic; following a two-way model which encourages feedback whilst staying focussed, consistent and authentic.



To kick-off, an article series was launched in the South African Fruit Journal, focussing on the return on investment that is brought about by HORTGRO Science's research projects, as well as the many other spin-offs associated with this process. In terms of content and lay-out, some changes were made and outputs increased. A total of 8 popular articles and 8 semi-scientific articles were published, on top of other general news items and report backs.

A much needed upgrade of the website was launched, with a fresh, modern feel that made it more user-friendly and interactive.
Accompanying the new site is a Facebook page - our first venture into hitherto unchartered social media waters. We have also invested in video-editing training which in future will be imbedded and used in conjunction with other communication tools. An effort will be made to integrate various communication tools with the aim of reaching different target audiences.

In June the annual HORTGROScience -Technical Symposium was a resounding success, as attested by the attendance figures on day one, 350, and day two 315. Producers, technical experts, researchers, chemical company representatives, exporters and government officials all agreed that the symposium is important to stay on top of new developments, and as a forum for interaction and exchange of ideas. Cold, rainy weather did not deter the 208 delegates that attended the pome fruit field day in the Grabouw region and the 115 delegates that attended the stone fruit field day at Simondium.

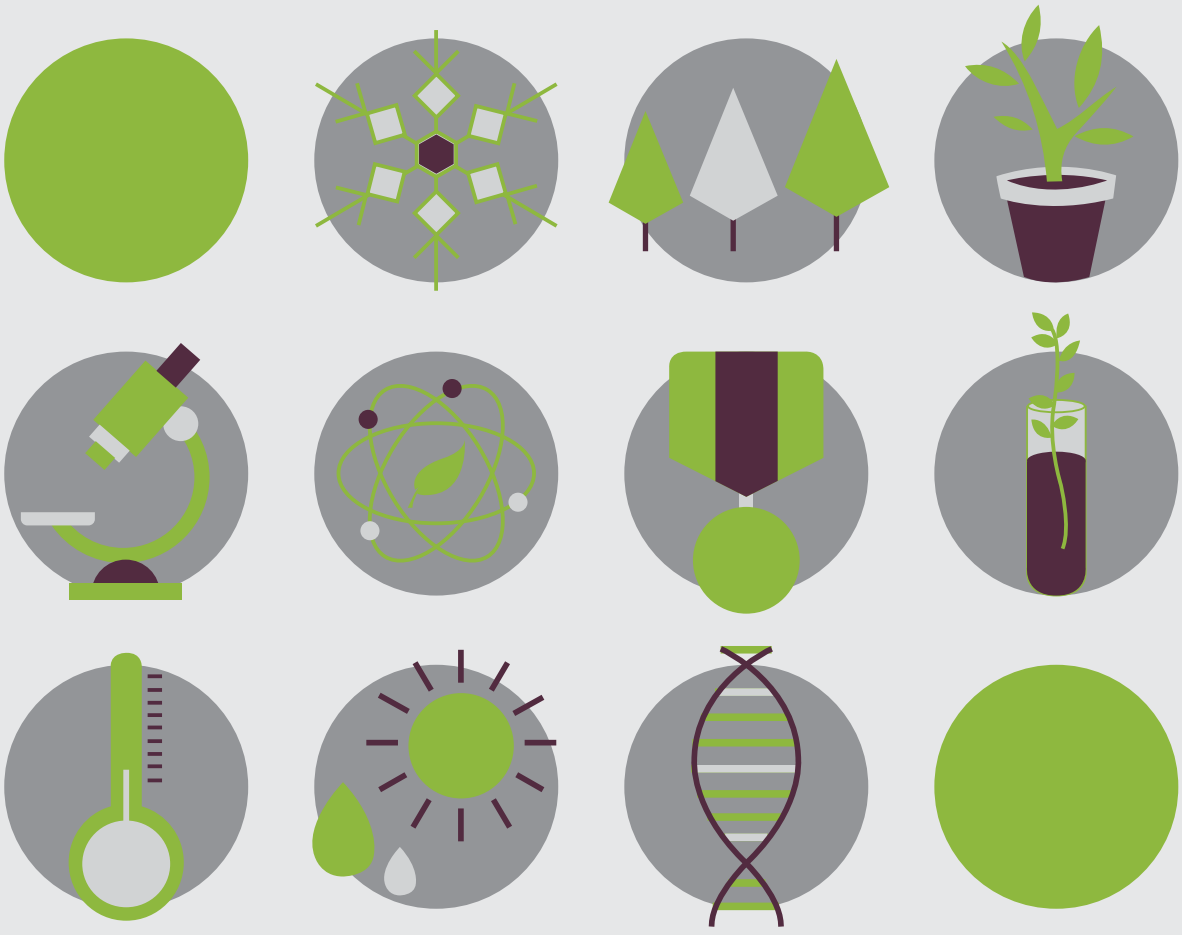
Keynote speaker, Prof. Jonathan Jansen, Vice-Chancellor and Rector of the University of the Free State, had the audience in the palm of his hand when he explained his view on ethical leadership. Prof. Karen Lewis, from Washington State University's Centre for Precision and Automated Agricultural Systems, minced no words explaining why automation and mechanisation are crucial elements of the future of agriculture, whilst Dr Stuart Tustin, from The New Zealand Institute for Plant & Food Research Limited, pointed out that spur extinction is the way to go in the control of fruiting for precision crop production of apple orchards.

To summarise the Symposium a special electronic edition of the Fresh Notes was compiled that was positively received by our producers. This effort was replicated with the Crop Protection Seminar that was held in Ceres during September 2014. Since October 2013 sixteen Fresh Notes were sent out.

Elise-Marie Steenkamp
Communications Specialist

See information Days, workshops and symposiums on Page 89 appendix as well as the SAFJ publications list.

BREEDING AND EVALUATION



'SUCCESS IS DUE TO THE ENERGY OF OUR TEAM.'

HORTGRO Science co-sponsors Breeding & Evaluation programmes for the major deciduous fruit crops, within the 'Research Investment Focus Area' of Genetic Optimisation. The programmes pay particular attention to adaptability to the warm winters of South Africa and resistance to pests and diseases, as well as to yield and fruit quality, including cold-storage ability for export and suitability for canning or drying, in the case of scion cultivars and to ease of propagation and orchard performance in the case of rootstocks. The projects are presented each year to Culdevco, when objectives and progress are discussed, and this year will also be presented to the Fruit Route Steering Group for review. And promising Phase 2 selections of pome and stone-fruit are displayed at periodic Fruit Exhibitions held at the Infruitec campus in Stellenbosch.

A list of Breeding & Evaluation research projects, conducted in the Cultivar Development Division of ARC Infruitec-Nietvoorbij, funded during the 2013/14 financial year is given in Table 1. Parliamentary grant (65%) and industry funding (35%) covers the costs of the traditional stages of the programmes: maintaining and improving genebanks, making controlled crosses, selecting the most promising seedlings (Phase 1) and evaluating them in trial (Phase 2). This work is now underpinned by appropriate genetic studies, which are mostly funded by NRF via a THRIP project worth 50% of the industry funding. The actions and outputs are described briefly in the summaries of the various annual reports. 2013-14 brought its challenges, not least the exceptional rains in November which adversely affected e.g. crops of stone-fruit and growth of pear nursery trees for Phase 2.

ARC and HORTGRO Science have been keen to develop existing staff and to train students as the next generation of plant breeders. Sonwabo Booi was awarded his MSc – on mapping the red-skin gene in pear – by the University of Western Cape in March. Four staff are currently registered for PhDs at Stellenbosch University: Louisa Blomerus (resistance to woolly apple aphid), Carl Hörstmann (mapping various traits in apricot and plum), Trevor Koopman (races of apple scab), and Werner Pieterse (carotenoids in peach). Also registered at Stellenbosch University, students Solomon Ntladi (NRF-funded) and Zama Mbulawa (THRIP funded) are continuing their PhDs on mapping and improving genetic understanding of important traits in pome-fruit and MSc students Khethani Mhelembe (HORTGRO Science) and Thembeka Nyawo (HORTGRO Science), who are fingerprinting the pome-fruit and stone-fruit genebanks, have been joined by Lawrence Kwalimba (HORTGRO Science).

Six staff and four students attended the Southern African Plant Breeders' Association Meeting in Free State in March 2014. And, internationally, Trevor attended the American Phytopathological Society in USA in August 2013, Zama the 7th Rosaceous Genomics Conference in USA in June 2014, Sonwabo the ISHS Pear Symposium in Belgium in July, and Carl the International Horticultural Congress in Australia in August. Such meetings are an ideal forum for exchange of ideas with other scientists.

And, in response to an invitation from China, Taaibos spent a week visiting the pear breeding programme at Zhengzhou Fruit Research Institute in September 2014.

The realignment of the Breeding and Evaluation programmes that was initiated with the Fruit Route review in 2010 is continuing. Success is due not only to the energy and flexibility of the team but also to collaborations developed with supervisors of the various staff and students registered at Stellenbosch University and, of course, to the support received from ARC, THRIP, SAAPPA, SASPA and HORTGRO Science.

Ken Tobutt, ARC Infruitec-Nietvoorbij

RUNNING PROJECTS, ALL CONDUCTED AT ARC INFRUITEC-NIETVOORBIJ

1
Apple
Breeding high quality disease resistant apples for first and second economies.
Johan Kriel / Ken Tobutt

2
Pear
Breeding of pear cultivars.
Taaibos Human

3
Peach
Breeding of peaches and nectarines for commercial and emerging farmers.
Werner Pieterse

4
Plum, Peach, Apricot
Breeding of new peach rootstocks.
Sonwabo Booi

5
Plum
Breeding of Japanese plums for commercial and emerging farmers.
Carl Hörstmann

6
Apricot
Breeding of apricot cultivars for commercial and emerging farmers.
Carl Hörstmann

7
Apple
Phase II evaluation of apple cultivars.
Khashief Soeker

8
Pear
Phase II evaluation of pears in the Western Cape
Khashief Soeker

9
Peach
Phase 2 evaluations of peach and nectarine cultivars in the Winter rainfall region.
Chris Smith

10
Plum
Phase 2 evaluations of plum cultivars in the Winter rainfall region.
Chris Smith

11
Apricot
Phase 2 evaluations of apricot cultivars in the Winter rainfall region.
Chris Smith

12
Plum, Peach, Apricot
Evaluation of stone fruit in the Summer rainfall area.
Irwin Meintjies

13
Apple, Pear, Plum, Peach, Apricot
Planting and maintenance of germplasm of pome fruit, stone fruit and alternative deciduous fruit crops
Werner Pieterse

14
Apple, Pear, Plum, Peach, Apricot
Three studentships to apply molecular markers to the pome-fruit and stone-fruit breeding programmes
Ken Tobutt

15
Plum
Determination of cross pollinators for plum varieties.
Jannie De Klerk

16
Plum, Peach, Apricot
Evaluation of newly bred stone fruit rootstock hybrids.
Sonwabo Booi

17
Plum, Peach, Apricot
Cold storage characteristics of new cultivars and selections.
Ester Lotz

18
Plum, Peach, Apricot
Evaluation of newly developed stone fruit cultivars and training in fruit growing for the Second Economy
Trevor Koopman

19
Apple, Pear
Evaluation of newly developed pome fruit cultivars and training in fruit growing for the Second Economy
Trevor Koopman

20
Apple
Determination of apple scab races occurring in South African apple growing regions to underpin breeding for resistance
Trevor Koopman

01 BREEDING HIGH QUALITY DISEASE RESISTANT APPLES FOR FIRST AND SECOND ECONOMIES

Research Organisation Project number: 2100-01
Project leader: Kenneth Tobutt/ Johan Kriel
(ARC Infruitec-Nietvoorbij)

1. 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.

2. The breeding involves maintaining gene-banks, making controlled crosses, screening and selecting Phase 1 seedlings and promoting the best to Phase 2 – and is underpinned by complementary genetic studies..

3. Budwood of twelve selections in the Phase I orchards at Drostersnes that were earmarked in 2013 was collected for propagation by SAPO to raise trees for Phase 2. Over 8000 trees in Phase 1 were assessed for crop, appearance, and season and 30 were harvested for assessment of storage performance; nine selections were short-listed for promotion to Phase 2. Some 42 controlled cross-pollinations were made e.g. to combine fruit quality with low winter chilling requirement or columnar growth habit or for genetic studies on the inheritance of woolly aphid resistance or low chill requirement; 10,000 of the resulting 20,000 seeds were sown. Mislabellings in the Elgin and Drostersnes genebanks were corrected. Genomic DNA was isolated from 600 accessions, and used for generating SSR profiles with a standard set of 12 SSR markers, and for characterization of the accessions with respect to the agronomically-important 1-aminocyclopropane-1-carboxylate synthase (ACS1) gene. Ten accessions from East Malling are currently in quarantine. Two staff members are continuing with their PhD studies.

4. 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.

02 BREEDING OF PEAR CULTIVARS

Research Organisation Project number: 2100-02
Project leader: Mr Taaibos Human

1. The aim of this project is to provide the South African pear industry with new, locally adapted cultivars.

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

3. Budwood of 27 Phase 1 selections and eight selections for Inter-Phase Evaluation (promoted the previous year) was supplied to SAPO. Forty-one new selections were harvested and, after storage evaluations, were reduced to 27 for Phase 2 evaluation. These comprised 18 blush, five yellow, one blush-on-russet and three fully red selections. Outstanding selections included: the early blush selection P14-01 (14 Jan) with good appearance, attractive colour, good texture and better than average taste, scoring 18/30; blush selection P14-19 (4 Feb) with good appearance, attractive colour and better than average taste and texture, scoring 19/30. Cross pollinations produced 7 344 seeds, including 25% for blushed, 14% for various coloured miniature pears, 17% for green, 16% for reds, 6% for tri-coloured, 2% for intergeneric and 9% for future genetic studies. About 4 383 new seedlings were planted in seedling Block 2 at Drostersnes. A Ph.D. student is using one of the seedling progenies at Drostersnes for his project on mapping the blush trait.

4. Three new selections P14-01, P14-19 and P14-22, show potential for the future and may follow the "fast track" route with the collaboration of Culdevco and co-operatives for further evaluation.

03 BREEDING OF PEACHES AND NECTARINES FOR COMMERCIAL AND EMERGING FARMERS

Research Organisation Project number: 2100 03
Project leader: Mr W-M. Pieterse
ARC Infruitec-Nietvoorbij

1. 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.

2. As set out in previous reports.

3. The 2014 winter season's data capture will be completed by mid-September, therefore results for the 2014 season are not yet available.

4. Progress was made with aligning the peach breeding programme with opportunities in molecular breeding, by conducting crosses with this objective in mind, reviewing the literature for the CCD4 gene controlling flesh colour and registering for a PhD. Industry objectives have been addressed by performing crosses aimed at early ripening, lower chilling requirement, leaf curl resistance and to fill the ripening gap in January. Further attempts will be made to source useful accessions for the genebank.

04 BREEDING OF NEW PEACH ROOTSTOCKS

Research Organisation Project number: 2100-04
Project leader: Mr S. Booi

1. The aim of this project is to provide the South African Stone-Fruit Industry with new, low-chill stone-fruit rootstocks (peaches, plums, apricots and interspecies) resistant/tolerant to stress conditions associated with heavy clay soil conditions, drought, soil salinity, lime-induced iron chlorosis and nematodes (ring and root-knot), and thus adapted to South African soil and climate conditions in order to be competitive in the overseas markers. The aims 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.

2. Twelve ARC-bred stone-fruit rootstock selections, mostly plums, and five commercial rootstock cultivars were screened in the Nematode Glasshouse at Bien Donné Experiment Farm to check for resistance/tolerance to the combination of ring and root-knot nematodes. Three progenies from controlled crosses Soldonne x Palsteyn, Soldonne x Supergold (apricot) and Nemaguard x Katera (peach), with seedling numbers of 18, 120 and 18 respectively, were screened for resistance/tolerance to both nematode species.

3. Eleven ARC-bred selections were found to be resistant to both nematode species, whereas one selection was susceptible to ring nematodes and resistant to root-knot nematodes. In the three progenies also inoculated, Soldonne x Palsteyn, Soldonne x Supergold and Nemaguard x Katera, 10 out of 18, 34 out of 120 and 14 out of 18 respectively were tolerant/resistant to both nematode species.

4. Of the eleven ARC-bred selections found to be resistant to both nematode species, four had previously been promoted to Phase 2 for having resistances for other characters. For the remaining seven, it was the first time that they were screened for resistance to both nematode species and, therefore, a second screening test needs to be conducted to confirm results.

05 BREEDING OF JAPANESE PLUMS FOR COMMERCIAL AND EMERGING FARMERS

Research Organisation Project number: 210005
Project leader: Mr CU Hörstmann

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

2. In addition to the traditional breeding approaches – maintaining genebanks, crossing and selecting – recently initiated work on molecular breeding continued.

3. Budwood of eleven promising selections from 2012 was provided to SAPO for propagation. Four promising selections, harvesting from week 51 to week 5, were identified in Phase I orchards for promotion to Phase II. During the 2013 season, hand pollinations yielded a total of 169 embryos. Work on the THRIP project launched in April 2012 included collecting additional leaf samples from the genebank accessions, DNA extraction, and SSR primer optimisation for fingerprinting. The breeder registered as a PhD student at Stellenbosch Universit and attended the 10th South African Plant Breeders Symposium, presenting one poster as primary author and several as co-author. One presentation was made to representatives of the Stone Fruit Industry.

4. Progress was made during the past season: several promising selections were identified from Phase I, despite environmental constraints; successful crosses were performed generating seedlings to satisfy breeding objectives and genetic studies; and important contacts were made. In addition, THRIP funding is allowing the fingerprinting of the genebank.

OVERCOME THREATS/ RISKS

06 BREEDING APRICOT CULTIVARS FOR COMMERCIAL AND EMERGING FARMERS

Research Organisation Project number: 210007
Project leader: Mr CU Hörstmann (Mrs L Steyn)
(ARC Infruitec-Nietvoorbij)

1. This project aims to breed a full range of canning, drying, dessert and multi-purpose cultivars ripening from very early to very late in the season which are easy to grow and easy to sell. This involves staying abreast of the latest developments in breeding practices and the stone-fruit industry.

2. The traditional approaches of maintaining a genebank, making crosses and selecting promising seedlings for trial are now being complemented by THRIP-funded marker work to fingerprint germplasm and undertake marker-assisted selection.

3. Budwood of thirteen promising selections from 2012 was provided to SAPO for propagation. Seven promising selections, harvesting from week 48 to week 51, were identified in Phase I orchards and will be promoted to Phase II. During the 2013 season, hand pollinations yielded a total of 235 embryos. For the complementary THRIP project, additional leaf material was collected and DNA extracted for fingerprinting germplasm, and marker data from seedlings screened for PPV resistance was analysed. The breeder attended the 10th SAPBA Symposium. Two presentations were made to representatives of the Stone Fruit Industry.

4. Progress was made during the past season: despite adverse conditions several promising selections were made from Phase I, successful crosses were performed generating seedlings to satisfy breeding objectives and genetic studies and important contacts were made. THRIP-funded research is allowing the breeding programme to benefit from molecular markers.

07 PHASE II EVALUATION OF APPLE CULTIVARS

Research Organisation Project number: 2100/08
Project leader: Dr MK Soeker

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

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

3. A total of 21 locally bred selections were identified for removal from the evaluation programme after comparing evaluation data of the last five years. Ten new selections were planted at Elgin Experimental Farm in December 2013. A total of 60 selections including standard commercial cultivars 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 after periods of four and twelve weeks in cold storage, for low chill and medium chill selections, respectively. Of these, 19 stored well, 11 showed average storage ability, 14 were below average, 12 had no storage potential and four needed to be re-evaluated due to decay. The best selections, after quality assessment, from each category were: 4-61-35, low chill, 77%; 4-54-87, bi-colour, 76%; 4-13-23R, striped, 63% with balanced taste, good flavour and average texture. DNA was extracted from selections in one of the three orchards containing Phase 2 selections i.e. 118 selections and these will now be screened with 12 SSR markers, as part of an on-going THRIP genotyping project.

4. Feedback from industry contacts during orchard walks and exhibitions led to nine new apple selections (two of which had the highest scores in their categories, viz. 4-54-87 and 4-16-81, respectively) being identified and these will be closely watched in the coming seasons.

08 PHASE II EVALUATION OF PEARS IN THE WESTERN CAPE

Research Organisation Project number: 2100/09
Project leader: Dr MK Soeker

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

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

3. Thirty-two Phase 2 and 14 ARC Interphase selections were planted at Elgin Experimental Farm in 2013. A total of 69 selections and cultivars were harvested from Phase 2 plots and evaluated and tested for cold storage ability at the Post Harvest Division at ARC-Infruitec after eight weeks in cold storage. Of these, 35 selections stored well, 22 did not store well, ten were below average and 2 needed to be re-evaluated. The best selections for each of the product types were as follows: P07-3, blush, scoring 77% for consumer traits; P04-28, full red, scoring 75%; P07-28, green, scoring 70%; 'Harrow Sweet', yellow, 58%; P05-17 and 11B-7-17, green/yellow, 67%; P04-64(IF), brown, 36%; and P99-5(MP), yellow miniature, 84%. No selections were sent for canning and drying this year, but a few have been identified for the 2014/2015 season. Seventeen selections from this past season were identified for canning and drying in the coming season. Thirty-nine entries scored low marks (<60%) in the past season during quality assessments and, after comparison of evaluation data of the last five years, 15 will be discarded. Leaves were collected from 59 selections and these were prepped for genotyping with microsatellites as part of the THRIP project.

4. Feedback from industry contacts during orchard walks and exhibitions have been very informative and early input on new pear selections have been quite positive. Two new selections show early promise, after only 2 years of evaluation and will be closely monitored in subsequent evaluations.

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

Research Organisation Project number: IT2100.10
Project leader: Mr W.J.C. Smith

1. The project aims to evaluate and release locally bred peach and nectarine varieties for export, canning and drying industries.

2. Fruit samples were harvested on a weekly basis for cold storage, drying and canning evaluations. Horticultural data was captured on a MS Access database.

3. Evaluation results are supported by climate information. There is a significant variation in accumulation over years on Bien Donné (405 to 897 ICU) and Robertson (440 to 722 ICU) farms. Twenty-three peach and four nectarine selections were planted at Bien Donné and Robertson Research Farms. Two peach selections were planted at the Ceres evaluation site. Nineteen peach and thirty-nine nectarine selections were evaluated for cold storage abilities - one peach and fourteen nectarine selections obtained 80% or more after evaluation. Twenty-one canning peach selections scored >70% during canning evaluation. Eight nectarine samples were evaluated for drying ability and six selections scored 70% or higher. Seven peach selections or cultivars were tested for drying - three cultivars scored > 70% of which two obtained >80%. A number of promising peach and nectarine selections were given special attention on request of Culdevco. No new selections were submitted for Plant Breeders' Rights (PBR) or Variety Listings (VL) registrations. Four fruit exhibitions were held which were attended by 128 delegates. Meetings were held with Culdevco and its clients on new varieties and planting guidelines. Support was given to the second economy projects managed by the Cultivar Development Division as well as the projects in Mozambique, etc.

4. Horticulture and post-harvest evaluations and fruit exhibitions should continue in 2014/15. Peach and nectarine selections that do not perform after years of evaluation will be removed from the evaluation blocks at Bien Donne and Robertson.

10 PHASE 2 EVALUATIONS OF PLUM CULTIVARS IN THE WINTER RAINFALL REGION

Research Organisation Project number: IT2100.11
Project leader: Mr W.J.C. Smith

1. The project evaluates and releases locally bred plum varieties for the fresh export markets.

2. Fruit samples from promising plum selections were harvested weekly for cold storage (single and dual temperature regimes) trials. Horticultural, climatic, and fruit evaluation data were captured on a MS Access database.

3. The evaluation results were supported by climate information; there is significant variation between the accumulations of chilling units over nine years on Bien Donné (405 to 897 ICU) and Robertson (440 to 722 ICU) Research Farms. Four new plum selections were planted at Bien Donne, Robertson and Uitkoms. Fifty-nine selections were evaluated for cold storage ability and 17 scored ≥80% while six selections scored ≥90%. Various promising plum selections were given special attention at Culdevco's request. Three fruit exhibitions were held and were attended by 96 people. Meetings were held with Culdevco and its clients on new varieties and planting guidelines. Support was given to the second economy projects managed by the Cultivar Development Division as well as the ones in Mozambique. There was regular liason with the Deciduous fruit industry and technical support and technology transfer was given in South Africa and abroad.

4. Horticulture and post-harvest evaluations and fruit exhibitions should continue in 2014/15. Selections that do not perform well after five years of evaluation will be removed from the evaluation blocks at Bien Donne and Robertson Research Farms.

11 PHASE 2 EVALUATIONS OF APRICOT CULTIVARS IN THE WINTER RAINFALL REGION

Research Organisation Project number: IT2100-12
Project leader: Mr W.J.C. Smith

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

2. Fruit samples were harvested each week from November 2013 to February 2014 at Simondium (Bien Donné), Robertson and Ceres evaluation sites and subjected to cold storage, drying and canning trials at the Post Harvest and Wine Technology Division. Representative samples were also collected for horticultural evaluation and the data captured on a MS Access data base.

3. During the past winter, as in the previous winter, Bien Donné Research Farm received more chilling units than Robertson Research Farm. Three selections, harvested to test cold storage ability, scored 80% (cut-off point) or more. Six canning selections scored 60% (cut-off point) or more in canning evaluation and fifteen selections scored 60% (cut-off point) or more during drying evaluation. Several promising apricot cultivars and/or selections were given special attention at request of Culdevco with regards to horticultural traits. One fruit exhibition was held at ARC Infruitec-Nietvoorbij which was attended by approximately 40 people from the fruit industry. Meetings were held with Culdevco and its clients about new varieties and planting guidelines. Continuous support was given to the second economy projects managed by the Cultivar Division at the University of Venda in Thohoyandou and in Mozambique.

4. Horticulture and post-harvest evaluations as well as fruit exhibitions will continue in 2014/15. Apricot selections that do not perform after years of evaluation will be removed from the evaluation blocks at Bien Donne and Robertson Research Farms.

12 EVALUATION OF STONE FRUIT IN THE SUMMER RAINFALL AREA.

Research Organisation Project number: 2100-13
Project leader: Mr I.J. Meintjes

1. 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.

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

3. Evaluations were conducted on 458 phase 2 selections (6 or 3 trees each) at the three evaluation sites at Groblersdal Collette Farm, Mookghopong Bufland Farm and Mookghopong, Pro-Plum Farm. From the 458 selections, 86 peach, 82 nectarine, 0 plums and 0 apricot selections could be sampled and were evaluated on the standard evaluation data forms. Currently there are 19 promising selections (11 peach, 8 nectarine, 0 plum, and 0 apricot selections) which will be re-evaluated in the 2014 season. Possible promotion to Phase 3 will be discussed in collaboration with Culdevco in order to make final decisions. A summary of the best performing selections was prepared.

4. 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.

13 PLANTING AND MAINTENANCE OF EXISTING AND NEW GERMPLASM OF POME FRUIT, STONE FRUIT AND ALTERNATIVE DECIDUOUS FRUIT CROPS.

Research Organisation Project number: 2100-18
Project leader: Mr W-M. Pieterse

1. 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.

2. As set out in previous reports.

3. The BV apple genebank was grubbed as it contained accessions duplicated elsewhere. The block plan of the new pear genebank was updated with new information of parentage. A new site for the Apricot and Japanese plum genebanks was identified, as all the accessions in the peach/nectarine genebank were re-propagated. DNA was extracted from leaf samples collected previously from approximately 500 apple accessions and 200 pears and amplified with 12 microsatellite primers for each crop; fingerprinting is in progress. Some discrepancies between recorded data from apricot and plum accessions in the genebank and published data is under investigation. Six pear selections from Kazakhstan, with small fruit, were propagated on rootstocks by SAPO and two ornamental Malus - with genes affecting growth habit or phenolic constitution - were acquired for the apple genebank along with apple accessions from the genebank at East Malling Research, UK, imported in vitro. Twenty one peach accessions were ordered (and delivered at the quarantine station) from USDA-ARS-National Clonal Germplasm Repository University of California but, due to mite infestation, the whole consignment had to be destroyed. Accessions from all the stone and pome fruit genebanks were used by students for M.Sc. and PhD. projects and in the breeding programmes.

4. Progress has been made with the sourcing of new accessions from sources overseas. Establishing new peach and pear genebanks should safeguard these collections. The fingerprinting will help rationalise the collections. Passport descriptors should be agreed upon. Documentation should be improved and a database for genebanks should be established.

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

Research Organisation Project number: 2100-32
Programme leader & Project leader: Kenneth Tobutt

1. One aim of this project is to use molecular markers for verifying and characterising the ARC tree-fruit germplasm collections – in support of the programmes to breed new cultivars of stone-fruit and pome-fruit for South Africa. The other aim is to train students in marker techniques in the context of fruit genetic resources and improvement.

2. Young leaves were collected from the genebanks, or recollected as necessary, and DNA extracted and quantified. DNAs of some 600 apple accessions and 200 pears were amplified with sets of fluorescent microsatellite markers and the products sized on an automated sequencer. The apple samples were also amplified with primers for the ACS-1 gene affecting ethylene production and storage. Regarding the stone-fruit, optimisation of conditions for amplification of microsatellites and endoPG affecting stone adhesion was undertaken.

3. Thembeka Nyawo and Lawrence Kwalimba took up the two MSc studentships to work on stone-fruit, in September 2013 and January 2014 respectively, joining Khethani Mhelembe on pome-fruit. All three registered with the Genetics Department at Stellenbosch. The fingerprinting of the apple and pear genebanks and the genotyping of the apples for ACS-1 was completed and is being written up. Information on mis-named pear accessions and possible triploids was passed to the pear breeder. The stone-fruit analyses are in progress.

4. The project is not only training three students but is generating valuable information on trueness to name of genebank accessions. As a spin-off, ~120 rootstocks, mostly supposed to be M9, were fingerprinted at the request of HORTGRO Science and a surprising proportion of rogues were detected.

15 DETERMINATION OF CROSS POLLINATORS FOR PLUM VARIETIES

Research Organisation Project number: IT2100-22
Project leader: Mr J.A.T. de Klerk

1. The project aims to test the pollination requirements (cross- and/or self-pollination) of promising Japanese plum selections in Phase 3 and newly released cultivars and to update the plum cross-pollination chart with the new information obtained.

2. Two trees of the variety to be tested were isolated in a mesh cage and cross-pollinated or self-pollinated by bees, with access to a bouquet (flowering branches of the cross-pollinator) in the case of cross-pollination. Thinning was done according to the specified norms and fruit was harvested at optimum harvest maturity. Total fruit set was recorded.

3. During the past season, the cross-pollination requirements of two cultivars, Ruby Crunch and Ruby Sun, and one promising selection, Autumn Sun (PR00-30), were tested at Bien Donné Research Farm. The cultivars, Fortune, Harry Pickstone and Sun Breeze were tested as cross pollinators for Ruby Crunch, Ruby Sun and Autumn Sun respectively. PR01-14, promising selection, was tested for self-compatibility. The results show that Fortune is a suitable cross-pollinator for Ruby Crunch whereas Harry Pickstone and Sun Breeze are not suitable cross-pollinators for Ruby Sun and Autumn Sun respectively. The result of the self-pollination trial indicates that PR01-14 is self-incompatible. The general cross-pollination chart of Japanese plums planted in South Africa was updated. An article was published in the SA Fruit Journal.3

4. It is recommended that the cross-pollination compatibility of Ruby Sun and Autumn Sun should be retested with two different cultivars. Self-compatibility of a promising selection, Ruby Prince (PR03-15), should be retested. The general cross-pollination chart of Japanese plums planted in South Africa should be regularly updated.

16 EVALUATION OF NEWLY BRED STONE FRUIT ROOTSTOCK HYBRIDS

Research Organisation Project number: 2100-29
Project Leader: Sonwabo Booi

1. The aim of the project is to evaluate under nursery and orchard conditions the ARC-bred stone-fruit rootstock selections promoted from the Phase 1 breeding programme. The rootstock selections were promoted for having various resistances/ tolerances in comparison with commercial rootstocks, especially nematodes. In Phase 2, the rootstock hybrids are evaluated for rooting ability (>70%) and horticultural properties such as grafting compatibility and production potential.

2. In May 2013, cuttings from 6 ARC-bred hybrids and 6 commercial rootstock cultivars were rooted under standard nursery conditions at Bien Donné Experiment Farm with a spacing distance of 90cm x 20cm to evaluate their rooting ability. The cuttings were lined out in a soil which was first fumigated with Methyl Bromide. The cuttings were dipped in a solution of IBA rooting hormone for a few seconds before planting. The cuttings received water when necessary and were sprayed for pests and diseases. The orchard field trial planted in 2011 was monitored for compatibility and yield and fruit numbers were recorded at harvest time by Dr Piet Stassen and team.

3. Four ARC-bred hybrids (two interspecies, one plum and one peach) from the six had more than 70% rooting ability; these promising hybrids will be budded with indicator scion varieties (pioneer plum and alpine nectarine) in November 2014 to evaluate their compatibility. Fruits were harvested for the first time from the rootstock hybrids (pioneer plum) planted under field conditions at Bien Donné Farm and measurements of the fruits were taken.

4. Four ARC-bred rootstock selections (three plums and one peach) from the nine planted under field conditions at Bien Donné were chosen by the stone-fruit industry for planting at different commercial farms across South Africa. Fresh shoots of the four rootstock selections selected by the industry were collected in May 2014 by SAPO Trust for making trees for planting in 2015. The anticipated planting time is winter 2015.

17 COLD STORAGE CHARACTERISTICS OF NEW CULTIVARS AND SELECTIONS

Research Organisation Project number: 2600/09
Project leader: Ester Lotz

1. To evaluate new stone and pome fruit cultivars and selections from the Cultivar development programme of ARC Infruitec-Nietvoobij for cold storage ability. To supply the researchers of the Cultivar development division with the storage data which will help them and other stakeholders to decide on the future of new selections.

2. Each fruit kind is stored according to specific cold storage protocols, 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) are stored in MS Excel. Data is also integrated into the database of the Cultivar development programme together with production data on new selections
- Photographs of fruit at final evaluation are also recorded.

3. Fruit were received from 4 November 2013 to 8 May 2014
- A total number of 371 fruit samples were received for cold storage during the 2013/14 season. Data was shared with Cultivar development researchers
- Feedback aimed at improving production practices (decay, insect damage and harvesting maturity) were also shared.

4. Recommendations on the storage ability of 371 samples were made to the relevant researchers of the Cultivar Development division of ARC Infruitec-Nietvoorbij.

18 EVALUATION OF NEWLY DEVELOPED STONE FRUIT CULTIVARS/VARIETIES AND TRAINING IN FRUIT GROWING FOR THE SECOND ECONOMY

Research Organisation Project number: 282031
Project leader: Trevor Koopman

1. We evaluate new stone-fruit selections developed by the ARC Infruitec-Nietvoorbij breeding programmes for the Second Economy emerging and existing farmers. Outcomes of this project will provide an opportunity for small-scale farmers to enter the deciduous fruit producing sector and will also help address the aim of food security within specific communities.

2. We liaise with the communities, Koekedou near Ceres and Mgwali in Eastern Cape, by giving them advise on cultural practices needed for successful stone-fruit growing and we help them plant new cultivars to see which are suitable for their fruit growing region.

3. Eight nectarines, two peaches and ten plums were evaluated at Koekedou, Ceres. The best performing cultivars were Alpine, Crimson Blaze, 17C-28-9 and Summer Prince nectarines, Summer Sun and 17C-13-7 peaches and the plum PR00-29. One new hectare of peach or nectarine cultivars was planted at six of these Koekedou farmers, funded by Department of Agriculture Forestry and Fisheries. Fruit at Mgwali were not available for evaluation as there were problems with the irrigation system which caused problems with fruit set. Ongoing informal training on pruning and thinning were done.

4. Informal training of management practices given to communities at Koekedou and Mgwali during the past season will help the communities with fruit production. The evaluation of fruit has identified cultivars suitable for the second economy production.

19 EVALUATION OF NEWLY DEVELOPED POME FRUIT CULTIVARS AND TRAINING IN FRUIT GROWING FOR THE SECOND ECONOMY

Research Organisation Project number: 282032
Project Leader: Trevor Koopman

1. We evaluate apple scion selections from the ARC Infruitec-Nietvoorbij breeding programme suitable for producers from the South African second economy, i.e. developing and up-coming fruit producers as well as small-scale, resource-limited producers and home-based growers.

2. We liaise with communities at Koekedou farmers in Ceres and Mgwali in Eastern Cape, by giving advice on cultural practices needed for growing pome-fruit, and help with plantings of new pome-fruit selections and we evaluated these for adaption for the local regions.

3. Nineteen summer apples selections and six medium to late apple selections were evaluated at Koekedou, DN 1-12-197, DN 4-35-78, DN 1-12-113, DN 2-4-81R, DN 4-22-69R and Elegant performed well. One hectare of new plantings of apple or pear was established for four Koekedou farmers, funded by Department of Agriculture Forestry and Fisheries. Informal training to communities were given on pruning and thinning during visits.

4. Informal training of management practices given to communities at Koekedou and Mgwali during the past season will help the communities with apple production. The evaluation of fruit at Koekedou has identified cultivars suitable for growing under their climatic conditions.

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

Project Leader: Trevor Koopman

See Crop Protection Programme page 65.

CROP PRODUCTION

'KNOW TO GROW.'

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. In line with these priorities, we (HORTGRO Science with input from the Crop Production TAC) have identified new projects to initiate during the 2014/15 cycle on developing alternatives to Dormex, determining the effect of a range of apple rootstocks on red colour development and sunburn tolerance, and scoping the use of spatial and information system tools to enable improved and more efficient farming decisions. I foresee that we will invite projects on nursery tree quality, climate risk mitigation and orchard water use efficiency during the next funding cycle (2015/16) following upon a rigorous process of consultation with stakeholders.

Final project reports have been received for five projects and another nine reports are expected by May 2015. Karen Theron's project on mechanical thinning of stone fruit clearly illustrated the benefits of this practice, viz. lesser dependence on labour and favourable climate. Many farmers have since invested in mechanical thinning machines. The results of two projects, respectively evaluating the cost effectiveness of platforms and mechanical thinning of pome fruit, are eagerly awaited. These projects fit with our overarching goal to increase farming efficiency.

Rootstocks that are more yield efficient and adapted to South African conditions is a key priority and necessity for achieving the objectives of the orchard of the future. It therefore comes as no surprise that most of our crop production projects are aimed at evaluating rootstocks. While we are awaiting the results of these trials, Elmi Lötze's project on rootstock adaptability to high temperatures questioned the belief that M9 apple rootstock is not adapted to South African conditions. Based on her findings, South African producers should reconsider their hesitancy to utilise dwarfing rootstocks.

Allowing growers to harness the benefits of dwarfing rootstocks may be one of the potential benefits of installing hail/shade nets according to the research of Willie Kotze. In addition to the proven benefit of reducing sunburn in Granny Smith, other potential benefits of netting (e.g. water saving and increased spray efficiency) that still need to be quantified under South African conditions should form part of the equation when deciding on whether to net or not.

Wiehann Steyn

RUNNING PROJECTS

01

Apple

Physiological and molecular dynamics of dormancy in apples by comparing hormone levels, respiration rate and gene expression in areas with sufficient and insufficient winter chill and the effects of rest breaking agents.
Esmé Louw

02

Pear

Rest breaking programmes for warm winter regions.
Willie Kotze

03

Peach, Plum, Apricot

Determining the chill requirement of important stone fruit rootstocks available to the South African fruit industry.
Laura Allderman

04

Apple, Pear

Mechanical thinning of pome fruit.
Karen Theron

05

Apple

Quantifying water use of high performing commercial apple orchards in the winter rainfall area of South Africa.
Sebinazi Dzikiti

06

Apple

Apple root dynamics.
Elmi Lötze

07

Apple

Apple rootstock evaluation at Paardekloof, Witzenberg Valley.
Willie Kotze

01 PHYSIOLOGICAL AND MOLECULAR DYNAMICS OF DORMANCY IN APPLES BY COMPARING HORMONE LEVELS, RESPIRATION RATE AND GENE EXPRESSION IN AREAS WITH SUFFICIENT AND INSUFFICIENT WINTER CHILL AND THE EFFECTS OF REST BREAKING AGENTS

Researcher: E. Louw

1. The objectives for 2014 included capacity building, establishing the study sites, acquiring of research material during first dormancy cycle and developing laboratory methods to determine respiration, oxidative stress and hormone status of dormant apple buds in contrasting winter conditions.

2. A PhD student was recruited successfully in Jan 2014. Contrasting climatic regions were established by selecting five commercial orchards each in the Koue Bokkeveld and Elgin to represent "cold" and "warm" winter conditions respectively. Bud samples were collected; snap frozen and stored at -80°C to be used for oxidative stress and hormone analysis. 'Real-time' assay development for determination of respiration pathways was given priority and four possible instruments were investigated to measure oxygen consumption of the buds. Literature reviews and laboratory training commenced to address further method development for oxidative stress and hormone assays.

3. The Oxygraph Plus System (Hansatech Instruments) gave the most accurate results relating to the inhibition of different respiration pathways and further method optimisation is currently underway. Laboratory training and method development for the determination of oxidative stress is partially achieved and will be completed on the preserved study material. Collaboration with CAF at SU has been established to develop an HPLC-based assay for hormone determination.

4. The project is on track in terms of objectives, mile stones and time lines and currently no extensions or delays are foreseen.

02 REST BREAKING PROGRAMMES FOR WARM WINTER REGIONS

Researcher: W. Kotze

1. 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.

2. The following rest breaking treatments were applied in 2013.
Reinders Golden Delicious:
1. 1% Dormex + 4% oil
2. 3% Dormex
3. 1% Dormex followed 7 days later with 1% Dormex + 4% oil
4. 0.5% Lift + 1.5% oil + 1 kg KNO3 + 0.5% Dormex

Fuji:
1. 3% Dormex
2. 0.5% Dormex + 3% oil
3. 1% Dormex followed 7 days later with 5% oil
4. 0.5% Lift + 1% oil + 1 kg KNO3 + 0.5% Dormex
5. 2% LB Urea + 2% KNO3 followed 7 days later with 3% oil + 0.5% Dormex

3. 3% Dormex was the most effective treatment on 'Reinders Golden Delicious' and its fruit thinning effect had a beneficial effect on fruit size. The application rates of treatment 4 (0.75% Lift + 1.5% Oil + 1.5% KNO3 + 0.75% Dormex) was to low and were adjusted for 2014 application.

4. 3% Dormex applied to drip was too strong a treatment on Fuji in the overly wet 2013 season. The water volume of this treatment was decreased to 600 L/ha for 2014 application. Treatments 4 (0.5% Lift + 1% oil + 1 kg KNO3 + 0.5% Dormex) and 5 (2% LB Urea + 2% KNO3 followed 7 days later with 3% oil + 0.5% Dormex) gave satisfactory results and were repeated in 2014.

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

Researcher: L. Allderman

1. In order for farmers and nurserymen to make informed decisions regarding rootstock/ scion combinations best suited to the diverse growing conditions prevalent in South Africa, Dormancy Progression Curves (DPC) of commercially available stone fruit rootstocks are currently being determined.

2. All commercially viable rootstocks available from two climatically different nursery locations have been included in this study. To determine DPC of the rootstocks, ten one-year-old shoots of each rootstock are presently being collected at three week intervals from each location. Sampling started when terminal buds had formed and will continue until spring bud burst in the field. The shoots are forced (25 C 24hrs light) in buckets containing a mild bleach solution. Percentage bud break per bundle is determined three times a week until 50% bud burst is reached. The shoots are then discarded. Graphs depicting DP (depth of dormancy of the buds over time) will be plotted as soon as the data capture is complete. The DP of all the rootstocks at both sites can then be compared.

3. The 2014 winter season's data capture will be completed by mid-September, therefore results for the 2014 season are not yet available.

4. The trial is progressing according to plan.

04 MECHANICAL THINNING OF POME FRUIT

Researcher: K. Theron

1. The recent labour issues make the use of mechanical thinning (alone or in combination with chemical treatments) even more relevant than before. The data obtained from the first two season's research using the Darwin 300™ on plum and nectarine trees are very promising. We extended the project to apple and pear.

2. The Darwin 300™ and BAUM machines were evaluated at different tractor speeds and spindle rotation speeds on 'Cripps Pink' and 'Forelle'.

3. The Darwin 300™ did not significantly reduce hand thinning requirement in the 'Forelle' orchard, but neither did 50% removal of flower clusters. The BAUM did not significantly affect yield or fruit size in 'Cripps Pink'. The Darwin improved fruit size in 'Cripps Pink but also reduced yield efficiency when used at a tractor speed of 5.2 km.hr-1 and 240 r.p.m.

4. Trials in the coming season will be performed at the higher tractor speed only, while adjusting rotor speed according to fruit type. A hand-held thinning machine will be evaluated in apple and pear orchards. In addition, the effect of reducing flower cluster number at full bloom will be further evaluated in both apple and pear.

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

Researcher: S. Dzikiti

1. HORTGRO Science in collaboration with the Water Research Commission initiated a study with the overall aim to determine the water use, yield and quality of selected high yielding apple cultivars across different orchard age groups from planting to full-bearing in selected climatic zones and specific soils. Specific objectives of the study are:·To measure the unstressed water use of apple orchards according to seasonal growth stages from planting to full-bearing;· To model the water balance of apple orchards according to seasonal growth stages from planting to full-bearing for future extrapolation to other apple cultivars and climatic zones, and; To determine the water use productivity in full-bearing orchards in terms of crop yield in relation to quality.

2. For the first stage of the project, high yielding (90+ ton/ha) and non-bearing 'Golden Delicious' and 'Cripps' Pink' orchards were identified in the Koue Bokkeveld region. We are currently installing instrumentation in the orchards and data collection will commence during October 2014.

3. There are no results or conclusion to date.

06 APPLE ROOT DYNAMICS

Researcher: E. Lotze

1. Our aim is to establish white root growth dynamics for apple trees under varying conditions in 4 South African orchards. The ultimate aim is to link root growth to aboveground phenology and to increase the precision of fertiliser application.

2. We studied root growth dynamics and performed physiological measurements during the 2013/14 growing season at two sites (Vyeboom, non-bearing 'Royal Gala' trees in sandy soil; Elgin, bearing 'Golden Delicious' trees on heavy soil) up to 60 cm soil depth. Yield was recorded for the bearing orchard.

3. Distinct peaks in root growth were observed during early summer and autumn/winter in the 'Golden Delicious' orchard (Elgin), but no distinct peaks were found in the young 'Royal Gala' trees (Vyeboom). Root growth was observed throughout most of winter. So far we were unable to establish relationships between white root dynamics and physiological measurements.

4. The 2014/15 season will establish whether root growth during the winter months is the norm.

07 APPLE ROOTSTOCK EVALUATION AT PAARDEKLOOF, WITZENBERG VALLEY

Researcher: W. Kotze

1. The objective of this trial is to assess various new dwarfing and semi-dwarfing apple rootstocks from the GENEVA® range against the industry standards M793, M7, M25 and MM109.

2. Trees grafted to Rosy Glow were planted during winter 2010 at Paardekloof in the Witzenberg Valley. Dwarfing and semi-vigorous rootstocks were grouped together in two adjacent plots that are managed separately. Cepiland, GENEVA222, CG3007, GENEVA6210, Lancep, M793, M7, MM106, MM109/M9 and RN29 were planted in 5 blocks at 4 x 1.25 m spacing as the more dwarfing site while GENEVA222, GENEVA228, GENEVA778, GENEVA934, M25, M793, Maruba and MM109 were planted in 6 blocks at 4 x 1.5m spacing as the more vigorous site.

3. The 2014 yield was recorded and tree height and trunk diameter measured as an indication of tree growth. GENEVA3007 from the dwarfing site is currently the most yield efficient rootstock together with the clones of M9. M793 followed by MM106 and M7 are the least yield efficient rootstocks at the dwarfing site. When adjusting means at the more vigorous site for tree size at planting in 2010, GENEVA222, GENEVA778 and GENEVA228 show the highest combined yield efficiencies over 2012/13 and 2013/14. Differences in fruit maturity and quality were insubstantial.

4. It is still too early for any recommendations and trends may become more obvious over the next few seasons as the trees are now close to filling their allotted space.

08 APPLE ROOTSTOCK EVALUATION AT HELDERWATER, LANGKLOOF.

Researcher: W. Kotze

1. The objective of this project is to assess the various new apple rootstocks (most from the Geneva range) that have recently become available against the industry standard M793, M7 and MM109. The use of GENEVA222 and M9 Emla as potential interstems will also be assessed.

2. More dwarfing (M9 Emla, NIC29, GENEVA222, M7, MM109 / M9, MM109 / GENEVA222, M793 / M9, M793 / GENEVA222, GENEVA778 / M9, GENEVA778 / GENEVA222) and more vigorous rootstocks (M7, GENEVA202, GENEVA778, M793, MM109, GENEVA228) were grouped together in two adjacent, but separate plantings. Trees were planted during spring 2013 using randomised complete block designs for both plantings.

3. Trees were planted during winter 2013 and trunk diameter and height increases were assessed as a measure of tree growth during the 2013/14 season.

4. Excellent growth was achieved with all rootstocks in the trial. GENEVA778 seemed to impart more vigour to scions on M9 Emla and GENEVA222 interstems compared to other rootstocks at the dwarfing site. No other conclusions are possible at this early stage.

09 APPLE ROOTSTOCK EVALUATION AT OAK VALLEY ESTATE, GRABOUW.

Researcher: W. Kotze

1. The objective of this project is to assess the various new apple rootstocks (most from the Geneva range) that have recently become available against the industry standard M793, M7 and MM109. The use of GENEVA222 and M9 rootstocks as interstems will also be assessed.

2. More dwarfing (M9 Emla, NIC29, GENEVA222, M7, MM109 / M9, MM109 / GENEVA222, M793 / M9, M793 / GENEVA222, GENEVA778 / M9, GENEVA778 / GENEVA222) and more vigorous rootstocks (M7, GENEVA202, GENEVA778, M793, MM109, GENEVA228) were grouped together in two adjacent, but separate plantings. Trees were planted during spring 2013 using randomised complete block designs for both plantings.

3. Trees were planted during winter 2013 and trunk diameter and height increases were assessed as a measure of tree growth during the 2013/14 season.

4. It is early days in the growth of this orchard and we do not want to rush to conclusions. However, it does appear that GENEVA778 impart more vigour to scions at the vigorous site, but even with M9 Emla and GENEVA222 as interstems compared to other rootstocks at the dwarfing site.

10 APPLE ROOTSTOCK EVALUATION AT BREËVLEI, GRABOUW

Researcher: W. Kotze

1. The project evaluates and releases locally bred plum varieties for the fresh export markets.

2. More dwarfing (M9 Emla, NIC29, GENEVA222, M7, MM109 / M9, MM109 / GENEVA222, M793 / M9, M793 / GENEVA222, GENEVA778 / M9, GENEVA778 / GENEVA222) and more vigorous rootstocks (M7, GENEVA202, GENEVA778, M793, MM109, GENEVA228) were grouped together in two adjacent, but separate plantings. Trees were planted during spring 2013 using randomised complete block designs for both plantings.

3. Trees were planted during winter 2013 and trunk diameter and height increases were assessed as a measure of tree growth during the 2013/14 season.

4. It is early days in the growth of this orchard and we do not want to rush to conclusions. M9 Emla and the M793 / M9 combination seem the most dwarfing while M7 and the interstem trees on GENEVA778 seemed to have grown the most at the dwarfing site. GENEVA778 trees increased the most in height at the more vigorous site while GENEVA228 and GENEVA202 seemed to impart less vigour.

11 APPLE ROOTSTOCK EVALUATION AT VERGELEGEN, GRABOUW.

Researcher: W. Kotze

1. The objective of this project is to assess the various new apple rootstocks (most from the Geneva range) that have recently become available against the industry standard M793, M7 and MM109.

2. Trees were planted in December 2012 and tree height and trunk diameter were assessed as a measure of tree growth during the 2013/14 season.

3. It appears that the GENEVA and Maruba rootstocks are generally growing more strongly at this site compared to the industry standards M7, M793 and MM109.

4. It is early days in the growth of this orchard and we do not want to rush to conclusions.

12 PLUM ROOTSTOCK EVALUATION

Researcher: P. Stassen

1. This project aims to identify and evaluate rootstocks for plum trees that can optimise the performance of the scion cultivar in different soil conditions (sandy, wet, calcareous and different scenarios of plant-parasitic nematodes).

2. Two trials with 'African Delight' were planted during 2008 (Elkana, Simondium and Sonskyn, Robertson). Another trial with 'African Rose' was planted during 2010 to include new available rootstocks (Roodehoogte, Robertson). Three trials using, 'Sensation', 'Sunbreeze' and 'Laetitia' were planted at Stellenbosch during 2011. Recommended statistical lay-outs were use.

3. At Elkana trees on Maridon, Cadaman and Atlas perform well during the fourth harvest, on low lying sandy soil that was well drained. At Sonskyn trees on GF 677 and Cadaman perform well on calcareous soil with high numbers of ring and spiral nematodes. At Roodehoogte trees on GF 677, Marianna and Atlas perform well on high potential soil (25% silt and clay). The other three trials was harvest for the first time and no conclusions can be drawn.

OPPORTUNITIES

13 EVALUATION OF PEACH ROOTSTOCKS

Researcher: P. Stassen

1. The long term aim is to evaluate potential rootstocks for peach and nectarines in order to optimise the scion's performance. Evaluation includes suitability to high pH, water logging, salinity, soil texture, soil born diseases and replant problems, plant-parasitic nematodes as well as horticultural traits such as yield, yield efficiency, fruit size and climatic adaptability.

2. Seven trials were planted in different areas and soil conditions on commercial farms, using recommended statistical lay-outs.

3. Trees (Alpine) at Mookgophong (low chill, moderate ring and spiral nematodes present, 93.3-95.8% sand and irrigation by micro sprinkler every third day) yielded their fourth crop. Over four seasons, trees on Flordaguard and Atlas (planted in 2008) and Flordaguard (planted in 2009) performed the best. Trees on Kakamas seedling (Penta and Tetra) perform poorly under the prevailing conditions. At Worcester on high potential, but high pH soil, 'Artic Star' on Atlas, Cadaman, Filenem, Monegro, Viking, Kakamas seedling and Garnem do not differ significantly in terms of cumulative yield. Trees on Kakamas seedling however show 48% symptoms of iron-induced chlorosis whilst Cadaman, Garnem and Felinem shows 10% and less. All other trials yield only their first crop.

4. Flordaguard is the most suitable rootstock on sandy soils (less than 10% silt and clay), also when moderate numbers of ring and spiral plant-parasitic nematodes are present. Atlas, Viking and Cadaman may also be considered. On high pH soils, the rootstocks Cadaman, Garnem and GF 677 show less chlorosis symptoms than Atlas and Viking. Trees on Flordaguard and Kakamas seedling show severe symptoms.

14 EVALUATION OF APRICOT ROOTSTOCKS

Researcher: P. Stassen

1. The aim of this project is to identify rootstocks for apricot trees in order 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.

2. Two trials, using 'Rustic' and 'Solitaire' as scion cultivars were planted during 2012 on Royal, Bulida, Soldonne and Sunshine seedlings to evaluate the possibility of broadening the rootstock base for apricots. Two trials were planted during 2013, using the promising rootstocks available to the plum and peach industry. To overcome incompatibility, a 'Royal' interstem was used. The following rootstocks were selected: Atlas, GF 677, Cadaman, SAPO 778, Guardian, Viking, Marianna, Maridon and Tsukuba 4 with Royal seedling as the standard.

3. DAll four orchards are in excellent condition and the necessary measurements and practises have been taken care off.

4. No recommendations at this stage.

15 EVALUATION OF NEW APPLE ROOTSTOCKS FOR TOLERANCE TO WOOLLY APPLE APHID

Researcher: C. Costa

1. The objective of this year's work was to propagate the entire range of available apple rootstocks for pot trials under controlled conditions in order to determine their comparative resistance and/or tolerance to woolly apple aphid (WAA).

2. Methodology entails the establishment of mother plants in greenhouse, establishment of explants in vitro, proliferation in vitro, rooting in vitro, hardening off and transplanting into greenhouse trays, and then transplanting into planting bags in greenhouse, then transplanting into larger bags for inoculation and transferring to netted shadehouse. Trees need to be at least 40 cm high before inoculation with WAA to ensure accurate measure of resistance and tolerance.

3. To date we have succeeded in establishing 19 of the 20 genotypes in vitro, 15 which have passed the proliferation stage, 13 which have passed the rooting stage and 12 which have been transplanted into planting bags, of which 8 have been inoculated initially.

4. The work plan will therefore need to be extended to allow for repeated successful replicated over 2 years inoculation trials of the entire series.

3. It was concluded that from the percentage increase in trunk and total shoot growth, G222 seems to be most tolerant, while results with G778 and CG4202 varied at the two sites. The previous round of field trials found MM109 to be the the only rootstock that consistently showed tolerance to ARD conditions in the field. G222 showed the least growth in the current trial, which can be expected from a semi-dwarfing rootstock. In the previous field trials, CG4202, MM109 and M7 generally induced more growth after the first growing season, while CG3007 and G228 induced less growth. The rootstocks, MM109 and M793 seems most susceptible during the current trial, when evaluating percentage increase in trunk and total growth, but they also show highest growth, together with G778.

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

Researcher: P. Stassen

1. To evaluate the growth performance and host status of selected commercial stone fruit rootstocks in pots when the following treatments are carried out: a) Control (no nematodes) b) Inoculation of pots with ring nematodes and c) Inoculation of pots with root-knot nematodes.

2. During December 2013 the rootstocks, Flordaguard, Marianna, Maridon, GF 677, Kakamas seedling, Atlas and Viking were inoculated with ring and root-knot nematodes and these plants were evaluated during May 2014. Another group of five rootstocks were re-inoculated during May 2014 with ring nematodes for evaluation during August 2014. All commercial stone fruit rootstocks were propagated for plant during spring 2014. Inoculation will take place during October and evaluation six months later.

3. Analysis and growth measurements indicate that there are no significant differences in the host status for ring nematodes at this preliminary stage, and that Kakamas seedling and GF 677 has more root-knot galls whilst Flordaguard, Marianna and Maridon has the lowest occurrence of galls. It is clear that ring nematodes result in a significant decrease in new growth mass except in the case of Marianna and Maridon.

4. Two more evaluations will be done before final conclusions can be drawn after March 2015.

17 APPLE REPLANT ROOTSTOCK TRIALS FOR DETERMINING A SCREENING TECHNIQUE

Researcher: K. Bezuidenhout

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

2. Rootstocks from the Cornell Geneva range and local rootstocks were investigated under ARD conditions in field trials in Elgin.

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

Researcher: L. Allderman

1. In order for farmers and nurserymen to make informed decisions regarding rootstock/ scion combinations best suited to the diverse growing conditions prevalent in South Africa, Dormancy Progression Curves (DPC) of commercially available stone fruit rootstocks are currently being determined.

2. All commercially viable rootstocks available from two climatically different nursery locations have been included in this study. To determine DPC of the rootstocks, ten one-year-old shoots of each rootstock are presently being collected at three week intervals from each location. Sampling started when terminal buds had formed and will continue until spring bud burst in the field. The shoots are forced (25 C 24hrs light) in buckets containing a mild bleach solution. Percentage bud break per bundle is determined three times a week until 50% bud burst is reached. The shoots are then discarded. Graphs depicting DP (depth of dormancy of the buds over time) will be plotted as soon as the data capture is complete. The DP of all the rootstocks at both sites can then be compared.

3. The 2014 winter season's data capture will be completed by mid-September, therefore results for the 2014 season are not yet available.

4. The trial is progressing according to planwill help the communities with apple production. The evaluation of fruit at Koekedou has identified cultivars suitable for growing under their climatic conditions.

3. The 2014 winter season's data capture will be completed by mid-September, therefore results for the 2014 season are not yet available.

4. The trial is progressing according to plan.
will help the communities with apple production. The evaluation of fruit at Koekedou has identified cultivars suitable for growing under their climatic conditions.

19 EFFECT OF DIFFERENT COVER CROP MANAGEMENT PRACTICES ON THE SOIL AND PERFORMANCE OF APPLE TREES.

Researcher: J. Fourie

1. Producers of deciduous fruit have prioritised the need to improve the health of orchard soils. The aim is, therefore, to supply scientifically based guidelines for soil management practices that will improve soil health and promote sustainable apple production.

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

3. Bacterially dominated and fungal dominated decomposition pathways were detected where Ornithopus sativus cv. Emena (pink Seradella) and Avena strigosa cv. Saia (Saia oats) was established, respectively. The permanent cover crop caused the total soil inorganic N to be less than the generally accepted norm of 10 to 15 mg/kg. The annual cover crops created conditions under which N is more readily available to the tree roots during the growing season. This benefit seemed to realise between three and 12 weeks after chemical control with herbicides. This lasts longer where an N-fixing monoculture is used. Changes in the weed spectrum occurred within one season. Effective control of Lolium species (annual ryegrass) was achieved using Saia oats.

4. The observed trends need to be confirmed. It is also important to determine whether the observed trends will manifest stronger over time. It is, therefore, suggested that the project should be allowed to continue, to supply the fruit industry with scientifically based guidelines for the sustainable use of cover crops for effective nematode and weed suppression that will be beneficial to the economically sustainable production of apples.

20 NEMATODE COMMUNITY STRUCTURE AND FUNCTION AS A BIO-INDICATOR OF THE EFFECTS OF SOIL AMENDMENTS ON SOIL HEALTH.

Researcher: S. Storey

1. Soil samples were collected from the ridge of the tree row and the working row in an apple orchard in the Vyeboom area in order to determine the nematode community structure, function and biodiversity.

2. In total 50 samples were collected from 5 treatments. Nematodes were extracted from the soil using the Cobb's method followed by a modified Baermann funnel. Samples were then concentrated and nematodes were enumerated and identified to family level.

3. Sowing a nitrogen fixing species as cover crop during autumn and applying full surface chemical control from bud break to harvest (Treatment 3) resulted in the highest numbers of Tylenchidae and Pratylenchidae. Trichodoridae were present in this treatment and also for Treatment 4 where a grain species/nitrogen fixing species mixture was sown as cover crop during autumn. Dorylaimidae were present in all samples. Sowing a grain species as cover crop during autumn and full surface chemical control application from bud break to harvest (Treatment 2) resulted in the greatest number of Cephalobidae. The highest number of Aphelenchidae occurred in Treatment 1, which is the practice currently applied by industry, i.e., chemical control in the tree row and slashing of weeds in the work row. Mononchidae only occurred in low numbers in soil from Treatment 2. The current faunal analysis indicates that soil food web conditions for Treatments 4 and 3 are unstructured and disturbed with bacterially dominated decomposition pathways. Treatment 5, i.e. sowing a species with bio-fumigant properties, is borderline structured with high levels of enrichment, and a disturbed food web. Treatment 1 is maturing with low to moderate disturbance. Treatment 2 indicates structured conditions with low enrichment, an undisturbed soil food web and decomposition dominated by fungal pathways indicating an unbalanced soil food web.

4. Further samples will be taken to establish the effect of various cover crops on the nematode population within the tree row as well as changes over time.

21 VALIDATION OF AN ENZYME-BASED SOIL ALTERATION INDEX FOR TESTING SOIL HEALTH IN LOCAL APPLE ORCHARD SOILS.

Researcher: A. Meyer

1. AI3 is an enzyme-based index of soil alteration. Internationally, testing has shown that AI3 could be used successfully in soils that ranged from mine spoil to forest. However, its value for use under conditions that prevail in local apple orchards, has not been tested yet.

2. The objective was to (1) test the ability of AI3 to distinguish between orchard soils under different soil management protocols, to relate index scores to (2) soil nutrient and (3) tree data, and (4) validate its use as an index of soil health and tree performance in Western Cape apple orchards. In accordance with the first objective and targets set for the first six months of the trial, suitable trial sites and soil management regimes were first identified.

3. Two sites are located in Oak Valley (Grabouw), involving compost tea and earthworm compost treatments, in combination with either mulch or no mulch. Two more mulching trials were selected, both located at Graymead Fruitways Farming. Two short term rootstock trials were also selected, both involving a variety of rootstocks, MM109, G202, M7, CG3007, G222, M793, G228, G778, being tested against apple replant disease at Glen Fruin farm and methyl bromide treatments at Vergelegen farm, in Elgin. A cover crop trial at Vyeboom Boerdery was also included. All trials followed a statistical design. Sampling at the respective sites will commence in October 2014.

4. As the trial progresses, further sites need to be identified to establish its value for use under conditions that prevail in Western Cape apple orchards.

22 HEAT STRESS IN PLUMS

Researcher: W. Steyn

1. The objective of this project is to ascertain the link between climate, tree water status, sunburn and pitburn development in Japanese plums.

2. Irrigation was manipulated at Sandrivier Estate and Welgevallen farm. A control (farm practice), half irrigation and double irrigation treatments were used at Sandrivier throughout the season on 'African Delight' plums. At Welgevallen farm, full irrigation (control), half irrigation and no irrigation treatments were used 15 days in the early season and again 15 days late in season on different trees of 'Laetitia' plums. Plant water status, photochemistry, anti-oxidant concentration, and sunburn were assessed. Daily light and temperature changes were closely monitored in early, late and non-summer pruned treatments of 'African Delight' plums at Môrelig farm.

3. Stem water potential decreased and antioxidant concentration, sunburn incidence and sunburn severity increased linearly with a decrease in late season irrigation. Photochemical processes and chlorophyll flourescence seemed insensitive to irrigation while late summer pruning increased sunburn. No pitburn was observed.

4. Water stress, particularly late in the fruit development stage, indeed aggravates sunburn, but does not seem to influence pitburn. The exact threshold point in fruit development when water becomes critical for sunburn development requires further investigation.

23 THE EFFECT OF CLIMATE ON SPLIT PIT IN PLUMS

Researcher: M. Jooste

1. The effect of climate and growing area (Trial 1) and foliar Ca (NO3)2 and K2O3Si (Trial 2) application were evaluated on broken stone incidence in 'Laetitia' plums. Fruit growth patterns of a susceptible (Laetitia) and non-susceptible (Songold) cultivar was also compared (Trial 3).

2. Trial 1: Fruit were sampled and inspected for broken stones and temperature and RH were logged on three farms each in Stellenbosch and Robertson from 4 weeks after full bloom (WAFB) until the optimum harvest date. Trial 2: Ca (NO3)2 were applied weekly and K2O3Si at 10-day intervals from 3 WAFB until stone hardening. On the optimum harvest date, fruit were inspected for broken stone incidence. Fruit was also cold-stored and evaluated for quality defects. Trial 3: Fruit of both cultivars were sampled and 3D computed tomography scans were created from 4 WAFB until the optimum harvest date.

3. Trial 1: Stone breakage started during the onset of stone hardening. Rapid lengthwise growth pulled the stone apart near the apical end of the fruit. Lower night temperatures lead to enhanced fruit growth and delayed stone hardening. Trial 2: Ca (NO3)2 caused a significantly higher and K2O3Si the lowest incidence of broken stones. Trial 3: 'Songold' has an earlier onset of stone hardening, higher dry weight accumulation, denser endocarp and lower broken stone incidence than 'Laetitia'. Stone breakage in 'Laetitia' occurred near the apical end of the fruit, which also had the most radial growth and the lowest stone density.

4. Results of all trials will be verified in 2014/2015.

24 CHEMICAL THINNING OF STONE FRUIT

Researcher: K. Theron

1. Hand thinning of stone fruit is highly labour intensive and time consuming. This results in thinning being expensive and taking long to complete. Ideally thinning should be completed early and quickly to obtain best results on fruit size during the current season and good return bloom for the next season. Chemical thinning either alone or in combination with mechanical thinning should in theory achieve this.

2. We evaluated two strategies to thin stone fruit (nectarine, plum and peach) chemically. The first approach was to evaluate VBC 30160 as a fruitlet thinner at 8-10 mm fruitlet diameter on its own and in combination with 6-BA. The second approach was to combine two growth regulators at the fruitlet stage. The latter did not give any significant results.

3. VBC 30160 applied at the 8-10 mm fruit diameter stage significantly reduced fruit set in 'African Rose' plum, 'Turquoise' nectarine and 'Keisie' peach. It also showed promise in a non-statistical trial on 'Laetitia' plum. However it did induce leaf drop when applied at the higher rates in 'Turquoise' and 'Laetitia' but not in 'Keisie' and 'African Rose'.

4. Further trials are needed on all three fruit types to evaluated VBC 30160 further. This will be done in combination with mechanical thinning in the case of early cultivars in order to reduce fruit set earlier and in combination with 6-BA when applied at higher rates to combat leaf drop.

25 CHEMICAL THINNING OF APPLES

Researcher: W. Kotze

1. In the 2012/13 season, the Crop Production TAC and Horticulture PWG suggested that the new chemical thinning agent, Brevis (Metamitron), should be evaluated.

2. Thinning treatments were applied with backpack mist blower to 'Fuji' and 'Golden Delicious' in the Koue Bokkeveld and to 'Cripps' Red' and 'Golden Delicious' in the EGVV area.

3. The 2x Brevis application in 2012/13 reduced Spring 2013 return bloom in Vyeboom. Brevis application in 2013/14 at 4 mm and 14 mm fruit size showed great potential to reduce the hand thinning requirement and increased average fruit size at harvest in 'Golden Delicious'. Brevis application in 2013/14 reduced fruit set and the hand thinning requirement in both 'Fuji' and 'Cripps' Red'. Two consecutive Brevis applications thinned more aggressively than NAA followed by Brevis. Both treatments improved fruit size at harvest. NAA followed by NAA + MaxCel followed by Sevin worked well as a thinning programme on 'Fuji' in Witzenberg by reducing hand thing and improving fruit size at harvest, but reduced yield efficiency.

4. The following changes to the thinning programmes will be made for 2014/15: 'Golden Delicious' - repeat 2013/14 applications in 2014/15 to confirm results. Increase the concentration of MaxCel (6BA) to 750 ml/100L according to Philagro recommendation. 'Fuji' and 'Cripps' Red' - repeat 2013/14 applications in 2014/15 to confirm results. Include a combination of Brevis and MaxCel (6BA) according to Philagro recommendation. 2014/15 trials will be conducted in Ceres only due to the resignation of the Regional Fruit Researcher.

26 CHEMICAL THINNING OF PEARS

Researcher: W. Kotze

1. The original objective was to develop a chemical thinning programme for 'Abate Fetel' that will minimize hand thinning and result in regular, good quality yields. The scope of the project has been expanded upon request from the Crop Production TAC to include 'Forelle' and in future potentially also other pear cultivars.

2. The following 4 treatments were applied to an 'Abate Fetel' orchard in the Ceres region: 1) control, 2) 11 ml Planofix at petal drop + 750 ml MaxCel per ha, 3) Brevis at 4 mm fruit size, 4) Brevis at 14 mm fruit size.

3. Treatments two and four significantly reduced the hand thinning requirements on 'Abate Fetel' pears. However, the thinning effect was slight and considerable hand thinning was still required.

4. Brevis shows potential to chemically thin 'Abate Fetel'. The Crop Production TAC has advised the evaluation of multiple Brevis applications or application of Brevis in combination with other thinning agents to try to increase the thinning effect.

27 NAA AND ETHEPHON TO INCREASE RETURN BLOOM IN APPLES AND PEARS

Researcher: W. Kotze

1. The objective of this project is to determine the effect of NAA application on return bloom in heavy bearing 'Fuji' and 'Abate Fetel' orchards and to determine the effect of Ethephon application on return bloom in heavy bearing 'Fuji' and 'Abate Fetel' orchards.

2. The methodology used was as follows:
1. Control (No sprays)
2. Four NAA sprays two weeks apart starting 40 days after full bloom. (beginning of November)
3. Three NAA sprays two weeks apart starting 40 days after full bloom. (beginning of November)
4. Two NAA sprays two weeks apart starting 40 days after full bloom. (beginning of November)
5. Two NAA sprays two weeks apart starting 68 days after full bloom. (beginning of December)

3. Four biweekly NAA applications starting at 40 days after full bloom increased return bloom of 'Abate Fetel' at $p<0.1$. This bloom increase was, however, not reflected in the 2014 yield. NAA treatments had no significant effect on 'Fuji' return bloom or yield.

4. Repeat the trials on 'Fuji' and 'Abate Fetel' and include the treatments form the original work plan with Ethephon.

FINAL PROJECT REPORTS RECEIVED IN 2014

PROJECT TITLE	FRUIT KIND	RESEARCHER
Evaluation of mechanical thinning and GA application on crop load of stone fruit.	Plum, Nectarine	Karen Theron
Quantifying the effect of selected ambient summer temperatures on rootstock growth in a pot trial in environmental chambers.	Apple	Elmi Lötze
Evaluation of soil surface and mulching practices for organic production of deciduous fruit.	Apple	John Wooldridge
Effect of shade nets on the productivity of 'Granny Smith' and 'Fuji' apples in the EGVV region.	Apple	Willie Kotze
The application of sucrose to enhance fruit set in'Packham's Triumph' pear.	Pear	Willie Kotze

FINAL PROJECT REPORTS DUE 2015

PROJECT TITLE	FRUIT KIND	RESEARCHER
Establish the effect of rest breaking agents on vegetative and reproductive development of apples in the Koue Bokkeveld/ Witzenberg valley.	Apples	Willie Kotze
The response to and efficacy of rest breaking chemicals under laboratory conditions as a function of cultivar, chill unit accumulation, time of application and temperature after application.	Apple, Pear and Plum	Laura Allderman
Determining the chill requirement of important rootstocks available to the South African apple industry.	Apple, Pear	Laura Allderman
Cost effectiveness of picking platforms and the Hermes harvesting system relative to conventional labour intensive farming practise.	Apple, Pear, Plum, Nectarine	Wiehann Steyn
Evaluate pear rootstocks and planting systems.	Pear	Mike North
Ecophysiological assessment of the effect of different apple rootstocks on scion performance.	Apples	Michael Schmeisser
Determining the chill requirement of important rootstocks available to the South African apple industry.	Apple, Pear	Laura Allderman
Inherent and acquired resistance to fruit sunburn and poor colour in various apple and pear cultivars.	Apple, Pear	Wiehann Steyn
Water relations and sunburn in pome fruit.	Apple, Pear	Wiehann Steyn

NEW PROJECTS APPROVED FOR 2015

PROJECT TITLE	FRUIT KIND	RESEARCHER
Using the shoot assay to screen combinations and sequential application of existing and possible new rest breaking agents in apples.	Apple	Esmé Louw
Investigating the seasonal progression of bud dormancy as a function of temperature.	Pome, Stone	Laura Allderman
Spatial FruitLook data: Uses and benefits to the Fruit Industry (Discussion document).	Pome, Stone	Caren Jarmain
Acclimation of apple peel to light and temperature and the effect thereof on red colour development and tolerance to sunburn.	Apple	Stephanie Midgley
Net effects on microclimate and apple physiology.	Apple	Elmi Lötze
Stone fruit phenology and physiology in the Northern Province as related to orchard practices and productivity.	Peach, Nectarine	Nicky Taylor

Previously approved

FINAL PROJECTS RECEIVED IN 2014

01 EVALUATION OF MECHANICAL THINNING AND GA APPLICATION ON CROP LOAD OF STONE FRUIT

Project Leader: Karen Theron

Producing fruit of the appropriate size and high quality is of the upmost importance to realize a profit in the fruit industry. This can be achieved through bloom or fruitlet thinning to reduce the number of fruit left on the tree. The cost of production is rising and labour cost forms a large part of the total production cost. Thinning of stone fruit is labour intensive and expensive, so an alternative to hand thinning needs to be found. Two alternatives are chemical and mechanical thinning. Chemical thinners are not routinely used in stone fruit as it is in pome fruit production and gibberellins were evaluated in this study. The Darwin 300TM was evaluated as a mechanical alternative to hand thinning. It thins flowers during bloom, before fruitlet thinning by hand is performed. In our trials on nectarines and Japanese plums the objective of reducing the time required for hand thinning was achieved, with the Darwin 300TM reducing the time required by up to 50%. When the time required to thin was reduced too much it also reduced the yield, but this could be overcome by lowering the rotor speed or using different strategies during supplementary hand thinning at the fruitlet stage. The bloom thinning and reduction in yield led to an increase in the fruit size. Care should be taken when using the Darwin 300TM as the earlier thinning could increase pit splitting and/or fruit cracking, especially in cultivars that are prone to these defects. The optimal rate of thinning needs to be determined for each cultivar individually. The application of gibberellic acid (GA3) and gibberellin A4+7 (GA4+7) at the pit hardening stage in the previous season could decrease the number of flowers for the following growing season. There was no effect on the yield at harvest or fruit size in the season of GA3 and GA4+7 applications, but the fruit firmness was increased. This effect was more pronounced for the GA4+7 applications. Our objective of reducing the time required for thinning was achieved in some but not all cultivars. The yield was not significantly reduced, with the fruit maturity only delayed in 'African Rose' plum. Again no increase in fruit size was found, but the fruit firmness was again increased. The GA-applications therefore were not satisfactory in their reduction of the time required for hand thinning. A positive effect is the increase in fruit firmness, which could possibly increase the storage potential of the fruit without having negative effects on the other aspects of fruit quality but this needs further evaluation.

02 QUANTIFYING THE EFFECT OF SELECTED AMBIENT SUMMER TEMPERATURES ONROOTSTOCK GROWTH IN A POT TRIAL IN ENVIRONMENTAL CHAMBERS PROJECT LEADER

Researcher: Elmi Lotze

The performance of new CG - versus present commercial apple rootstocks were evaluated in controlled climate chambers simulating warmer soil conditions due to climate change predicted for our growing regions.
Trees were all obtained from SAPO and placed at 4°C in the cold room for one month before being planted in pots. Two year old rootstocks with Fuji scions were transplanted into 4L bags at beginning of Sep 2013 and subjected systematically to 15, 30 or 35°C until the beginning of Nov 2013, when plants had to be harvested as some reached the ceiling of the growth chambers.

The only interaction between rootstocks and temperatures was noticed for root mass at harvest. A significant increase in root mass occurred as temperatures rose from 15 to 35°C for M7, and a significant decrease in the case of M793. In GC 222 and 2404, there was a decline in root mass as temperatures increased. MM109 showed the highest root mass for 30°C.

Main effects after applying initial size of the trees as covariate showed significant differences between combinations for the following parameters: Stem mass at harvest was significantly higher for CG222 than the rest of the rootstocks. Stem diameter was significantly higher for CG222 than all rootstocks except for CG2404. M7 and MM109 had the smallest stem diameters. Shoot mass at harvest was significantly lower for CG2404 compared to CG222 and M7. Total fresh weight at harvest was the highest for CG222 which differed significantly from the rest of the rootstocks.

The only significant differences between temperatures were found for shoot mass at harvest, where shoot mass at 35°C was significantly lower than for 15 or 30°C as expected.

The lack of interaction between temperature and rootstocks for most of the parameters did not justify mineral analyses of the new growth.

03 EVALUATION OF SOIL SURFACE AND MULCHING PRACTICES FOR ORGANIC PRODUCTION OF DECIDUOUS FRUIT

Project Leader: J. Wooldridge, M. Joubert

Evaluation of soil surface and mulching practices for organic production of deciduous fruit.

Present guidelines on organic fruit production are not scientifically based, mainly because very little trial data is available. This project, which entailed a seven-year orchard trial, sought to provide information concerning the effects of soil surface management and fertilisation practices on soil, leaf and fruit element concentrations, soil quality, tree growth, yield and fruit quality.

The trial was conducted in a 'Cripps' Pink' apple orchard on M7 rootstock on a gravelly soil in the Elgin area. Organic cultivation practices were compared with integrated/conventional farming practices (IP). The organic practices entailed the provision of plant nutrition through compost and weed control through mulching and hand weeding. IP entailed the application of inorganic fertiliser and the use of herbicides in the tree rows during the growing season.

It is important to note that the performance of the orchard was way below industry standards and does not offer a fair comparison between organic and conventional practice as far as tree growth and yield is concerned. What it does provide is an indication of what can go wrong and common pitfalls when using organic orchard floor management practices. The provision of compost in accordance with previous / current practice to supply adequate N, led to an over-supply of P and K. This induced an imbalance between vegetative and reproductive growth. Tree growth was stimulated resulting in a reduction in yield. The yields of the organic treatments would have benefited from a better balance between vegetative growth and reproductive development. To maximise fruit yield and quality, composts that are used in apple orchards must be formulated to deliver nutrients at rates that match the seasonally varying requirements of the tree. Provision of balanced mineral nutrients in quantities appropriate to each phenological stage, and adjusted for tree vigour and anticipated yield, is essential for a balance between tree growth and yield. Unless standardised, nutritionally balanced organic nutrient sources are available, IP management is likely to be easier and probably more effective than the organic approach.

Activities of β-glucosidase, phosphatase and urease were determined in extracts of tree-row top-soils over five consecutive seasons in order to calculate the alteration index three (AI3). The significant correlation between AI3, soil organic matter and trunk circumference suggests that this index could be useful indicator of potential tree performance.

04 EFFECT OF SHADE NETS ON THE PRODUCTIVITY OF 'GRANNY SMITH' AND 'FUJI' APPLES IN THE EGVV REGION

Researcher: Willie Kotze

Sunburn is a major defect of apples produced for the fresh markets under the warm growing conditions in South African. In 'Granny Smith', which is very susceptible to sunburn and where even the slightest chlorophyll bleaching is visible, the pack-out may be as low as 40%. Shade nets decrease sunburn by decreasing the light exposure and thereby also the radiant heating of the fruit peel. This makes shade netting the most effective means to reduce sunburn on apples.

Two-a-Day Pty Ltd and Vegtech initiated this project in 2007 to evaluate the production of different apple cultivars under 20% shade nets in the Elgin, Grabouw, Vyeboom, Villiersdorp (EGVV) area. Different coloured nets were used in the trials; however, only the netted strips (nets) to uncovered (control) strips were compared due to unsuitable trial design. An area of approximately 0.5 ha was covered with horizontal nets in full-bearing 'Granny Smith', 'Cripps' Red', 'Cripps' Pink' and 'Fuji' orchards. Adjacent uncovered trees served as control. There were at least 5 replicates for each treatment. Data were collected only from central trees under each strip. Vigour control was adjusted under the nets, but irrigation, nutrition and all other orchard practices were managed the same as the control. This is not ideal since netting affects irrigation and nutritional demands and also affects fruit set, therefore requiring adjustments in thinning programmes.

Nets substantially reduced the incidence of sunburn in 'Granny Smith' reflecting in in a considerable increase and decrease in the percentage class 1 and 3 fruit, respectively. The average yield for netted 'Granny Smith' was not affected. It makes economic sense to cover new and even old 'Granny Smith' plantings under nets. The reduction in sunburn alone justifies the considerable cost of netting. Netting reduced sunburn by ±10% in 'Fuji', but also resulted in a large increase in the percentage of poorly coloured fruit. The effect on 'Fuji' yield and pack out was variable over the different seasons and alternate bearing in the last season resulted in yield losses under the nets. In 'Cripps' Pink', the slight decrease in sunburn (± 6 %) did not compensate for the loss in red colour (± 20 %). In 'Cripps' Red', the decrease in fruit with adequate red colour was evened out by the reduction in sunburn. The reduction in sunburn in less sunburn-sensitive and in red and blushed cultivars does not justify the cost of netting. The economics may improve for orchards on dwarfing rootstocks like M9 or GENEVA222 and with better coloured strains of blushed cultivars. The project did not answer the question of whether coloured nets are better than the durable and most commonly used black nets. However, such research is difficult due to the effect of coloured nets on both the light spectrum and quantity of light that is allowed through. Research under local conditions is needed so that informed decisions that consider all potential benefits and drawbacks of netting can be made.

05 THE APPLICATION OF SUCROSE TO ENHANCE FRUIT SET IN 'PACKHAM'S TRIUMPH' PEAR

Project Leader: Willie Kotze

The objective of this project was to evaluate the effectiveness as well as the cost effectiveness (if proved effective) of sucrose applications in full bloom to improve fruit set in 'Packham's Triumph' pears. Many fruit growers, especially in the EGVV region, were spraying sucrose in the believe, based on two foreign publications, that this increases fruit set.

In the 2011/12 season, a 10% sucrose application resulted in a significant yield increase. The same trend was observed in the 2012/13 season, but the effect was not significant. The project subsequently relocated to the Warm Bokkeveld area in the 2013/14 season to a very suitable orchard that usually blooms profusely. None of the sucrose treatments were able to increase fruit set or yield in this orchard.

Based on our results, we cannot recommend the application of sucrose to increase fruit set in 'Packham's Triumph' pear. It could be that sucrose (or other sugars) may play a role as component of fruit set programmes, but we are not at liberty to discuss any such role.

FINAL REPORTS DUE 2015

1. Establish the effect of rest breaking agents on vegetative and reproductive development of apples in the Koue Bokkeveld/ Witzenberg valley
Researcher: W. Kotze

2. The response to and efficacy of rest breaking chemicals under laboratory conditions as a function of cultivar, chill unit accumulation, time of application and temperature after application.
Researcher: L. Allderman

3. Determining the chill requirement of important rootstocks available to the South African apple industry.
Researcher: L. Allderman

4. Cost effectiveness of picking platforms and the Hermes harvesting system relative to conventional labour intensive farming practise.
Researcher: W. Steyn

5. Evaluate pear rootstocks and planting systems.
Researcher: M. North

6. Ecophysiological assessment of the effect of different apple rootstocks on scion performance.
Researcher: M. Schmeisser

7. Determining the Chill Requirement of important Stone Fruit Rootstocks available to the South African Fruit Industry.
Researcher: L. Allderman
8. Inherent and acquired resistance to fruit sunburn and poor colour in various apple and pear cultivars.
Researcher: W. Steyn

9. Water relations and sunburn in pome fruit.
Researcher: W. Steyn

NEW PROJECTS APPROVED 2015

1. Using the shoot assay to screen combinations and sequential application of existing and possible new rest breaking agents in apples.
Researcher: E. Louw

2. Investigating the seasonal progression of bud dormancy as a function of temperature.
Researcher: L. Allderman

3. Spatial FruitLook data: Uses and benefits to the Fruit Industry (Discussion document).
Researcher: C. Jarmain

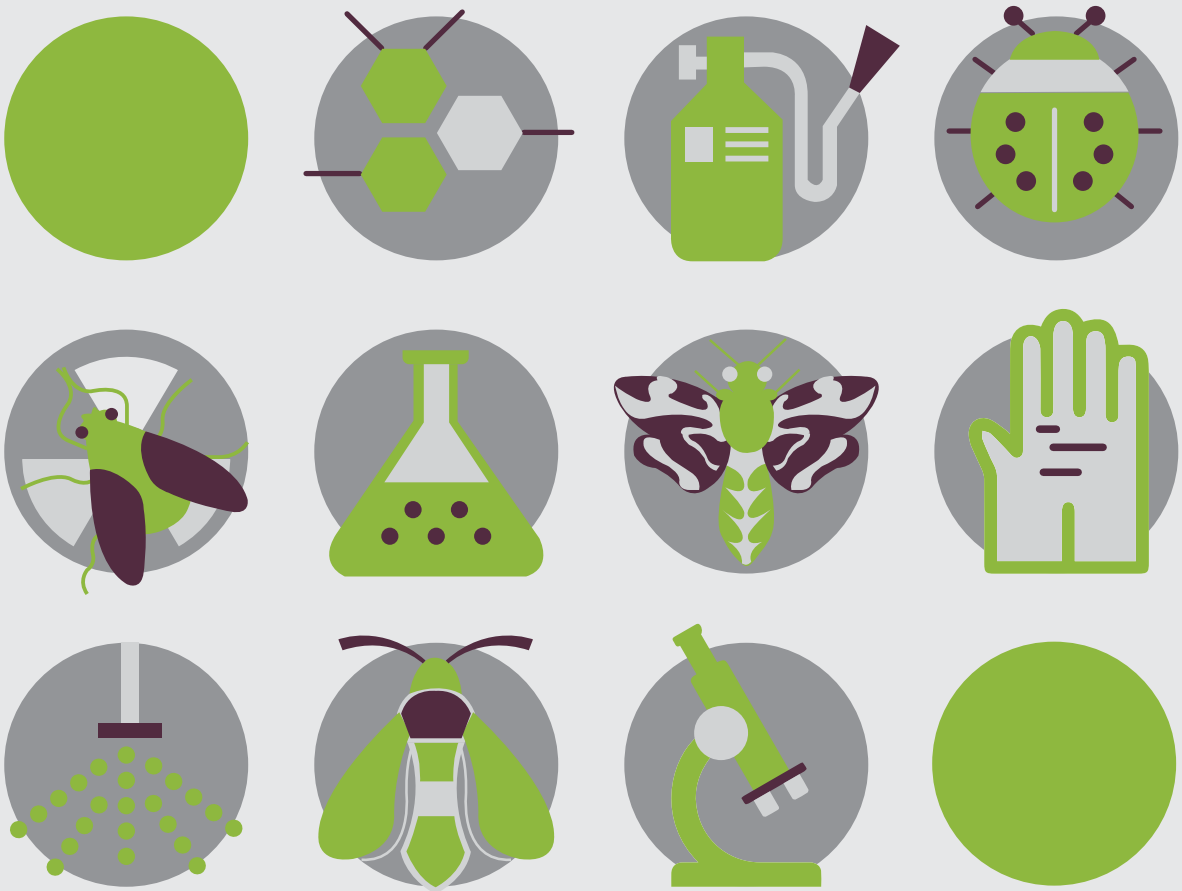
4. Acclimation of apple peel to light and temperature and the effect thereof on red colour development and tolerance to sunburn.
Researcher: S. Midgley

Provisionally approved

5. Net effects on microclimate and apple physiology.
Researcher: E. Lotze

6. Stone fruit phenology and physiology in the Northern Province as related to orchard practices and productivity.
Researcher: N. Taylor

CROP PROTECTION



'RESEARCH IS CRITICAL.'

The Crop Protection research program was productive and a variety of applied and basic research involving plant pathology, nematology and entomology was undertaken.

A number of projects were completed during the 2013/14 season (see Table 1). They include basic and applied research on fruit flies. Hans Hugo completed two studies on ring nematode biology and two plant pathology projects were completed. A number of projects will end in December 2014, they include applied research on codling moth egg parasitoids and pheromone disruption.

The research projects underway are listed in Table 2. The projects cover a wide range of topics and include both pre and post-harvest research. A number of the running projects have been delayed due to a variety of reasons. However, good progress has been made overall. Entomology projects address a wide range oaf issues including applied research on Bactrocera invadens, the invasive fruit fly. Research on this invasive insect is regarded as critical as the insect poses a significant threat to the deciduous fruit industry. Nematology projects include research on plant parasitic nematodes and entomopathogenic nematodes. The research is applied and the development of EPN's as effective pest control agents remains a priority.

The structure and function of the Crop Protection program was changed and the results thereof can be seen in the above. The Crop protection research programm continues to form a significant part of the reseach effort within the Faculty of Agriculture at Stellenbosch University. In addition, the crop protection research programme has involved a number of other departments on the campus. The programme continues to attract external funding, and a new funding proposal has been submitted for research on nematodes.

As noted previously, the demands on crop protection research are high. The threat posed by Bactrocera invadens and the phytosanitary status of false codling moth are concerning. In addition, a new strategy for the integrated management of codling moth will have to be developed as the sterile insect release project is now closed. The new research projects on more integrated approaches to pest management are encouraging and bode well for the future.

I would like to thank both SAAPPA and SASPA for their support during the past year, without which the above would have been impossible. I would also like to thank all of those involved in the Crop Protection research for their hard work and dedication.

Matthew Addison

RUNNING PROJECTS.

01
Entomology
Dispersal capacity of Bactrocera invadens.
C Weldon

02
Entomology
Investigating the use of semiochemicals for IPM of western flower thrips.
E Allsopp

03
Entomology
Biological control: Banded fruit weevil (Phlyctinus callosus) culture methods.
J Heunis

04
Entomology
Monitoring of mites in pear orchards.
J Heunis

05
Entomology
Chemical control: Determination of insecticide resistance levels in mealy bug populations.
J Heunis

06
Entomology
High temperature disinfestation of False Codling Moth larvae.
J Terblanche

07
Entomology
Thermal physiology and population dynamics of bollworm (Helicoverpa armigera) in SA fruit orchards.
J Terblanche

08
Entomology
Bactrocera invadens: Pest Risk Analysis for the deciduous fruit industry in the South Western Cape.
K Pringle

01 DISPERSAL CAPACITY OF BACTROCERA INVADENS

ENTOMOLOGY
Researcher: C. Weldon

1. 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.

2. Progress has been delayed substantially by the very long timeframe required to negotiate memoranda of agreement between the University of Pretoria and industry partners associated with the project. While an agreement has been made with and funding received from CRI (with matching funds from THRIP), to my knowledge, an agreement has only recently been signed by the South African Table Grape Industry, and the one with Hortgro is still outstanding. We have done our best to work towards reaching the objectives of the project, but due to delays in receiving funding, are now a full year behind schedule.

3. A PhD student, Mrs Louisa Makumbe, was appointed to the project in April 2013. Mrs Makumbe is based at the Plant Quarantine Station, Zimbabwe, where she has progressively worked to establish a B. invadens culture from locally-collected infested fruit with larval rearing medium supplied by CRI. She will shortly commence a pilot study to optimise marking of flies for planned dispersal studies. Preliminary modelling on the optimal spacing of traps to increase recaptures has been done by Prof. Anguelov. This modelling has been published in an open access, peer-reviewed journal and will benefit planned dispersal experiments.

4. Mathematical models on trap spacing recommend a non-symmetrical array of five traps in close proximity to maximise fly captures, but this prediction is yet to be validated with field data.

02 INVESTIGATING THE USE OF SEMIOCHEMICALS FOR IPM OF WESTER FLOWER THRIPS

ENTOMOLOGY
Researcher: E. Allsopp

1. The use of semiochemicals to modify western flower thrips behaviour and thus minimize economic damage on deciduous fruit crops, reducing the need for toxic pesticides, was investigated. Objectives for this season were to continue screen house trials with selected concentrations of essential oils, process and analyse volatiles collected from plum and clover flowers and test the relative attraction of clover and plum volatile bouquets to WFT females.

2. Screenhouse trials to test the efficacy of semiochemicals for reducing WFT egg-laying on plum blossoms were moved to glass-fronted breeding rooms to counter the cold, wet weather during flowering. Despite this, the WFT collected from wild clover in September 2013 laid too few eggs to obtain meaningful results - only 3 eggs in 1 297 untreated control blossoms. Plum flower volatiles were analysed at Rothamsted Research. The volatiles captured from closed plum blossoms at the balloon stage differed from those of half open and open blossoms.

3. Since plum flowering is not well synchronized with WFT population build-up in the Western Cape, the screen house trials were replaced with a small-scale field trial in a demonstration orchard at Roodeplaat research farm (Pretoria). Further analysis of plum volatiles are being done to confirm the first findings and to identify the volatile compounds. Olfactometer studies continue to determine if volatiles of clover flowers are more attractive to WFT females than those of balloon stage, half open and open plum blossoms. This will indicate whether clover is a suitable trap crop for use in a push-pull system.

03 BIOLOGICAL CONTROL: BANDED FRUIT WEEVIL (PHLYCTINUS CALLOSUS) CULTURE METHODS

ENTOMOLOGY
Researcher: J. Heunis

1. The development of a rearing technique for the cultivation of large numbers of banded fruit weevil (BFW) is necessary before different control measures of BFW can be investigated.

Adult BFW were collected from corrugated carton strips secured around apple trees. Adults were kept on Coprosma plants in Perspex cages according to the method of Ferreira (2010) in an insectary that receive some natural lighting in addition to artificial lights set to L:D of 12h:12h, and 25°C day and 21°C night temperature.

2. A second colony was kept at room temperature near a window in the laboratory. This colony laid eggs at regular intervals from collection until the end of July 2014. Adults in the insectary laid eggs only the day after collection and therefore were removed after 4 weeks to the laboratory where egg laying started within 2 days.

3. Eggs were collected from moistened cotton wool disks placed with adults twice a week. All eggs were removed from disks under a microscope and placed on a moist filter paper disk inside a petri dish. After emergence larvae were placed on carrots (Ferreira 2010) planted in course river sand. Final instar larvae or pupae were removed from the sand and kept in peat moss (Horne & Stackpoole 1989) until adults emerged.

4. Emergence from eggs varied and survival up to adult stage was low. Adults were collected 77 to 90 days after emerging from the eggs. Development slowed with cooler winter temperatures. Problems with carrots rotting before removal of pupae were minimised by dipping carrots in Spore kill before planting.

04 MONITORING OF MITES ON PEAR ORCHARD

ENTOMOLOGY
Researcher: J. Heunis

1. To develop an action threshold, to limit mite damage on pear in the Ceres area, mite populations were monitored from November 2013 to February 2014 on cultivars susceptible to mite and scorching damage on 3 farms with 2 blocks on each farm.

2. Phytophagous and predatory mites were recorded by counting in the orchard. Predatory mites were unidentified with a microscope. Monitoring was done weekly from mid-November until mid-February. The degree of scorching of leaves in trees used for monitoring of mites was also noted. On Freeland a Bosc and Packham's orchard were monitored, with a Packham's and Early Bon Chretien on Marceaux and two Packham's orchards on Lorraine, all close to Ceres.

3. Phytophagous and predatory mites were recorded from late November to early December but the maximum infestation levels reached in different orchards varied considerably (Fig. 1). Mite numbers increased rapidly in December and where high mite numbers were recorded scorched leaves were recorded soon thereafter (Fig 1a, b and c). On Lorraine mites increased later in the season. (Fig. 1e). However, when the proposed action level (Pringle and Botha 1987) was nearly reached predatory mites were increasing and lower temperatures were predicted (Fig. 1). Therefore, the decision to spray was postponed. Phytophagous mite numbers dropped thereafter as biological control was effective and scorching of leaves on this farm were very low (Fig 1e).

4. Monitoring is necessary to prevent unnecessary spraying to prevent the development of resistance to miticides. However, not only the population level of the mites is important in determining timing of sprays, but also the influence of temperature, wind, predatory mites and the susceptibility of the pear cultivar.

05 CHEMICAL CONTROL: DETERMINATION OF INSECTICIDE RESISTANCE LEVELS IN MEALY BUG POPULATIONS

ENTOMOLOGY
Researcher: J. Heunis

1. To examine if insecticide resistance is the reason for increasing mealybug (Pseudococcus viburni) populations in pome and stone fruit orchards mealybug colonies need to be reared successfully in sufficient numbers to use in bioassays with insecticides presently used for their control. The first step was to establish a susceptible mealybug colony which could be used to determine the base line insecticide susceptibility. Apples collected from an old neglected orchard on the Elgin Experimental farm were examined and all mealybugs placed on a butternut as rearing medium (Mudavanhu 2009) inside a Perspex cage.

2. A second colony was established from mealy bugs collected on apples from a commercially treated orchard on Molteno which could be used as a potentially resistant strain.

ECONOMIC SUSTAINABILITY

3. Mealybug colonies were kept in an insectary room with constant day temperature of 25°C and night temperature of 21°C and L:D of 12:12. Increase of the susceptible mealybug colony was slow as only 1 adult female and few crawlers were found on the apples from the Experimental farm. Most colonies on these apples were parasitised. The susceptible colony is presently at a level that experimental techniques for the bioassays can be examined from the end of August 2014.

4. Even though more mealybugs were collected from Molteno these mealybugs increased much slower. Mealybug cages need to be examined regularly for the presence of "laboratory mites" as their numbers can increase quickly. Testing different methods for the bioassays and testing the different important insecticides can only start when sufficiently high population numbers are available. Mealybug samples were positively identified by Wilma Pieters as Pseudococcus viburni.

06 HIGH TEMPERATURE DISINFESTATION OF FALSE CODLING MOTH LARVAE

ENTOMOLOGY
Researcher: J. Terblanche

1. 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.

2. We aimed to fill the knowledge cap 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 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.

3. 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.

4. 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.

07 THERMAL PHYSIOLOGY AND POPULATION DYNAMICS OF BOLLWORM (HELICOVERPA ARMIGERA) IN SA FRUIT ORCHARDS

ENTOMOLOGY
Researcher: J. Terblanche

1. Over the past twelve months, we have developed a biophysical model that focuses on the African Bollworm (Helicoverpa armigera). The model translates spatially explicit data on climate and terrain into the microclimates encountered by the different life-history stages of the Bollworm on its host apple tree (on the trunk of a tree, on a leaf within the canopy, or buried underground). 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 survive and develop. Model simulations were then run where the above process was performed at hourly time-steps, tracing the insect's phenology throughout the year, and was then repeated for multiple sites across a fruit-growing region of the Western Cape province, centering on Villiersdorp.

2. Pseudothecial densities (PD, number of pseudothecia per fertile lesion) and ascal densities (AD, number of asci per pseudothecium) were compared between in Koue Bokkeveld (KB), a cold winter region, and Elgin (EL), a warm winter region experiencing climate warming, in 2012 and 2013. Scabbed leaves were detached during leaf-drop and overwintered in their region of origin and in the other region. The PD in leaves collected in KB and overwintered in KB was significantly higher than for leaves collected in EL and overwintered in EL, and leaves collected in KB and overwintered in EL. These results agreed with what was expected, as temperature during pseudothecial formation (i.e. the first four weeks after leaf-drop) was significantly lower in KB than in EL. However, the PD for leaves collected in EL and overwintered in EL did not differ significantly from EL leaves overwintered in KB. AD values in all treatments did not differ significantly from one another. Results suggest that factors other than temperature may be involved in controlling PD, e.g. the EL population may include strains not present in the KB population, with higher optimal temperatures for pseudothecial formation.

3. We have also found that running the model on a number of different spatial scales, with varying degrees of cell resolution, affects our predictions of Bollworm phenology and survival across the landscape. The discrepancies in predictions between different resolutions are most pronounced in regions with high topographic variation, like the agricultural region of the Western Cape. To further explore these patterns, we are currently running simulations for South Africa, and the globe, with different spatial scales. We hope to demonstrate the importance of selecting an appropriate spatial scale when running species distribution models, and aim to publish this study by October, 2014.

08 BACTROCERA INVADENS: PEST RISK ANALYSIS FOR THE DECIDUOUS FRUIT INDUSTRY IN THE SOUTH WESTERN CAPE

ENTOMOLOGY
Researcher: K. Pringle

1. The most likely pathway for entry of Bactrocera invadens into the Western Cape is in consignments of mangoes and citrus from Mpumalanga and Limpopo. Mortality of B. invadens during harvest, packaging and transport is considered to be low. Average survival was estimated to be 0.6138 (61.38%).

2. Data of infestations of mangoes and citrus in other African countries were obtained from the literature. From these data bootstrapping was used to generate datasets of infestation to simulate the number of fruit flies entering the Western Cape in mangoes and citrus. The beta general distribution fitted the data well (X^2 = 18.77, P = 0.91 for mangoes; (X^2 = 16.51, P = 0.96 for citrus). Using these data the estimated mean ± standard deviation of fruit flies/kg was 11.18±9.90 and 4.12±3.12 in mangoes and citrus respectively.

3. These are very high populations as the data were mainly from mango and citrus plantings in which no control measures were applied. However, good estimates of the shape parameters for the beta general distribution were obtained. These were used to simulate populations entering the Western Cape. Between December and March an estimated 112.5 fruit flies per week could enter the Western Cape and between March and April and average of 117 per week in citrus.

09 INTEGRATED USE OF STERILE CODLING MOTHS AND FRUIT FLIES IN APPLE AND PEAR ORCHARDS

ENTOMOLOGY
Researcher: M. Addison

1. The objective of the study is to establish if pheromone treated sterile fruit flies can be used to suppress codling moth populations in the field.

2. A number of factors were determined. These included the assessment of suitable codling moth pheromone formulations, determining the effects of the applied pheromone of fruit flies, and establishing an efficient application method. In addition, the effect of releasing pheromone treated fruit flies on codling moth populations was assessed.

3. A suitable microencapsulated formulation of codling moth pheromone was identified. Application of the formulation to fruit flies proved problematic. The formulation is toxic at high concentrations. Very high fruit fly mortality was observed when undiluted formulation was applied via an air brush to caged flies. Diluted formulation was less toxic but rendered flies immobile. Application of the pheromone formulation via a Potter's Tower was assessed and was unsuitable . Initial attempts at releasing pheromone treated fruit flies in an apple orchard were unsuccessful in that wild moths in the orchard were still able to locate pheromone baited adhesive traps. It is assumed that pheromone treated fruit flies failed to distribute in trees due to their impaired flight performance.

4. Various options were considered with respect to treating fruit flies with pheromone. The use of pheromone impregnated plant wax was considered and deemed unsuitable as fruit flies are able to remove the wax within days.

10 INUNDATIVE RELEASE OF TRICHOGRAMMATOIDEA LUTEA IN APPLE AND PEAR ORCHARDS TREATED WITH STERILE CODLING MOTH

ENTOMOLOGY
Researcher: M. Addison

1. The objective of the study is to apply current research findings on the use of the parasitic wasp, Trichogrammatoidea lutea, in commercial apple and pear orchards as a biological control agent for codling moth and other moth pests.

2. Various approaches were used in the study. These include methods to improve the in-field production of wasps, to establish suitable monitoring methods, assess the persistence of the wasp in untreated orchards. In addition, the effects of the release of sterile codling moth on the wasps population in commercial orchards is being assessed.

3. Field cage production of wasps was successful. The evaluation of wasp populations in untreated orchards (apple, pear and stone fruit) in Stellenbosch indicated that wasp populations remained very low. Release of sterile codling moths did not influence low wasp populations. Due to the shortage of sterile codling moths more extensive trials were not possible in 2013. During 2014 the in orchard mobility of wasps was assessed. The wasps were found to be relatively mobile and the parasitism rate of eggs on sentinel egg sheets was relatively high. The release of sterile codling moths in the treated orchards appeared to have little or no effect on the wasp population.

4. The methods used to produce wasps in cages in orchards was refined. The field cages were loaded with sterile codling moths and wasp populations within cages increased rapidly thus allowing for the continuous release of field adapted wasps. Cage design was amended and optimized to allow for efficient loading and maintenance.

11 MOLECULAR ANALYSIS AND BIODIVERSITY SURVEYOF FRUIT FLIES ASSOCIATED WITH DECIDUOUS FRUIT AND VINES, WITH FOCUS ON ECONOMICALLY IMPORTANT SPECIES

ENTOMOLOGY
Researcher: P. Addison

1. We first investigate the diversity of fruit flies in orchards and in agro-ecological zones in the Western Cape. Second, determine the suitability of Loop-mediated isothermal AMPlification of DNA (LAMP) to identify Bactrocera invadens rapidly in the field and finally we investigate the population genetic structure of Ceratitis rosa in South Africa using molecular and morphological markers to estimate gene flow, propagule pressure and dispersal ability.

2. For the survey we sampled in orchards and associated natural habitats in the Western Cape using different baits. For the C. rosa genetic structure all individuals were genotyped for 12 polymorphic microsatellite markers. Wings from these individuals were mounted, imaged and analysed using wing morphometrics. Initial LAMP protocols have been tested and more detailed analysis will continue.

3. Data from surveys have been analysed and written up as an article submitted to a journal. All C. rosa individuals have been genotyped and wings mounted. Both sets of data have been analysed and results have been written up as a journal article. Work for LAMP for B. invadens is still continuing with 2 candidate genes tested to date.

4. In our survey only Ceratitis capitata and C. rosa was detected in high numbers.C. capitata had the highest abundance overall, with the attractant Biolure being more effective than the three other lures (Cue Lure, Olive Fly Lure and Questlure). C. rosa populations in South Africa show no clear intra-specific differentiation and belong to only one morphological type (R2) and within the R2 morphotype there are high levels of connectivity.

12 FORECASTING BACTROCERA INVADENS INVASION POTENTIAL USING TRAIT-BASED MODELLING APPROACHES

ENTOMOLOGY
Researcher: P. Addison

1. The aim of this research is to develop further alternative models based on thermal, energetic and water balance physiology, to assess the pressing issue of why, where and by how much, can B. invadens succeed in South Africa at a range of spatial and temporal scales.The permits and permissions needed to establish a Bi colony in quarantine have been obtained. The Bi colony has been started and is in the process of being expanded to supply the numbers of flies needed for the experiments.

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

ENTOMOLOGY
Researcher: S. Johnson

1. 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.

2. 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 CO2 and low O2 (4%CO2 + 4%O2), the CATTS mixture of high CO2 and low O2 at 15% CO2 & 1% O2, high CO2 (4%CO2) and low O2 (4%O2). Supercooling points and lower lethal temperatures of insects collected in each period were determined.

3. 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.

4. 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.

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

ENTOMOLOGY
Researcher: S. Johnson

1. The aim of this project is to better understand the chemical ecology of the grain chinch bug and evaluate the use of its aggregation pheromone in monitoring and trapping bugs as they enter into aestivation. Due to problems with the GC-MS equipment used in analysing the chemical constituents of pheromones, progress of the project was affected in the past season. However, lure formulation and preparation is currently underway for use in the coming season and therefore, results are still pending.

2. Once the problems with the GC were solved, only active bugs were available, we therefore did some analyses on the pheromones produced during the active stage of grain chinch bug life cycle, for comparison with the aggregation pheromone. Some of the compounds isolated still need to be identified, but thus far, a number of compounds common to both the aggregation and sex pheromone has been confirmed. Compounds not previously isolated during aggregation collections must still be identified.

15 CONTROLLED ATMOSPHERE TEMPERATURE TREATMENT SYSTEM (CATTS) AS A POST-HARVEST TREATMENT FOR PHYTOSANITARY PESTS OF DECIDUOUS FRUIT.

ENTOMOLOGY
Researcher: S. Johnson

1. CATTS treatments were conducted on 'Forelle' pears, a CO2 sensitive cultivar, to evaluate the effect of heated CA post-harvest treatments on fruit quality.

2. Pears were subjected to slow and fast CATTS heating rates (12°C/h or 24°C/h) combined with regular air or a controlled atmosphere of 1% O_2, 15% CO_2 in N_2 for 3h. After treatment fruit was stored for either 12 or 16 weeks at -0.5°C, and each cold storage period was followed by a shelf-life period of 7 days at 23°C. Fruit quality evaluations were done after treatment and after each storage regime.

3. Scalding and shrivel were the main types of damage observed. The scalding damage was most likely aggravated by the high moisture levels inside the CATTS unit.

4. Results indicate that a 3 hour heated CA treatment cannot be used on 'Forelle' pears to control phytosanitary pests. Shorter treatment times may still be feasible, but high condensation levels inside the CATTS unit need to be reduced.

16 FACTORS AFFECTING CHEMICAL APPLICATION TO IMPROVE POME AND STONE FRUIT DISEASE AND PEST MANAGEMENT.

ENTOMOLOGY
Researcher: S. Van Zyl

1. Two milestones were answered during the 2013 season:
- Milestone 1, testing three different applicator technologies set up for optimum spraying, where spray volume, speed etc. settings differed. Two deposition assessment methods were used to give indication of pigment deposition on the target surface. The general conclusion was that the KWH performed very similar to the Atasa and Cima applicator technology types, while better deposition was sometimes observed for the Cima compared to the Atasa spray system on leaves and fruit surfaces. Applicators, with some exceptions, deposited significantly more pigment to the outer than inner, and top than bottom, canopy positions.
- Milestone 2, evaluating different deposition assessment methods, with the viewpoint of developing a rapid quantification method of spray applications. Different assessment methods (7 in total) were evaluated and compared for rapid, accurate and easy field assessment. Deposition was manipulated by adjusting the spray distance (2 meters vs. 3 meters) and spray coatings (1 vs. 2 coatings) on the target sprayed leaves (4 treatments in total).

2. Pearson's correlation procedure conducted for various deposition assessment methods was significant and indicated good correlation between various assessment methods. Correlation ranged between r2 = 0.98 (strongest) to r2 = 0.59 (weakest)] and at significant levels P = <0.0001 to P = 0.0022. Image analyses of deposition quantity showed strongest correlation with image analyses of water sensitive-paper, individually / collectively and visual droplet rating using

the Furness deposition chart and the Rapid deposit indication method, ranging between correlation values of r2 = 0.93 to r2 = 0.87 (P = <0.0001). Slightly poorer Pearson's correlation was exhibited between quantitative image analyses and Water-sensitive-paper either using a visual droplet count with a known density per cm2 or a visual droplet rating chart, with correlation values r2 = 0.67 (P = 0.0003 and r2 = 0.78 (P = <00001), respectively.

3. The biological efficacy / meaning of assessment values, will be determined in studies during the season of 2014. This will be validated with residue recovery and image assessment methods developed and validated by the University of Stellenbosch Plant pathology department (milestone 3, if agreed).

17 BIN AND ORCHARD TREATMENT WITH ENTOMOPATHOGENIC NEMATODES AND SHORT AND LONG TERM MONITORING FOR CODLING MOTH'.

NEMATOLOGY
Researcher: A. Malan

1. The impact of the inundative aerial application of entomopathogenic nematodes (EPNs), and the effect of environmental conditions, on the mortality of diapausing codling moth (CM) larvae was investigated in the laboratory.

2. CM larvae, reared under diapausing conditions, were used to culture infective juveniles (IJs) in vivo for use in the different trials. Wire-mesh cages filled with apple tree bark and 20 last-instar CM larvae were used as the containment method. Treatments were 25 IJ/ml of Heterorhabditis bacteriophora, Heterorhabditis sp.; Steinernema yirgalemense; and filtered water (control). Cages were pre-wetted, then dipped in / sprayed with treatments. Cages were placed in separate 1L containers, closed and left in a growth chamber at 22°C for 4h; then at 10°C for 12h; and, lastly, at 22°C for 8h. The containers were removed from the growth chamber after 24 h. The larvae were washed, transferred to Petri dishes lined with moist filter paper, and left in a growth chamber at 25°C. Mortality by infection with EPNs was confirmed by dissection, four days after application.

3. For the dip trials, H. bacteriophora and S. yirgalemense gave the highest infectivity, with the two species differing significantly with regard to CM mortality from Heterorhabditis sp. For the spray trial, there was a significant difference between all three treatments applied, with S. yirgalemense giving the highest infectivity, and Heterorhabditis the lowest.

4. In laboratory bioassays, a significant difference in CM mortality occur between dip and spray application techniques, with dipping being conducive to nematode infection. With the spray trials, the resultant efficacy was compromised by at least 20% for all isolates involved. Overall, S. yirgalemense was found to be the most effective species.

18 BIOPROSPECTING OF NATURAL ECOSYSTEMS FOR ENTOMOPATHOGENIC NEMATODES

NEMATOLOGY
Researcher: A. Malan

1. The aim of this study is to determine the occurrence, and the distribution, of endemic entomopathogenic nematodes (EPNs) in South Africa. The objectives that are aimed at in this study include finding new, low-temperature-adapted EPN isolates to be used against key pests (specifically codling moth), during the cooler seasons. Classic genetic breeding techniques with Steinernema yirgalemense will be used in a breeding programme directed towards selecting a more cold-tolerant EPN.

2. EPNs are currently being isolated from the different soil samples, using live insects, such as codling moth, wax moth, and mealworm, for trapping. The different nematode isolates found during trapping were identified using morphological and molecular techniques. New species found during the survey will be described in full as new species for South Africa.

3. The most abundant species that have, thus far, been found during the course of the survey have been Heterorhabditis bacteriophora and Steinernema, with a high diversity, and three unidentified species from the Fynbos biome. A second new species of Steinernema is currently in the process of being described as a new species for South Africa. A new isolate of S. yirgalemense, which is currently only the second live known isolate in the world, has been reported in the Grabouw area.

4. Commercially available species, such as S. feltiae, S. carpocapsae, and H. megidis have not yet been isolated from any of our soils. The new isolate of S. yirgalemense is a most important find, and requires comparing, for the purpose of establishing its virulence, with the Nelspruit isolate, against our key pests. These two isolates need to be cross-bred to diversify the genetic pool. The resultant domesticated isolate will be used for adaptation to low-temperature-adapted studies, and, in future, for the mass culture project.

19 POTENTIAL CONTROL OF THE WOOLLY APPLE APHID (ERIOSOMA LANIGERUM) USING ENTOMOPATHOGENIC NEMATODES

NEMATOLOGY
Researcher: N. Stokwe

1. The objectives of this study were: (1) to evaluate the efficacy of an entomopathogenic nematode species, two entomopathogenic fungal species, and a combination of a nematode and a fungal species against arboreal and subterranean WAA populations in glasshouse and field trials and (2) to investigate the effect of mulching on the efficacy of EPNs for control of soil populations of woolly apple aphid in pot and field trials.

2. Steinernema yirgalemense (157-C) and commercial isolates Beauveria bassiana (Eco- Bb strain R444) and Metarhizium anisopliae (ICIPE 69) were tested for their pathogenicity against woolly apple aphid (WAA) in glasshouse trials. M 109 rootstocks were planted in plastic pots and infected with WAA collected from the field. The experimental treatments were: 1) Control (WAA + water only), 2) WAA + 157-C, 3) WAA + B. bassiana, 4) WAA + M. anisopliae, 5) WAA + 157-C + B. bassiana and 6) WAA + 157-C + M. anisopliae. Both arboreal and root colonies were treated. Two types of mulch (pine wood shavings and apple wood chips) were evaluated for their effect on the efficacy of S. yirgalemense and Heterorhabditis zealandica infective juveniles.

3. Entomopathogenic fungi provided better control of WAA and even better control was achieved when nematodes were combined with entomopathogenic fungi.

4. Based on pot trial results, entomopathogenic fungi will be combined with S. yirgalamense in field trials.

20 NEMATODE COMMUNITY STRUCTURE AND FUNCTION AS A BIO-INDICATOR OF THE EFFECTS OF SOIL AMENDMENTS ON SOIL HEALTH

NEMATOLOGY
Researcher: S. Storey

1. Soil samples were collected from the ridge of the tree row and the working row in an apple orchard in the Vyeboom area in order to determine the nematode community structure, function and biodiversity.

2. In total 50 samples were collected from 5 treatments. Nematodes were extracted from the soil using the Cobb's method followed by a modified Baermann funnel. Samples were then concentrated and nematodes were enumerated and identified to family level.

3. Fig. 1 indicates treatment B3 has the highest numbers of Tylenchidae and Pratylenchidae. Trichodoridae were present in Treatment B3 and B4. Dorylaimidae were present in all samples. Treatment B2 had the greatest number of Cephalobidae. The highest number of Aphelenchidae occurred in treatment B1. Mononchidae only occurred in low numbers in soil from treatment B2. The faunal analysis (Fig. 2) was applied to each treatment. Since the apple trees are newly planted, it is anticipated this will change over time. The current analysis indicates that soil food web conditions for treatments B4 and B3 are unstructured and disturbed with bacterially dominated decomposition pathways. Treatment B5 is borderline structured with high levels of enrichment, and a disturbed food web. Treatment B1 is maturing with low to moderate disturbance. Treatment B2 indicates structured conditions with low enrichment, an undisturbed soil food web and decomposition dominated by fungal pathways indicating an unbalanced soil food web.

4. Further samples will be taken to establish the effect of various cover crops on the nematode population within the tree row as well as changes over time.

21 CONTROL AND MANAGEMENT OF LESION NEMATODES IN APPLE LAYER BEDS AND NURSERIES

NEMATOLOGY
Researcher: A. de Klerk

1. The Lesion nematode (Pratylenchus) is the most important nematode attacking apples. They feed inside the roots causing retarded growth and low yields. As no visible root symptoms are present, infected nursery trees may unknowingly be a great source of infecting newly planted commercial orchards. No pesticide is registered for the control of nematodes in apple nurseries and no other management options exist to limit the spreading through infected nursery material.

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

3. Observations on the seasonal occurrence over two consecutive seasons showed population peaks either in February or March or April. Adults as well as larvae occurred in the roots and also in the soil during the whole growing season at rooted layers as well as nurseries. This information will be used to determine the best time to apply chemi-cals and also what kind of chemical to be used.

4. The immersion technique was evaluated to control Lesion nematodes in the roots of rooted layers and nursery trees. Different dosages and exposure times with a systemic nematicide were used. Most of the results of this preliminary trial were positive, indicating that further observations are needed.

22 ENTOMOPATHOGENIC NEMATODE THERMAL TOLERANCE AND PERFORMANCE: EXPERIMENTAL MANIPULATION FOR INCREASED EFFICACY

NEMATOLOGY
Researcher: J. Terblanche

1. Through exploring thermal tolerance for important entomopathogenic nematodes (EPN) species and attempting to improve and modify these limits, it should be possible to increase field performance in biocontol programmes. Herein we focus on the nematodes Steinernema yirgalemense and Heterorhabditis zealandica, reared on the codling moth, Cydia pomonella.

2. We employed our developed methodology for assessing lethal lower temperatures and then also examined upper lethal temperatures and determined survival. To see if we could improve the thermal tolerance of these EPN species we then investigated acclimation effects, through holding nematodes at four different temperatures (5, 20, 25, 30°C) for 24 hours before temperature assays. To see if induced acclimation would translate to ecologically relevant measures, we examined the virulence (infectivity) by inoculating new hosts post acclimation treatments.

3. Steinernema yirgalemense was found to be a much more heat tolerant species than H. zealandica. Conversely, H. zealandica was more cold tolerant than S. yirgalemense. The EPN species both had strong responses (both negative and positive) to acclimation treatments that then influenced survival. The virulence of these species does not appear to be influenced by thermal acclimation, although more tests are needed to determine how different forms of acclimation may be used for pest-control strategies.

4. Our results give indication of large differences in thermal tolerance for the EPN species investigated, as well as large responses to acclimation treatments. Given success with our established protocols we aim to further test acclimation and virulence, as well as intergenerational selection responses, and relate our findings to pest-control strategies.

23 DETERMINING THE RAINFASTNESS OF MANCOZEB ON APPLE LEAVES, AND ITS CORRELATION WITH FLUORESCENT PIGMENT PARTICLE DEPOSITION AND SUPPRESSION OF APPLE SCAB.

PLANT PATHOLOGY
Researcher: A. McLeod

1. 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 activity by developing a spray deposition benchmark model. Rainfall is an important factor that influences disease control by foliar applied pesticides. The objectives of this study will be to first develop a spray deposition benchmark model for apple scab and mancozeb using macrophotography, fluorometry and image analyses. The second objective will be to investigate the rain fastness of Dithane NT relative to an alternative mancozeb product with and without a sticker (Nu-film 17).

2. The particle sizes of six commercially available mancozeb products were determined. The suitability of a yellow fluorescent pigment as a tracer for mancozeb residues was determined. A bioassay was developed for assessing the severity of V. inaequalis conidial infections on apple leaves.

3. The particle sizes of all of the products were significantly ($P < 0.05$) smaller than that of the yellow fluorescent pigment. However, taking the full spectrum of particle sizes of each product into account, it was still closely related in size. Using the predetermined point of run-off volume of 1.5 ml, there was little to no difference in deposition quantity (%FPC) between the five evaluated products, except for one product. The manganese ion residues of all five products were strongly correlated ($R2 = 0.92$ to 0.96) with percentage fluorescent particle coverage. A staining method was identified and evaluated that could within 5 days after inoculation, reveal V. inqaequalis infection points.

4. The yellow fluorescent pigment is good tracer for any of the five evaluated mancozeb products. Progress has been made in the development of a bioassay for quantification of V. inaequalis infections that can be used for the development of the spray deposition benchmark model.

24 IDENTIFICATION OF INOCULUM SOURCES OF OOMYCETES, A MAJOR CONTRIBUTOR TO APPLE REPLANT DISEASE, AND THE MANAGEMENT THEREOF

PLANT PATHOLOGY
Researcher: A McLeod

1. The major apple replant pathogens in South Africa consist of oomycetes, with plant parasitic nematodes also sometimes being involved. The project will determine whether nursery trees and irrigation water are inoculum sources of replant pathogens. The second aim will be to determine whether a combination of phenylamides, fenamiphos and phosphonates can increase tree performance on apple replant sites under orchard conditions on non-fumigated and fumigated soils. The third aim will be to determine what the effect of time, application method and dosage of phosphonate applications are on root phosphite concentrations, and whether all oomycete replant pathogens are sensitive to phosphite.

2. Inoculum sources will be investigated using conventional isolation and DNA based methods. The efficacy of phenylamides, fenamiphos and phosphonates in managing apple replant disease will be evaluated under orchard conditions, where tree performance and pathogen populations will be monitored annually. The effect of dosage and timing of phosphonate sprays will be evaluated by measuring root phosphite concentrations. The sensitivity of different oomycete replant pathogens to phosphite will be determined in vitro and in a root-bioassay.

3. Nursery trees showed a high percentage of contamination with the known replant pathogens Pythium irregulare and Pratylenchus. Although weakly and moderately virulent Pythium species were detected in irrigation dams, these pathogens were not detected in the drip/sprinkler systems within orchards. The application of fenamiphos, metalaxyl and phosphonates to trees planted on non-fumigated replant soil having a severe replant status, did not result in a significant increase in tree performance, nor did it improve growth on fumigated soil.

4. Nursery trees are a source of apple replant pathogens, specifically P. irregulare and Pratylenchus. Irrigation water is not a source of apple replant pathogens. Based on one orchard trial, the application of phenylamides, fenamiphos and phosphonates cannot significantly reduce replant symptoms.

25 DEVELOPMENT OF A FUNGICIDE RESISTANCE MONITORING SERVICE FOR SA POME FRUIT PATHOGENS

PLANT PATHOLOGY
Researcher: C. Lennox

1. Apple scab (caused by Venturia inaequalis) and pear gray mould (caused by Botrytis cinerea) fungicide sensitivity and the impact of sanitation treatments in the orchard on V. inaequalis demethylation inhibitor (DMI) sensitivity was evaluated.

2. Venturia inaequalis populations from two apple growing regions [Elgin (N=42), andKoue Bokkeveld (N=71), were tested for fungicide sensitivity towards DMIs using mycelial growth tests. Samples were collected from a sanitation trial orchard (either leaf shredding alone (N=26), or in combination with a spray programme (N=33), or just a spray programme (N=23), or no treatment (N=31)]. Botrytis cinerea pyrimethanil baseline fungicide sensitivity tests were conducted on two orchard populations (N=25 and N=24). Fungal isolates from pear trees previously exposed to botryticides (N=166) from three orchards were tested for fungicide sensitivity to benomyl, iprodione, and pyrimethanil at discriminatory doses.

3. Significant shifts towards resistance were identified in V. inaequalis populations (flusilazole mean EC50= 0.12 µg ml-1). Botrytis cinerea baseline sensitivity for pyrimethanil was found to be EC50= 0.13 ug ml-1, for benomyl at 0.07 ug ml-1, and iprodione at 0.21 ug ml-1. Mycelial growth was inhibited at discriminatory doses of 3 ug ml-1 pyrimethanil (100% of isolates), benomyl (99.4%), and iprodione (89.8%).

4. Results suggest that flusilazole (DMI) sensitivity levels in V. inaequalis have shifted towards resistance and that botryticides involving dicarboximides, or anilinopyrimidines could effectively control grey mould on pears.

26 INCIDENCE AND EPIDEMIOLOGY OF BULL'S EYE ROT OF APPLES IN SOUTH AFRICA. EXT REQUEST TO SEP 2014

PLANT PATHOLOGY
Researcher: C. Lennox

1. The incidence and distribution of N. alba was continued on stored Cripp's Pink apples from growing regions, as well as rapid detection during the growing season and fungicide sensitivity studies for products used in apple scab and decay management.

2. For disease incidence and distribution, 'Cripp's Pink' apples were cold-stored and evaluated for Bull's eye rot (BER) symptoms. For 2012/ 2013 the mean incidence of BER was 3.91%. The Witzenberg region was the most affected followed by Hemel-en-Aarde Valley, Vyeboom, Elgin and Koue Bokkeveldt. Data for the past three years show Witzenberg and Vyeboom to be the most affected BER disease, while Elgin and the Hemel-en-Aarde Valley shows yearly increase of the disease.

3. Rapid detection was continued with asymptomatic fruit, leaves and debris collected monthly in the growing season from two farms, one in Ceres and one in Grabouw. Collected material was washed and DNA extracted. Molecular markers identified N. alba from fruit washes one month post full bloom in Grabouw and two months post full bloom in Ceres for season 2012/ 2013. Analysis for the 2013/ 2014 season is in progress. Neofabraea alba was also present on cross-pollinators (Crab-apples) from the Ceres region, indicating the possibility of an alternative host. The pathogen was not found on leaves, leaf-litter, pruning material or weeds.

4. Weather data was collected for all seasons and regions sampled and is being analysed to determine deciding factors in survival and infection of N.

5. In vitro mycelial sensitivity of N. alba to fungicides flusilazole, pyrimethanil, fludioxonil and mancozeb are currently being assessed.

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

PLANT PATHOLOGY
Researcher: T. Koopman

1. We are determining which races of apple scab (Venturia inaequalis) occur in the different apple growing regions of South Africa and are also investigating the population genetic structure and the pathogenicity and virulence of the pathogen on different apple cultivars.

2. We collected apple scab samples from four different apple growing regions. Single spored cultures were established and differential cultivars were inoculated to determine the races. Apple differential cultivars with different resistance genes against apple scab are being imported. Fingerprinting of apple scab isolates was undertaking with six SSR markers to determine differences between isolates from the different apple growing regions.

3. Apple scab samples were collected from the Ceres, Grabouw and Lower and Upper Langkloof apple growing regions during the 2013/14 growing season (N=250). After single sporing and culturing on potato dextrose agar (PDA), DNA was extracted and genotyping with six SSR markers was done. SSR results from the 2012/13 growing season indicated that minor population differences were found between Ceres and the two Langkloof populations and moderate differences between the other populations (Fst = 0.065; p = 0.010). This indicates that the Ceres and the Langkloof populations are closely related to each other. Ten apple accessions were multiplied by either tissue-culture method or by budwood grafting. Accession B45 and TSR35T239 were re-imported from Hungary using tissue culture plantlets. Six different haplotypes were found in the ITS and ABC 2 gene regions of the fungal isolates.

4. Collection of the apple scab samples from the four apple growing regions enabled a population genetic study which indicated differences in the apple scab fungus between the different climatic regions and also indicated that the fungus adapted to the regions over time. Import and multiplication of the apple accessions will allow identification of the apple scab races in 2014/15. Differences in the ABC 2 gene region of the fungus could be due to variation in virulence in the fungal isolates.

COMPLETED INDUSTRY FUNDED PROJECTS.

PROJECT TITLE	RESEARCHER
ENTOMOLOGY	
Temperature-dependent flight performance of fruit flies.	J Terblanche
Generating a taxonomic database of fruit pests in the Western Cape.	P Addison
Impacts of climate variability on fruit fly (Ceratitis spp.) performance and population dynamics.	J Terblanche
NEMATOLOGY	
Measurement and evaluation of the effect of soil factors on ring nematodes (Criconemoides xenoplax).	H Hugo
Investigations into the survival of ring nematode (Criconemoides xenoplax) in soil.	H Hugo
PLANT PATHOLOGY	
Integrated management of apple scab.	C Lennox
A Survey of Rosellinia in apple orchards and nurseries in SA.	K Bezuidenhout

PROPOSED INDUSTRY FUNDED PROJECTS FOR 2015

PROJECT TITLE	RESEARCHER
ENTOMOLOGY	
Integration of GIS methods and spatial analysis with monitoring data of major pests for the purposes of area-wide pest management.	P Addison
CATTS as a postharvest treatment for stone fruit and associated phytosanitary insect pests.	S Johnson
NEMATOLOGY	
Ring nematode (Criconemoides xenoplax), distribution, characterization and culture methods.	A Malan
Incorporating of entomopathogenic nematodes and fungi in an integrated pest management system for the control of codling moth.	A Malan
PLANT PATHOLOGY	
Management of Rosellinia root rot of apple in SA.	K Bezuidenhout
Screening apple rootstocks for tolerance to Phytophthora crown rot.	K Bezuidenhout
Survey and epidemiology of stem cankers of young apple trees.	L Mostert
The prevalence of Botrytis spp. in and on pears, and alternative host plant tissue: an investigation on the occurrence of the fungus pre-and-post harvest in order to elucidate pathogen ecology, for new decay control strategies.(also Crop Protection)	I Paul
Deep sequencing of pear stony pit disease.	H Maree
The prevalence of Botrytis in and on plums and surrounding host plant tissue: an investigation on the occurrence of the fungus pre-and-post harvest in order to elucidate pathogen ecology, for new decay control strategies.(also Crop Protection)	I Paul

01 TEMPERATURE-DEPENDENT FLIGHT PERFORMANCE OF FRUIT FLIES

ENTOMOLOGY
Researcher: J. Terblanche

Field success of pest management and control programs such as the Sterile Insect Technique (SIT) is sensitive to environmental factors such as low temperatures. In consequence, seasonal or daily variation in thermal conditions can have a marked impact on fly dispersal ability and invasion impact in agricultural landscapes. The objectives of this study are to determine temperature thresholds for flight ability and assess if these can be influenced by various extrinsic or intrinsic factors.

Field success of pest management and control programs such as the Sterile Insect Technique (SIT) is sensitive to environmental factors such as low temperatures. In consequence, seasonal or daily variation in thermal conditions can have a marked impact on fly dispersal ability and invasion impact in agricultural landscapes. The objectives of this study are to determine temperature thresholds for flight ability and assess if these can be influenced by various extrinsic or intrinsic factors.

The influence of thermal history on temperature-dependent flight performance was investigated in an invasive agricultural pest insect, Ceratitis capitata (Diptera: Tephritidae). Flies were exposed to one of four developmental acclimation temperatures (Tacc: 15, 20, 25, 30°C) during their pupal stage and tested at these temperatures (Ttest) as adults using a full-factorial study design. Major factors influencing flight performance included sex, body mass, Ttest and the interaction between Ttest and Tacc. Successful flight performance increased with increasing Ttest across all acclimation groups (from 10% at 15°C to 77% at 30°C). Although Tacc did not affect flight performance independently, it did have a significant interaction effect with Ttest. Multiple comparisons showed that flies acclimated to 15°C and 20°C performed better than those acclimated to 25°C and 30°C when tested at cold temperatures, but warm-acclimated flies did not outperform cold-acclimated flies at warmer temperatures. This provides partial support for the 'colder is better' hypothesis. To explain these results, several flight-related traits were examined to determine if Tacc influenced flight performance as a consequence of changes in body or wing morphology, whole-animal metabolic rate or cytochrome c oxidase enzyme activity. Although significant effects of Tacc could be detected in several of the traits examined, with an emphasis on sex-related differences, increased flight performance could not be explained solely on the basis of changes in any of these traits. Overall these results are important for understanding dispersal physiology despite the fact that the mechanisms of acclimation-related changes in flight performance remain unresolved.

02 GENERATING A TAXONOMIC DATABASE OF FRUIT PESTS IN THE WESTERN CAPE

ENTOMOLOGY
Researcher: P. Addison

Correct insect pest identification is a critical aspect of IPM in fruit production. Damage symptoms are also often not identified correctly, which leads to incorrect treatment/management of a suspected pest problem. The aim of this project is to build an active taxonomic database of pests occurring in deciduous fruit orchards, wine grapes and other fruit crops based on, primarily, correct identification by an expert or using molecular techniques, which should lead to a better understanding and therefore better management of pest problems. Of the 470 of the samples submitted for identification, only 171 were related to the fruit industries. For this reason and due to limitations of capacity in the Department, it is recommended that for the service only samples limited to the fruit industry be processed. With limited capacity, this would be the most practical way in which to continue with the service in future and yet still gain valuable information on potential pest risks.

03 IMPACTS OF CLIMATE VARIABILITY ON FRUIT FLY (CERATITIS SPP.) PERFORMANCE AND POPULATION DYNAMICS

ENTOMOLOGY
Researcher: J Terblanche

Ceratitis capitata and Ceratitis rosa are fruit flies of major economic pests status in South Africa and the world. They cause widespread damage through puncturing fruit during egg laying and larvae subsequently developing within the fruit. Through the use of laboratory-based tolerance estimates, it has become apparent that the performance of these flies is strongly influenced by the thermal environment. However, it is currently unknown whether the patterns observed in laboratory studies reflect performance under natural environments. Gaining a better understanding of the field fitness in these flies is not only important for predicting when they are likely to be the most destructive, but also for the tailoring management strategies such as the sterile insect technique (SIT). It is therefore vital to translate laboratory estimates of performance to real world conditions.

Another strategy for the prediction of Ceratitis population phenology is the use of day-degree (DD) models. Associations between climatic variables and species phenology are used to predict peak abundance and plan management strategies accordingly. However, there is often significant mismatch between model predictions and realised abundance measures, indicating an absence of important information. Temperature is often used as a proxy for climate in general; however, abiotic variables occur in concert and the relationship between may not always be linear. Understanding the impact of multiple climate variables, such as temperature and humidity, may significantly improve our understanding of development in Ceratitis and improve DD models substantially.

We found a vast improvement in thermal tolerance when the thermal history of the flies matched the conditions of the assay (e.g. prior cold acclimation before cold stress) across laboratory, semi- and field performance assays. This also corresponded with a significant decrease in tolerance and performance when there was a mismatch between thermal history and environment. We recommend that future SIT practices maintain flies at thermal conditions similar to those of the intended site in order to maximise performance in these conditions. As adult acclimation generally resulted in similar or better acclimation effects compared to that during developmental life stages, this acclimation phase could adequately occur at the end of the production process and not disturb normal insect husbandry practices.

The development time assays in both C. capitata and C. rosa highlight the strong effect that temperature and humidity have on successful recruitment. For C. rosa in particular, it was not possible to find conditions appropriate for development under our experimental conditions, indicating a high level of sensitivity to sub-optimal conditions in this species. Due to the non-linear association between temperature and humidity on development, particularly at high temperatures, we recommend that day-degree models should be expanded to incorporate the interaction between high temperatures and humidity on development in C. capitata. This may greatly improve predictions made from these models in natural systems.

04 MEASUREMENT AND EVALUATION OF THE EFFECT OF SOIL FACTORS ON RING NEMATODES (CRICONEMOIDES XENOPLAX)

NEMATOLOGY
Researcher: H. Hugo

The objective of this project was three-fold: (1) to determine if soil factors such as soil texture and pH have any effect on ring nematode (Criconemoides xenoplax) (RN); (2) determine the vertical distribution of RN in soil for different crops; and (3) determine if RN populations exhibit seasonal fluctuations.

Samples received at ARC Infruitec-Nietvoorbij's nematode diagnostic service and at Nemlab were selected for their RN numbers: either classified as "low" (< 250 RN/250 cm-3 soil) or "high" (> 1 000 RN/250 cm-3 soil). Seventy-two samples were thus selected, representing all the major fruit and vine areas of the Western Cape, and also the Lower Orange River.

Soil from these samples was analysed for five different soil fractions, namely coarse sand, medium sand, fine sand, loam, and clay.

Our results show that the different soil fractions had no effect on RN numbers and that high RN numbers occurred in all types of soil, both sandy and clayey type soils.

The results also showed that pH values ranging between 4.5 – 7.0 had no effect on RN numbers.

To determine the vertical distribution of RN and also if seasonal fluctuations occur, a vineyard and a nectarine orchard was sampled in January, April, July, and October. Samples were taken at 20 cm intervals down to 1 m deep. Although RN numbers decreased below 60 cm depth, their numbers were still high enough at the 80-100 cm depth to cause serious damage. No seasonal fluctuations were observed.

The outcome of this project was:
1. This study confirms that soil fractions do not affect RN numbers;

2. Although almost 50% of the RN population present in a plant's root zone occurs in the top 40 cm soil, damaging high levels can occur to at least 1 m deep, posing a serious problem for effective nematode control. These high nematode numbers below the zone that can be effectively fumigated provide a source for re-infecting replanted vineyards and orchards;

3. Seasonal fluctuations do not occur, therefore samples for diagnostic analysis can be taken at any time of the year.

05 INVESTIGATIONS INTO THE SURVIVAL OF RING NEMATODE (CRICONEMOIDES XENOPLAX) IN SOIL

NEMATOLOGY
Researcher: H. Hugo

The objective of this project was to study the survival of ring nematode (RN) (Criconemoides xenoplax) in soil in the absence of a host.

Three separate studies were done. In the first study, soil containing RN was stored in plastic bags at 0,5 -2,0 °C in a cold storage room. RN numbers were monitored monthly. After nine months 52% of the original population was still alive, indicating that RN can survive in adverse conditions and in the absence of a host for at least nine months.

In the second trial two orchards were studied where stone fruit trees were removed in March and replanted in August of the same year. In both orchards the few months (March to August) were not long enough for the RN population to die out completely. In the one orchard the RN numbers did initially decline, but reached damaging levels by the end of the first summer. In the second orchard the RN did not drop below 500 RN/250 -3 soil in the period between tree removal and replanting.

In the third trial trees were replanted after 15 months of fallow. In this case RN numbers stayed below damaging levels (< 500 RN/250 cm-3 soil) for seven months after planting, when monitoring was terminated. This aspect of leaving soil fallow for a year should be further researched, as it could possibly be one of the tools in our arsenal to manage RN.

The outcomes of this project are:
1. RN is hardy and can survive for at least nine months in the absence of a host;

2. We strongly recommend that stone fruit orchards are not replanted in the same year that the old trees are removed, as RN populations do not decline to acceptably low enough levels in such a short period.

06 INTEGRATED MANAGEMENT OF APPLE SCAB

PLANT PATHOLOGY
Researcher: C. Lennox

The effect of leaf shredding on fruit and leaf scab incidence and severity was tested against a non-shredded, non-sprayed negative control, a positive control that followed a commercial fungicide programme and a combined treatment of a commercial fungicide programme with leaf shredding, from 2010 to 2013. Reductions in fruit and leaf scab incidence and severity in the leaf shredding treatment were significantly lower compared to the negative control. Quantitative real-time polymerase chain reaction (qPCR) of airborne ascospores trapped using volumetric spore traps was used to measure the reduction in airborne ascospores in the shredded plots, and confirmed the efficacy of shredding found by comparing scab incidence and severity on fruit and leaves. Shredding twice during leaf-drop increased the efficacy of the treatment. Results indicate that leaf shredding should be integrated into scab management strategies in future. However, practical considerations unique to South African orchards, e.g. timing of leaf shredding relative to leaf-drop and orchard layouts, need to be addressed.

Pseudothecial densities (PD, number of pseudothecia per fertile lesion) and ascal densities (AD, number of asci per pseudothecium) were compared between in Koue Bokkeveld (KB), a cold winter region, and Elgin (EL), a warm winter region experiencing climate warming, in 2012 and 2013. Scabbed leaves were detached during leaf-drop and overwintered in their region of origin and in the other region. The PD in leaves collected in KB and overwintered in KB was significantly higher than for leaves collected in EL and overwintered in EL, and leaves collected in KB and overwintered in EL. These results agreed with what was expected, as temperature during pseudothecial formation (i.e. the first four weeks after leaf-drop) was significantly lower in KB than in EL. However, the PD for leaves collected in EL and overwintered in EL did not differ significantly from EL leaves overwintered in KB. AD values in all treatments did not differ significantly from one another. Results suggest that factors other than temperature may be involved in controlling PD, e.g. the EL population may include strains not present in the KB population, with higher optimal temperatures for pseudothecial formation.

Apple buds and pygmy apples were collected and tested for presence, number and viability of conidia in 2010, 2011 and 2012. Pygmy apples are small, late season fruit that remain attached to the tree throughout winter, especially in regions with warmer winters where trees do not experience sufficient chilling to complete dormancy. High conidial numbers were found on outer bud tissue and low numbers on inner bud tissue, but viable conidia were only found on inner bud tissue, using microscopy, and generally in orchards with high scab levels in the previous season. Molecular methods using PCR-RFLP and qPCR confirmed the presence of high amounts of V. inaequalis DNA in outer bud tissues, although calculated conidial amounts were higher than data obtained when using microscopy, which could indicate presence of mycelia not detected during microscopic examination. Higher numbers of conidia with higher percentage viability were found on pygmy apples, which are a more likely source of asexual inoculum in South African apple orchards than the low number of viable conidia on inner bud tissue.

07 A SURVEY OF ROSELLINIA IN APPLE ORCHARDS AND NURSERIES IN SA

PLANT PATHOLOGY
Researcher: K. Bezuidenhout

White root rot of apple is caused by Rosellinia necatrix and causes the decline and death of trees. It occurs on many woody hosts commonly cultivated in Mediterranean climates such as grapevines, olives, pears and peaches. In this survey it was isolated from infected apple trees collected in the Western Cape and characterised with species-specific primers (R2 and R7) and sequencing of the ITS region. This is the first time Rosellinia necatrix collected from orchards in South Africa was identified by this means. The 40 isolates were all identified as Rosellinia necatrix and it is suspected that there is low diversity in the population associated with apple in South Africa. The typical symptoms included sparse foliage and small fruit, rotten roots, discolouration of the wood below the bark at soil level and in some instances white mycelial networks on the root surfaces. This disease has the potential to be a serious threat to the apple industry.

Various parties in the apple industry have reported recent apple tree deaths, apparently caused by Rosellinia (white root rot). This could potentially be a serious threat since this fungal disease is known to be aggressive (can kill trees within a single season) and is difficult to control. Therefore this project aimed to sample dying apple trees from various growing regions, including orchards and nurseries, to determine the extent of the problem. Rosellinia can easily be confused with Armillaria mellea or other root diseases such as Phytophthora and therefore samples have to be analysed by a plant pathology laboratory and identified accurately by means of DNA analysis.

Rosellinia was isolated from apple trees collected from five farms in the Villiersdorp and Grabouw/Elgin regions (Table 2), but none was isolated from the trees collected in the Koue Bokkeveld region. Rosellinia root rot does occur in apple orchards in the Koue Bokkeveld region (B. Wessels personal communication), but during this survey all symptomatic trees were removed shortly before the farms were visited. The typical symptoms observed included sparse foliage and small fruit (Fig. 1a), rotten roots, discolouration of the wood below the bark at soil level (Fig. 1b-d) and in some instances white mycelial networks were visible on the root surfaces (Fig. 1e-f). When mycelium was viewed under a light microscope, typical pear-shaped swellings at the septa were visible (Fig. 1g). In most instances the orchards in all areas affected by Rosellinia were more than 5 years old, but young trees used for replanting at these sites also got infected and died. No Rosellinia was isolated from current season rootstock material collected in the nurseries, but it was found in an old 'abandoned' rootstock block at one of the nurseries.

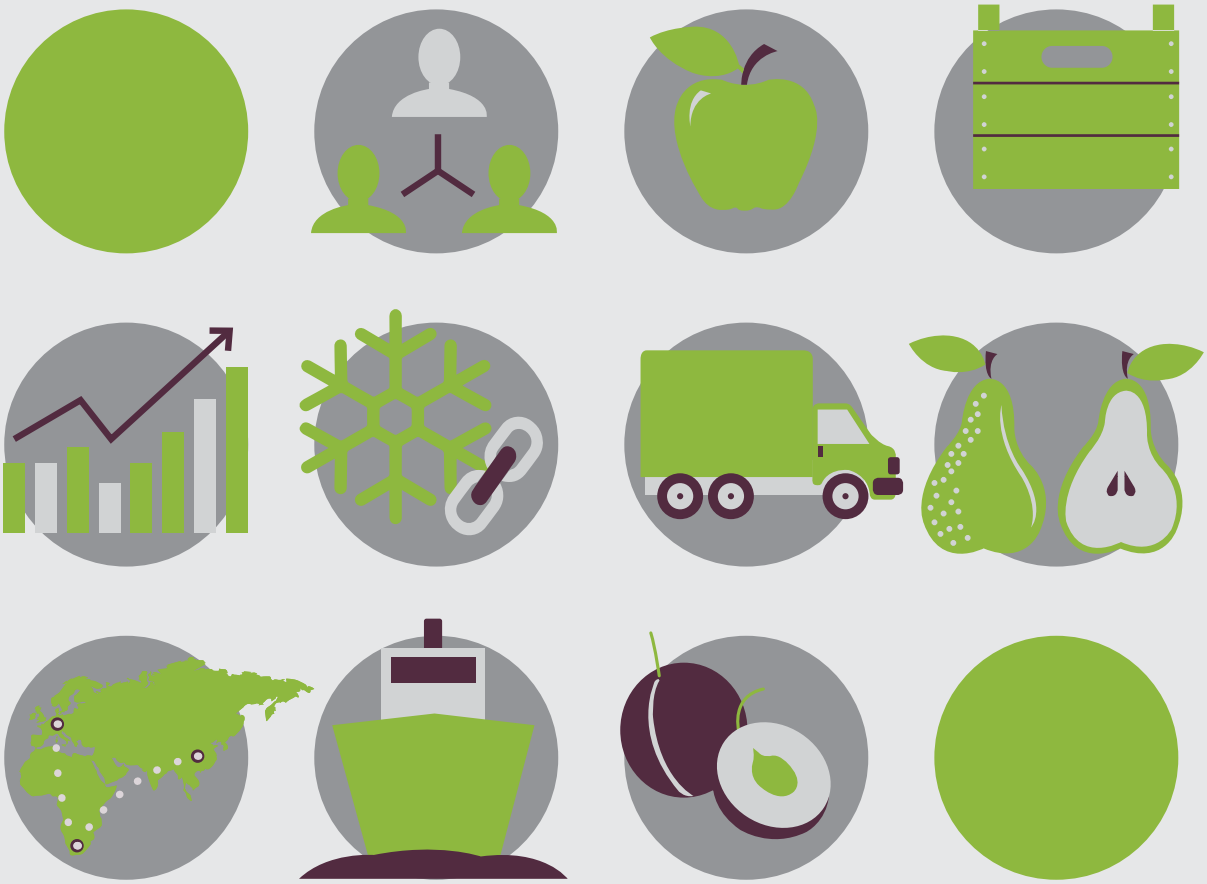
Rosellinia root rot of apple in South Africa was first reported by Van der Merwe and Matthee in 1971. In a subsequent study they collected apple and pear trees with die-back symptoms and isolated Rosellinia necatrix from infected roots (Van der Merwe and Matthee 1974). These identifications were based on the colour of older hyphae as well as pear-shaped swellings at the septa.

Due to a recent increase in the number of reports of this disease on apple, a survey was conducted in the main apple producing regions of the Western Cape Province to identify the causal organism by means of molecular characterisation and to determine the extent of the occurrence of these infections. This is the first time Rosellinia necatrix collected from orchards in South Africa was identified by this means. The pathogen has been reported from all the main apple production areas namely Ceres, Langkloof, Somerset West and Elgin (van der Merwe and Matthee 1974; Trench et al. 1992), although it could not be detected in the Koue Bokkeveld area during this survey. The sequence data revealed that there was no variation in the 40 isolates examined, which might be an indication of low population diversity such as reported by Armengol et al (2010) in a population from tiger nut in Spain.
Delatour and Guillamin (1985) observed that R. necatrix found optimal conditions in soils which are rich in non-decomposed organic material such as forest soils. Pérez-Jiménez (2006) also states that the development of R. necatrix is encouraged when vegetable debris is incorporated into the soil, since slow-decomposing organic matter activates the parasitic activity. This fact might partially explain the recent increase in the occurrence of this pathogen in the South African apple industry, since producers aim to increase soil organic matter to obtain higher production and improve soil health. Soil organic matter is increased by means such as compost application or mulching with organic material, which can then provide Rosellinia with decomposing matter.

White root rot poses a serious risk to the apple industry, since there is currently no chemical control registered for use against Rosellinia root rot in South Africa. Producers have to remove infected orchards and fumigate the soil before they can replant. Fumigation is very expensive and not always completely effective, since the pathogen can survive in old root debris or can infest the fumigated area from adjacent untreated soil. Using a fallow period as control measure is also not an option, since the pathogen can survive in the soil for many years (López-Herrera 2000).

Planting of alternative crops in Rosellinia affected soils should also be done with caution. In recent years some pome fruit orchards have been removed in the Grabouw/ Elgin region, mostly as a result of climate change, and replaced with vineyards. Rosellinia necatrix is a serious disease of grapevine and has the ability to kill infected plants within one or two years after planting. Even olive trees are also hosts to Rosellinia necatrix and can therefore also not be used for replanting old sites. Considerable research effort is necessary to prevent serious losses to the fruit industries in future.

POST HARVEST



'OUR GOAL IS INTRINSIC PRODUCT INTEGRITY.'

2014 PRODUCT INTEGRITY THROUGH THE CHAIN (POST-HARVEST) PROGRAMME

The essence of this programme is to support and enhance the processes across the supply-chain to ensure that intrinsic product integrity is maintained, and that a quality product is available to the end-consumer in local and distant global markets. The objective of this Investment Focus Area (IFA) is to increase the marketable tons of fruit delivered per ton of fruit loaded.

The themes of this programme include:

- Protocols and fruit quality maintenance
- Storage techniques
- Market access
- Decay control
- Fruit quality prediction
- Chemical residue reduction/alternatives
- Packaging
- Transportation systems

A great deal of effort has gone into the latest Post-Harvest Innovation (PHI) programme to ensure additional funding and projects for the Industry. This time, PHI required a 1:1 funding ratio for their two-year (2015/2016) sector plan. Bursaries are funded separately by PHI, which in some cases relates to a 70:30 PHI/Industry funding ratio. At the time of writing, a PHI contribution of R3,7 million, plus R1,68 million for bursaries (total R5,38 million), has been secured over a 2-year period.

STONE FRUIT

The study on broken stones on plums has shown that climate has an effect on the incidence. A combination of rapid fruit growth and a softer stone in susceptible cultivars results in the stone being pulled apart by the mesocarp. While calcium nitrate treatments increased the incidence, potassium silicate sprays reduced the incidence. The research is ongoing, but importantly has been used to substantiate a favourable interpretation of the export standard.

The use of SmartFresh in conjunction with pre-ripening in a 24 day cold-sterilisation at single temperature showed promise for some cultivars. The cultivars being tested include: African Rose, Sapphire, Fortune, Purple Majesty, Southern Belle, Lady Red, Laetitia and Sun Supreme. Temperature pre-conditioning without SmartFresh was not successful for cold-sterilisation of Pioneer, African Rose and Sapphire.

It was found that concentric rings in African Delight are open hairline cracks. The wider the cracks the greater the moisture loss. African Delight, followed by Laetitia, had the highest water vapour permeance. Sunbreez had the lowest water vapour permeance. African Delight should be packed and forced-air cooled as soon as possible to minimise moisture loss.

Studies by Experico showed that scald in African Delight could be reduced by harvesting the fruit at a slightly more advanced maturity. Additional maturity ratios are recommended for this cultivar.

With respect to heat damage, less mature fruit seem to acclimate better than mature fruit. African Delight appears to be a more heat tolerant cultivar.

The use of paper wrappers in a semi-commercial trial on Imperial apricots increased cooling time but reduced mass loss. Wrappers can also be considered on Charisma apricots.

POME FRUIT

Kobus van der Merwe and his team at ARC Infruitec-Nietvoorbij continued with research into alternatives to DPA, including Dynamic Controlled Atmosphere (DCA) technology. ILOS+CA and DCA were the only storage protocols tested which successfully inhibited the development of superficial scald on Granny Smith for 16 weeks storage followed by a handling and shipment period of 6 weeks. DCA storage successfully inhibited superficial scald on Packham's Triumph pears. Current research is focussing on the length of DCA storage required to control scald.

The Forelle Early Market Access (FEMA) programme has been a resounding success with 1 250 000 cartons successfully exported this year. Based on an economists' view of a R20/carton premium, the 2,3 million cartons exported in the first three years yielded a return on investment of R46 million. For every Rand spent on Forelle research since 2000, this amounts to a return of R10. Alternatively stated, the annual return exceeds the total pome research budget! Various other FEMA related trials to look at the maximum delay for 1MCP application, minimum firmness levels and applying the principle on other cultivars are still in process.

The study into mealiness of Forelle by Dr Elke Crouch showed that mealiness is associated with larger cells, larger intercellular spaces and soluble solids content. Near Infra Red (NIR) spectroscopy and X-ray computed tomography can detect and predict mealiness, laying the foundation for non-destructive mealiness pre-sorting.

Research on internal browning on Cripps' Pink by Experico and Stellenbosch University showed that browning incidence is exacerbated by lower maximum temperatures during the growing season. The growing degree day temperature model established by Australian researchers does not seem to apply under our conditions.

The Experico DPA cross-contamination and risk management trial has illustrated the risk of DPA exceedances.

The best post storage quality for Abate Fetel pears after a storage period of 4 months and a simulated storage period of 4 weeks RA at -0.5°C from both the Grabouw and Ceres production areas were stored at CA 1.5% O2+1% CO_2

ACKNOWLEDGEMENTS

Considering the past financial year Considering the past financial year regarding post-harvest research, we can conclude that exciting and promising research results were generated which will, and are, benefiting the pome and stone fruit industries. We commend the researchers from the different research organisations who contributed to the post-harvest programme for their outstanding work. The invaluable contribution made by the members of the post-harvest Peer Work Group and Technical Advisory Committee, who make constructive criticisms of the numerous project proposals and reports, is gratefully recognised. The contribution of the Postharvest Innovation Programme of the Department of Science and Technology to innovation in the post-harvest field is acknowledged

Richard Hurndall

RUNNING PROJECTS

01

Plum

Moisture loss studies in Japanese plums.
Mariana Jooste

02

Plum

Utilisation of SmartFresh to enable successful shipping of dual-temperature plums at a single temperature of -0.6 °C for 24 days to adhere to cold-sterilisation protocols for phytosanitary markets.
Handré Viljoen

03

Plum

Conducting scanning trials on additional dual-temperature regime plums, to enable successful shipping at a single temperature
H. Viljoen.

04

Plum

A study of broken stones in Japanese plums.
Mariana Jooste

05

Plum

Heat damage in plums.
Mariana Jooste

06

Stone

Decay control of tree fruit:
Testing of different control options using fungicides, sanitizers, soft chemicals and biological agents, to identify methods for use on stone fruit.
Ida Paul

07

Apple

Alternatives for the use of DPA: determining the critical minimum DCA storage exposure periods to inhibit superficial scald and the effects of CA storage and RA storage periods following DCA storage on superficial scald development on Granny Smith apples.
Kobus van der Merwe

08

Pear

Determine optimum controlled atmosphere storage conditions for Abate Fetel pears.
Kobus van der Merwe

09

Pear

Determine the effects of Initial Low Oxygen Stress (ILOS) treatment followed by controlled atmosphere storage (CA) and regular atmosphere storage (RA) on superficial scald control of Packham's Triumph pears.
Kobus van der Merwe

10

Pear

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.
Kobus van der Merwe

11

Pear

Extended cold storage of Abate Fetel pears for EU market.
Elke Crouch

12

Pome

Decay control of tree fruit: Testing of different control options using fungicides, sanitizers, soft chemicals and biological control agents, to identify methods for use on pome fruit.
Ida Paul

13

Pear

Identification of factors involved and control of astringency in pears.
Ian Crouch

14

Pear

The influence of cell number and size (cell division) and cell wall bound and free CA2+ on the development of mealiness of Forelle pear, as well as the evaluation of NIR as an early detection method for mealiness.
Elke Crouch

15

Pear

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.*
Ian Crouch

16

Pear

To determine the maximum delay in SmartFresh application from harvest to room filling for fruit destined for the FEMA programme.*
Ian Crouch

17

Pear

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

01 MOISTURE LOSS STUDIES IN JAPANESE PLUMS

Project Leader: M. Jooste

1. Determine if hairline cracks develop in the skin of a susceptible plum cultivar and its possible contribution to pre-storage moisture loss. We investigated, by means of fluorescence microscopy, if the concentric rings found on the pedicel area of 'African Delight' plums were open cracks and if these rings contributed to moisture loss. Fruit were classified according to the water vapour permeance of their skins into three classes, low, medium and high. Fruit were then stained with a fluorescent marker and five skin samples were investigated under a fluorescent microscope for open cracks. Crack width was determined from the microscope images and the classes was compared to each other using a one-way ANOVA. It was found that the concentric rings were indeed open cracks. We classified them as hairline cracks. We also found that fruit with higher moisture loss rates had wider cracks compared to fruit with lower moisture loss rates. It is suggested that careful attention should be paid to proper implementation and management of postharvest handling protocols of 'African Delight' plums with concentric rings on their pedicel ends to prevent moisture loss, and hence, shrivel manifestation.

2. Determine the effect of fruit to fruit variation, harvest date, tree and orchard effects and cultivar differences on water vapour permeance of plum fruit. We investigated the contribution from tree effects, orchard effects, cultivar differences, harvest date and fruit to fruit differences to the total variance of the water vapour permeance of plum fruit. Two trials were done, one focussing on the variation contributed by orchards from the same cultivar, 'African Delight', and the another one focussing on the variation contributed by different cultivars. From each orchard or cultivar five random trees were chosen, from each tree five visually unblemished fruit were harvested and the water vapour ermeance for each fruit was determined. In both trails it was found that fruit to fruit differences made the largest contribution to total variation in permeance (55.1% for trial 1 and 42.5% for trial 2). In trial 1 the different orchards had the second largest contribution (13.1%), followed by variation among trees (8.9%) to the total variation in permeance. In trial 2 differences among cultivars had the second largest contribution (38.3%), with tree effects contributing much less than in trial one (0.6%) to the total variance in water vapour permeance. It was found that 'African Delight' plums had the highest water vapour permeance, followed by 'Laetitia'. 'Sunbreez' had the lowest water vapour permeance. The results will be verified in the 2014/2015 season.

3. Determine the weight loss and contribution of the vapour pressure deficit between harvest and the end of forced air cooling on post-storage shrivel manifestation. We investigated the weight loss and contribution of the vapour pressure deficit between harvest and the end of forced air cooling on post-storage shrivel manifestation. African Delight' plums were harvest from a farm in the Stellenbosch. A total of 10 treatments were selected with 6 replications per treatment. An iButton measuring temperature was inserted into one fruit per rep. An iButton measuring relative humidity and temperature was placed in 5 of the 6 reps. The iButtons were set to log data every 45 minutes for the duration of the trial. Maturity indexing was done at harvest where firmness, hue angle, total soluble solids, acidity were determined. Fruit were weighed at harvest, arrival at the packaging shed, the end of forced air cooling (FAC), after cold storage and after shelf life. Hue angle, shrivel and decay was determined after cold storage and again after shelf life along with firmness and internal defects. It was found that it is best to pack and FAC fruit as soon as possible after harvest to minimize moisture loss. If fruit must be stored before packing it can be done at 0 and 15°C for 72 h or ambient for 24 h. The 0°C and 15°C treatments of the 24 h and 48 h periods did not differ significantly in terms of VPD, neither did it differ from the control. It was confirmed that fruit should not be left at ambient for more than 24 h because it was found that it led to much higher VPD's. Shrivel levels decreased from after cold storage to after shelf life. Fruit held at 0 and 15 °C before packing and FAC had significantly lower shrivel levels after cold-storage compared to the control, while fruit held at ambient for 72 h had significantly the highest shrivel levels after cold-storage, emphasizing that fruit should not be left at ambient.

02 UTILISATION OF SMARTFRESH TO ENABLE SUCCESSFUL SHIPPING OF DUAL-TEMPERATURE PLUMS AT A SINGLE TEMPERATURE OF -0.6 C FOR 24 DAYS TO ADHERE TO COLD-STERILISATION PROTOCOLS FOR PHYTOSANITARY MARKETS

Project Leader: H. Viljoen

1. This project was conducted to establish if SmartFreshSM application and warming treatments utilizing during cold storage can counter quality losses which may develop during cold-steri treatment of traditional dual-temperature stored plums.

2. Three cultivars were sourced from Franschhoek, and subjected to the different treatments and temperature regimes as indicated in the report. The fruit were evaluated after cold storage and after a shelf life period of 5 days at 10°C.

3. Cultivar differences were expressed. However, in general, quality of the three cultivars were best maintained by application of SmartFreshSM before the accumulation period, followed by warming for 10d at 7.5°C before shipping [T1], or by applying SmartFreshSM before the accumulation period, followed by no warming before cold-steri shipping [T6], keeping firmness and the least shrivel and internal defects. Quality maintenance was worst by not applying SmartFreshSM before the accumulation period, followed by no warming or 3d warming at 20°C before shipping [T7 and T5, respectively], or by applying SmartFreshSM before the accumulation period, but warming the fruit for 3d at 20°C before shipping [T4], or warming the fruit for 14d at 7.5°C before shipping [T2].

4. The results found in this year's project needs to be confirmed, since growing conditions across seasons may affect the reaction of the fruit to the treatments along with the cold-steri conditions.

03 CONDUCTING SCANNING TRIALS ON ADDITIONAL DUAL-TEMPERATURE REGIME PLUMS, TO ENABLE SUCCESSFUL SHIPPING AT A SINGLE TEMPERATURE

Project Leader: H. Viljoen

1. This project was conducted to establish if SmartFreshSM application and warming treatments utilized during cold storage can counter quality losses during cold-steri treatment of traditional dual-temperature stored plums.

2. Five cultivars were sourced from Franschhoek, and subjected to the different treatments and temperature regimes as indicated in the report. The fruit were evaluated after cold storage and after a shelf life period of 5 days at 10°C.

3. Cultivar differences were expressed. However, in general, quality of the five cultivars were well maintained by application of SmartFreshSM before the accumulation period, followed by warming for 14d at 7.5°C, before shipping and a cold-steri period of 24d at -0.55°C, maintaining firmness best especially when fruit are subjected to shelf life after cold storage. Shrivel and decay levels may occur, therefor further populations need to be accessed to confirm the findings. Cold-steri treatment is an option for the dual-temperature plum cultivars, if combined with SmartFreshSM, when this becomes a requirement for certain export markets.

4. The results of 2014 needs to be confirmed, since growing conditions across seasons may affect the reaction of the fruit to the treatments along with the cold-steri conditions.

04 A STUDY OF BROKEN STONES IN JAPANESE PLUMS

Project Leader: M. Jooste

1. Objective 1: Evaluate the effect of climate and growing area on the incidence of broken stones in a susceptible plum cultivar. The effect of climate and growing area on the incidence of broken stones in 'Laetitia' plums was evaluated.

Fruit were sampled from three farms each in Stellenbosch and Robertson twice a week from 4 weeks after full bloom (AFB) until the end of stone hardening and once a week thereafter until the optimum harvest date. Sixty fruit per farm were measured and inspected for the presence of broken stones on each sampling date.

Stone breakage increased during the onset of stone hardening, but decreased as the season progressed, likely due to the removal of malformed fruit during fruitlet thinning as fruit with severely broken stones are often malformed.

Negative correlations were observed between broken stones and average fruit diameter as well as diametric growth day-1 and this seemed to be due to rapid increase in fruit length during the same period. Rapid lengthwise growth seems to pull the stone apart near the apical end of the fruit.
Concurrently, lower night temperatures during stone hardening seemed to lead to enhanced fruit growth and delayed stone hardening. The combination of these factors led to an increased incidence of broken stones, due to strong pulling forces by the mesocarp on the endocarp before it has hardened completely. Average fruit diameter, diametric growth day-1 and low night temperatures before pit hardening might, therefore, be used to predict the occurrence of broken stones early in the season. This will be verified in the 2014/2015 season.

2. Objective 2: Determine how susceptible and non-susceptible plum cultivars differ regarding their growth patterns during the season to get a better understanding of the development of broken stones.

The fruit growth patterns between a susceptible and non-susceptible plum cultivar were compared to get a better understanding of stone breakage.

Heavy and standard thinning treatments were carried out to create a contrast in fruit size in order to also evaluate the effect of fruit size on the incidence of broken stones. Fruit were sampled weekly from 4 weeks AFB until optimum harvest date. Six fruit per cultivar were also used to create 3D computed tomography (CT) scans.

The incidence of broken stones was lower in 'Songold' than in 'Laetitia'. This is probably due to the earlier onset of stone hardening, higher dry weight accumulation and denser endocarp of 'Songold'. In both cultivars hardening of the endocarp started at the distal end and progressed towards the apical end of the fruit from approximately 4 weeks AFB. In 'Laetitia', stone breakage generally occurred near the apical end of the fruit. This part of the fruit also showed the most radial growth as well as the lowest stone density. Therefore, the rapid growth at the apical end of the fruit, coupled with the 'softer' stone in this part probably resulted in the stone being pulled apart by the mesocarp. This result will be verified in the 2014/2015 season.

3. Objective 3: Determine if calcium nitrate and potassium silicate applications can reduce the incidence of broken stones in a susceptible cultivar.

To determine their effect on broken stone incidence in 'Laetitia' plums, foliar sprays of calcium nitrate Ca(NO3)2 (at weekly intervals) and potassium silicate (K2O3Si) (at 10 day intervals) were applied from 3 weeks AFB until stone hardening. At the optimal harvest date, trees were stripped and the fruit were inspected for the presence of broken stones. Maturity indexing was performed at harvest and quality evaluations were performed after 42 days of cold storage as well as after 7 days of simulated shelf life.

We found that Ca(NO3)2 sprays caused a significantly higher incidence of broken stones while the K2O3Si treatment had the lowest incidence. It is likely that the silicate treatment increased the elasticity of the cell walls of the endocarp. Increased elasticity would better enable the stones to resist breakage due to the strong pulling forces exerted on it by the expanding mesocarp. None of the treatments had negative effects on yield or fruit quality parameters. The results will be verified in the 2014/2015 season.

05 HEAT DAMAGE IN PLUMS

Project Leader: M. Jooste

1. The heat tolerance of 'Laetitia' plums of different harvest maturities and 'African Delight' at uniform maturity was evaluated by subjecting the fruit to 30, 40 and 45°C for 1, 2 and 3 hours.

2. Rates of evolution for carbon dioxide, ethylene and ethanol and glutathione and ascorbic acid concentration fruit quality and internal heat damage were measured after simulated heat wave conditions and again after cold storage and shelf life. Although internal defects only became apparent after cold storage, less mature fruit were generally immediately more responsive to changes in heat exposure and duration. While high temperatures were inhibitory to respiration, the rate decreased with longer heat exposure in less mature fruit, accumulating higher internal ethanol content. Less mature fruit exposed to the highest temperature had low defects after cold storage but high antioxidant concentrations just after heat exposure. Internal defects were negligible in 'African Delight', but peel damage increased with increased heat exposure. Effects of heat exposure became less clear after shelf life.

3. Less mature fruit seem to acclimate better when exposed to adverse conditions causing heat damage possibly by synthesising a high concentration of ascorbic acid. 'African Delight' appears to be a more heat tolerant cultivar.

06 DECAY CONTROL OF TREE FRUIT: TESTING OF DIFFERENT CONTROL OPTIONS USING FUNGICIDES, SANITIZERS, SOFT CHEMICALS AND BIOLOGICAL AGENTS TO IDENTIFY METHODS FOR USE ON STONE FRUIT.

Project Leader: I. Paul

1. Postharvest decay of stone fruit remains a challenge to the South African stone fruit industry. However, only a few fungicides are registered for disease control. In a previous study, effects of several fungicides, sanitizers and biological control agents were tested for their in vitro inhibition or fungicidal action against Botrytis cinerea and Monilinia laxa. Fungicidal effects were found for three registered fungicidal chemicals, namely Chlorine, Iprodione and Fludioxonil, as well as for peracetic acid. Fungistatic effects in vitro were measured for three biological control agents with active antagonists Trichoderma harzianum, Bacillus subtillis and Cryptococcus albidus respectively. In follow up studies, conducted this year, two trials to further investigate the potential for these products to control decay on stone fruit in vivo were done. One trial investigated the in vivo fungistatic and fungicidal effects of Fludioxonil, and all three biological control agents when wounded fruit was first infected with Botrytis cinerea or Monilinia laxa, and droplets of the products were carefully placed in the wounds on fruit individually. A second trial on nectarines investigated decay control, only for Botrytis cinerea, when biological control agents, the three previously tested fungicidal products and a bio-sanitizer containing peracetic acid were applied at three different concentrations (0.5, 1 and 2X registered dosage) with an atomizer. Results on plums for B. cinerea and M. laxa indicated that only Fludioxonil was fully fungicidal. The biological control product containing B. subtillis exhibited some fungistasis against B. cinerea, whilst the product containing C. albidus exhibited some fungistasis against M. laxa. In all other treatments (C. albidus and T. harzianum for B. cinerea and B. subtilis and T. harzianum for M. laxa) decay was not significantly different from that of the untreated control. Results for nectarines indicate no significant differences when applying Fludioxonil or Iprodione, for which full decay control was obtained, at three different concentrations (0.5, 1 and 2X registered dosage). Decay control by chlorine followed, but it was significantly less than that obtained with Fludioxonil and Iprodione. Fungistatic properties by biological control against B. cinerea were measured in most (except one treatment – highest dosage, C. albidus) treatments, which resulted in decay levels significantly less than that of the untreated control. However, inhibition of decay by these products was not sufficient to be considered for commercial use by the industry.

07 ALTERNATIVES FOR THE USE OF DPA: DETERMINING THE CRITICAL MINIMUM DCA STORAGE EXPOSURE PERIODS TO INHIBIT SUPERFICIAL SCALD AND THE EFFECTS OF CA STORAGE EXPOSURE PERIODS TO INHIBIT SUPERFICIAL SCALD AND THE EFFECTS OF CA STORAGE AND RA STORAGE ON SUPERFICIAL SCALD DEVELOPMENT ON GRANNY SMITH APPLES.

Project Leader: K. Van der Merwe

1. To determine the critical minimum Dynamic CA storage exposure periods followed by RA and CA storage to inhibit superficial scald on 'Granny Smith' apples as an alternative to diphenylamine (DPA) treatment for the prevention of superficial scald development.
2. Granny Smith' apples from the Ceres or Grabouw production area, harvested at a pre-optimum and optimum maturity were used in the 2013 trials (MSc and PhD students involved). Fruit were stored at DCA conditions for 6, 16 and 24 w followed by a RA period of 6 w and subsequently subjected to shelf life periods of 0, 7 and 14 d at 20°C (MSc student). Additional trials were conducted on fruit were stored at DCA conditions for 5 d, 2 w, 4w, 8w, 12w, and 16 w and then subjected to additional RA periods for 4 w and 10 w and shelf life periods for 0, 7 and 14 d at 20°C to determine the critical minimum exposure periods to control superficial scald accurately. Effects of intermittent DCA periods with the same exposure periods were also conducted (PhD student). 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 on fruit during evaluations.

3. DCA was thoroughly tested for three seasons and proved to be a good alternative to the use of DPA to control superficial scald control. A project with the same objectives should be registered for conducted for 'Packham's Triumph' pears. The technique is recommended to industry as one of the effective alternatives to the use of diphenylamine and implemented by several institutions.

08 DETERMINE OPTIMUM CONTROLLED ATMOSPHERE STORAGE CONDITIONS FOR ABATE FETEL PEARS

Project Leader: K. Van der Merwe

1. Determine the optimum CA storage conditions for Abate Fetel pears in order to advise industry on the correct CA storage conditions to maintain the best fruit quality.

2. Abate Fetel pears at optimum maturity from the Ceres and Grabouw production areas will be stored at conventional CA conditions of 1.5% O2 in combination with 0% CO2 and 1% CO2 and a 6% O2 and 0% CO2 at -0.5°C for periods of 4 and 6 months followed by a simulated shipment period of 4 weeks at RA storage and shelf life periods of 0 and 7 days at 20°C. Fruit quality will be evaluated according to industry standards.
3. Abate Fetel pears from the Grabouw production area, stored at CA 1.5% O2+1% CO2 were of the best post storage quality after a storage period of 4 months and a simulated storage period of 4 w RA at -0.5°C followed by a shelf life period of up to 7 d at 20°C.

The 6 months storage period and simulated storage period of 4 w RA at -0.5°C followed by a shelf life period of up to 7 d at 20°C was too long for the pears and gas regimes should be modified and tested for a longer storage life.

Abate Fetel pears are susceptible to CO2 damage (2.5%) and CO2 gas regimes with a CO2 concentration of 0% should be tested in the next season. The project should continue for at least three seasons.

09 PROJECT TITLE: DETERMINE THE EFFECTS OF INITIAL LOW OXYGEN STRESS ILOS TREATMENT FOLLOWED BY CONTROLLED ATMOSPHERE STORAGE (CA) AND REGULAR ATMOSPHERE STORAGE (RA) ON SUPERFICIAL SCALD CONTROL OF PACKHAM'S TRIUMPH PEARS

Project Leader: K. Van der Merwe

1. To find an industry applicable alternative treatment for the control of superficial scald on Packham's Triumph pears. Determine the efficacy of ILOS treatment to control of superficial scald on Packham's Triumph pears. To determinate the incidence of superficial scald on CA and RA stored fruit following ILOS treatment during storage periods.
2. Packham's Triumph pears apples from the Grabouw production area, harvested at optimum maturity were used in the trials starting in 2013 and which will be repeated over three seasons. Fruit of treatments will be stored at ILOS conditions followed by CA and RA as well as DCA conditions for 10 d, 6 w and 16 w at -0.5°C followed by a handling and shipment RA period of 6 w and subsequently subjected to a shelf life period of 0, 3 and 7 d at 20°C. Quality evaluation will be conducted according to industry standards on fruit of each treatment combination during each storage period. The main focus will be on the development of superficial scald on fruit during evaluations.

3. ILOS+CA and DCA were the only storage protocols tested which successfully inhibited the development of superficial scald for 16 w storage followed by a handling and shipment period of 6 w followed by shelf life periods of 0 and, 3 and 7 d at 20°C.

DEVELOPMENT AND RETENTION OF SKILLS.

10 DETERMINE THE CRITICAL MINIMUM DYNAMIC CONTROLLED ATMOSPHERE (DCA) STORAGE EXPOSURE PERIODS TO EFFECTS OF CA AND RA STORAGE PERIODS FOLLOWING DCA STORAGE ON SUPERFICIAL SCALD DEVELOPMENT OF PACKHAM'S TRIUMPH PEARS

Project Leader: K. Van der Merwe

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

2. To find an industry applicable alternative treatment for the control of superficial scald on Packham's Triumph pears. Determine the efficacy of DCA treatment to control of superficial scald on Packham's Triumph pears. To determinate the incidence of superficial scald on DCA, CA and RA stored fruit during storage periods.

3. Packham's Triumph pears from the Grabouw production area, harvested at optimum maturity will be used in the trials, which will be repeated over three seasons. Fruit of treatments will be stored at DCA conditions for 10 d, 6 w, 16 w and 24 w followed by a RA period of 6 w and subsequently subjected to a shelf life period of 0, 7 and 14 d at 20°C. Quality evaluation will be conducted on fruit of each treatment of each storage period combination according to industry standards. The main focus will be on the development of superficial scald on fruit during evaluations.

4. DCA storage successfully inhibited superficial scald for 24 weeks on pears during the past season and can be used as an alternative to the use of DPA. Trials must be repeated over the next two seasons to confirm results.

11 EXTENDED COLD STORAGE OF ABATE FETEL PEARS FOR EU MARKET

Project Leader: I. Crouch

1. The objective of the trial is the successful storage of Abate Fetel pears under controlled atmosphere (CA) and regular atmosphere (RA), without compromising the fruit quality of the fruit, through development of soft scald, decay, colour break or flesh softening. Abate Fetel pears were subjected to long term (6 months) and short term (3 months) CA storage in combination with SmartFreshSM treatments, to compare the post-storage quality of fruit subjected to regular long term CA (6 months CA, no SmartFreshSM) storage. The 3 month CA storage plus SmartFreshSM treatment had the best results, similar to 2012, compared to the other two treatments. Lower (significantly in some populations) incidence of internal browning and CO2 damage was noted compared to the other two treatments. There was also no development of any scald on these fruit. This cold storage regime could potentially be a solution for the long term storage of Abate Fetel pears. The trial should be repeated in 2014, with emphasis on the 3 month CA storage with fruit pre-treated at harvest with SmartFreshSM followed by different RA storage durations.

12 DECAY CONTROL OF TREE FRUIT: TESTING OF DIFFERENT CONTROL OPTIONS USING FUNGICIDES, SANITIZERS, SOFT CHEMICALS AND BIOLOGICAL CONTROL AGENTS, TO IDENTIFY METHODS FOR USE ON POME FRUIT.

Project Leader: I. Paul

Abstract will be available in February 2015.

13 IDENTIFICATION OF FACTORS INVOLVED AND CONTROL OF ASTRINGENCY IN PEARS

Project Leader: I. Crouch

1. The effect of harvest maturity and storage duration on the expression of astringency in Cheeky and Forelle pears was investigated. The influence of SmartFreshSM and CO2 spiking on the expression of astringency in Forelle pears was assessed.

2. Although astringent fruit were found in this trial, data for Cheeky was inconclusive as to the effect of harvest maturity and storage duration. After 12 weeks cold storage, astringency was noted in harvest 2 and harvest 3 fruit of one population each. Levels appeared to decline the longer the fruit were stored. A shelf life period resulted in a drop in astringency. No mealiness was noted in Cheeky directly after cold storage, regardless of population or storage duration. Fruit subjected to shelf life after cold storage for 6 weeks exhibited low levels of mealiness, disappearing in total as the storage duration was increased.

between TSS (%) and mealiness shows possible potential of NIR spectroscopy as a non-destructive tool for determining internal fruit quality and possibly mealiness of 'Forelle' pear. X-ray CT showed that mealy 'Forelle' pears have significantly larger volume of voids compared with non-mealy ones both at the end of cold storage and after ripening.

4. 'Forelle' mealiness is related to larger cells and higher void volumes and NIR has potential in predicting TSS and possibly a model relating to early mealiness detection or prediction.

3. Astringency levels generally decreased the longer Forelle were stored. Albeit not significant, both SmartFreshSM and CO2 treatments resulted in increased levels of astringent fruit. The addition of CO2 resulted in a slight reduction of astringent fruit compared to the SmartFreshSM alone. High levels of mealiness was only noted in untreated Forelle cold stored for up to 8 weeks, followed by a shelf life period, decreasing as the storage duration was extended.

4. The trial will be amended to conduct maturity profiling of Cheeky. The astringency quantification method will proceed as per milestone.

14 THE INFLUENCE OF CELL NUMBER AND SIZE (CELL DIVISION) AND CELL WALL BOUND AND FREE CA2+ ON THE DEVELOPMENT OF MEALINESS OF FORELLE PEAR, AS WELL AS THE EVALUATION OF NIR AS AN EARLY DETECTION METHOD FOR MEALINESS.

Project Leader: E. Crouch

1. 'Forelle' pear research refers to the possible involvement of cell-to-cell adhesion in mealiness development. The objective of this study was therefore determining the role of cell size (diameter and cell volume) and number in the development of mealiness of 'Forelle' pears.

2. X-ray computed tomography (X-ray CT) was used to examine internal cellular differences between mealy and non-mealy pears. Models based on Fourier Transform NIR spectroscopy were used for a possible prediction of mealiness related parameters. 'Forelle' pears were harvested from four farms in the Ceres and Wolsley areas. Cell numbers and size variations in fruit were incited by application of different combinations of plant growth regulators. Scanning electron microscopic techniques and software were used to count cells and measure dimensions. Regression techniques were used to establish the role of cell number and size in mealiness development.

3. Plant growth regulators did not influence yield but had variable effects on fruit cell diameter, cell volume and cell numbers. Mealiness (%) was found to be positively correlated with cell diameter and volume. No relationship existed between cell numbers and mealiness. SEM micrographs indicated that the combination of larger cells and larger intercellular volume produced high incidences of mealiness. The good correlation between spectral information and TSS (%) and the relation

15 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

Project Leader: I. Crouch/P. van der Merwe

1. The aim of this study is to determine if pear cultivars such as Williams' Bon Chretien and Abate Fetel pears 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}.

2. Williams' Bon Chretien and Abate Fetel pears were subjected to a SmartFresh^{SM} (600 ppb) application within 1 day of each of three harvests and enclosed within (industry 37 µm PE liner bags) to simulate shipping 4 weeks before the end of the cold storage periods of 4, 8 and 12 weeks at -0.5°C. Post storage quality of fruit was evaluated at the end of the cold storage period and again after a shelf life period of 7 days at 20°C.
3. Ripening of Williams' Bon Chretien pears was successfully retarded by the application of SmartFreshSM. Pears subjected to SmartFresh^{SM} exhibited greener fruit, decreased incidence of especially senescent breakdown, and lower internal ethylene levels than untreated control fruit.

Ripening of Abate Fetel pears was also successfully retarded by the application of SmartFresh^{SM}. Fruit subjected to SmartFresh^{SM} exhibited greener fruit with lower internal ethylene levels compared to the untreated control fruit and was more appealing than the untreated fruit.

4. A consumer acceptance study needs to be conducted to determine if consumers will accept firmer Williams' Bon Chretien and Abate Fetel pears or if they will still prefer the a more conventional 'sweet and juicy' taste.

16 TO DETERMINE THE MAXIMUM DELAY IN SMARTFRESH APPLICATION FROM HARVEST TO ROOM FILLING FOR FRUIT DESTINED FOR THE FEMA PROGRAMME

Project Leader: I. Crouch

1. Forelle pears from two populations were treated 7, 9, 14 and 21 days after harvest with SmartFreshSM (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. Standard efficacy results indicated that successful treatments were obtained in both populations.

2. Fruit treated 7, 9 and 14 days after harvest exhibited firmer (≥ 4.0 kg) and greener (≤ 3.2) fruit compared to the firmness (≤ 3.6 kg) and colour (3.3) of fruit treated 21 days after harvest in both populations.

3. Mealiness only occurred in fruit from population 1 treated 21 days after harvest. Internal ethylene levels of fruit from both populations increased with increasing delay in treatment time. This trend was exhibited by internal ethylene levels from maturity data at time of SmartFreshSM application. The increase in internal ethylene decreased the efficacy of the SmartFreshSM treatment. This resulted in fruit treated 14 and 21 days after harvest are of lower quality compared to fruit treated 7 and 9 days after harvest.

4. From the data it is evident that Forelle pears could be treated up to 14 days after harvest with SmartFreshSM without compromising fruit quality. However, at this stage of the trial it is suggested to not delay the SmartFreshSM application for longer than 9 days.

17 TO DETERMINE THE MINIMUM FLESH FIRMNESS THAT FEMA FRUIT CAN BE EXPORTED WITHOUT BECOMING OVERRIPE AFTER STORAGE, AND TO DETERMINE THE EFFECT OF EXTENDED STORAGE OF FEMA FRUIT (STOCK ROLLING).

Project Leader: I. Crouch/D. Viljoen

1. The objective of this trial is to determine the effect of FEMA fruit packed at a minimum target firmness of 4.0 kg on fruit quality after 4-6 weeks cold storage, and to determine the maximum storage period from harvest at a range of packing firmness's before fruit quality is compromised.

2. Forelle pears were harvested at 4 different firmness' (5.9 kg, 5.7 kg, 5.0 kg and 4.9 kg) and subjected to 600 ppb SmartFreshSM treatment within 6 days after harvest. Fruit from each harvest were stored for 4, 6, 8, 12 and 16 (only harvest 1) weeks at -0.5°C.

Fruit harvested from the 1st (week 12, 5.9 kg) and 2nd (week 14, 5.7 kg) harvests and stored for 12 weeks did not ripen below 5.0 kg during a 7 day shelf period and so no mealiness developed. Harvest 1 stored for 16 weeks however, ripened to 2.9 kg, but did not express mealiness as fruit had been subjected to sufficient cold storage (>12 weeks).

3. Fruit harvested in 3rd and 4th harvests (weeks 15 and 16; 5.0 kg; and 4.9 kg, respectively) and stored for less than 12 weeks at -0.5°C, generally ripened below 4.0 kg with the resulting expression of mealiness. Fruit stored for 12 weeks resulted in no mealiness in harvest 3, and only 7.3% in harvest 4 fruit.

4. This data identified a risk of delaying FEMA harvests beyond a certain time as fruit harvested in weeks 15 and 16 developed mealiness if stored for less than 12 weeks at -0.5°C. The SmartFreshSM concentration applied was not effective in maintaining flesh firmness in post optimum fruit and higher concentrations need to be assessed.

FINAL PROJECT REPORTS RECEIVED IN 2014

PROJECT TITLE	FRUIT KIND	RESEARCHER
Determine of the optimal packaging, with the view the view to reduce moisture loss on Charisma apricots	Apricot	Arrie de Kock
Effect of alternative application methods (electrostatic) of Iprodione for post-harvest decay control on plums.	Plum	Arrie de Kock
Optimum harvest maturity determination for African Delight plums planted in different production areas.	Plum	Arrie de Kock
The relationship between Cripps Pink internal browning and various environmental factors in different growing areas after extended CA storage and the evaluation of the NIR technique for detecting internal browning.	Apple	Heleen Bergman
The relation between 'Cripps' Pink' internal browning and pre-harvest temperatures, mineral nutrition, tree age, soil type etc. in two production areas after long term CA storage and the evaluation of the non-destructive NIR technique for sorting internal, brown fruit.	Apple	Elke Crouch
Packaging of the Future: Integrated model-based design and performance evaluation of packaging for the SA fruit industry.	Pome, Stone	Linus Opara
To use Radio Frequency Identification Technology (RFID) to get an understanding of the storage air and fruit pulp temperatures and relative humidity in a typical South African fruit export supply chain from the very beginning to the very end over two seasons.	Pome, Stone	Malcolm Dodd

NEW PROJECTS APPROVED FOR 2015

PROJECT TITLE	FRUIT KIND	RESEARCHER
Non-chemical storage technologies for apple and pear superficial scald prevention.	Apple, Pear	Kobus van der Merwe
The prevalence of Botrytis spp. In and on plums, and alternative host plant tissue: A preliminary investigation on the occurrence of the fungus pre-and post-harvest, using molecular technology, in order to elucidate pathogen ecology, for new decay control strategies.	Plum	Ida Paul
Moisture loss studies in nectarines.	Nectarine	Mariana Jooste
Postharvest 'Forelle' mealiness development, detected at harvest by CT-X ray scanning and semi-commercial colo ur pre-sorting influenced by canopy position at harvest as well as pollination.	Pear	Elke Crouch
Production of antimicrobial lipopeptides by Bacillus spp.for biological control of postharvest phytopathogens in the perishable fruit industry.	Stone	Prof K Clarke
The development of the industrialization process for various ideas towards optimization of cargo freight capacity utilization (space, mass, packaging, refrigeration) in refrigerated shipping containers to reduce logistic costs while maintaining product quality.	Pome, Stone	Koos Bouwer
Detection and quantification of Botrytis cinerea incidence and severity in harvested pears for the development of a monitoring system to support commercial exports.	Pear	Stephan Ferreira
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 / deports.	Plum	Arrie de Kock
The effect of temperature from orchard to cold store on apricot quality, specific to areas removed from cold storage facilities.	Plum	Arrie de Kock
To determine the minimum flesh firmness that FEMA fruit can be exported without becoming overripe after storage, and to determine the effect of extended storage of FEMA fruit (stock rolling)*.	Pear	Ian Crouch

PROJECTS COMPLETED IN 2014

01 DETERMINE OF THE OPTIMAL PACKAGING, WITH THE VIEW TO REDUCE MOISTURE LOSS ON CHARISMA APRICOTS

Project Leader: A. de Kock

2011

Charisma apricots harvested at different maturities were packed in Polyethylene (PE) plum wrappers and PE bags with 54 x 2, 54 x 6, 108 x 6 and 162 x 6 mm perforations.
Fruit were examined for moisture loss, external and internal quality, as well as taste after 32 days in cold storage at -0.5°C and after a shelf life of 5 days at 10°C.
Flesh firmness was affected negatively by PE wrappers and perforated outer bags.
Decay tended to be higher in PE wrappers and bags.
Taste was of fruit packed in PE wrappers and bags was inferior, compared to the control (no bag or wrapper).
Internal disorders were low after cold storage but were higher in wrappers and bags after shelf life.
Mass loss and wilting were reduced significantly by wrappers and perforated bags.

2012

Due to the negative effects of PE bags and wrappers on flesh firmness, decay and taste, paper wrappers were tested in 2012 in an effort to reduce moisture loss without the negative effects on quality found with perforated PE bags.
The paper wrappers did not affect flesh firmness significantly.
After shelf life, Harvest 2 (H2) Charisma apricots packed in perforated plum wrappers were significantly softer than control apricots.
Decay, shrivel, wilting, gel breakdown and overripeness was not affected significantly by the wrappers tested.
Mass loss was not affected in Harvest 1 (H1) fruit, but in H2 fruit, mass loss was reduced significantly by all the wrapper treatments, compared to the controls. Mass loss in the PE and paper wrapper treatments was similar.
Reduction in diameter (shrinkage) was reduced in H1 fruit by the plum wrapper. Shrinkage was similar in the paper wrappers and the control fruit.
Albeit non-significant, taste was affected negatively by the PE plum wrapper, compared to the controls and the paper wrappers. Taste in the paper wrappers was similar or better than the controls.

2013

In the semi-commercial trial with Imperial apricots, earlier results with paper wrappers were confirmed. Flesh firmness was not affected by the wrappers and mass loss was reduced significantly. The paper wrappers did not affect internal quality and no decay occurred.

02 THE EFFECT OF ALTERNATIVE APPLICATION METHODS OF IPRODIONE FOR POST-HARVEST CONTROL OF BOTRYTIS DECAY ON PLUMS

Project leader: A.de Kock

Post-harvest decay of stone fruit presents a challenge to the stone fruit industry. The application of fungicide is the principle method for the prevention of decay. However, the levels of fungicide residue on fruit are restricted by law in order for fruit to be safe for human consumption. The objective of this study is to evaluate alternative post-harvest fungicide application methods in order to reduce fungicide residues on fruit whilst optimising decay control. Songold, Laetitia and Angeleno plums were artificially infected with Botrytis grey mould, and then treated with Iprodione at either the full (11ml/L), or half (5.5 m/L) of the registered dosage, at three different atomiser volumes of 1.2L, 2L and 3L per ton of fruit respectively. Furthermore, one application of Iprodione was made with a high volume spray at a product dosage of 1ml/L, one industry control of 8.3ml/L Fludioxonil (sprayed at a volume of 1.2L/ton fruit) and one treatment was left unsprayed as the untreated control. Fruit were stored for 35 days in cold storage followed by a shelf life of 5 days at 10°C. Subsequently, fruit were examined for the incidence of decay (a percentage calculated from the total number of fruit decayed, divided by the total number of fruit treated), decay severity, and overt fungal sporulation. High levels of overt fungal sporulation were observed. No significant differences in decay control were found between all the Iprodione treatments for the cultivars Laetitia and Songold. However, decay control by Fludioxonil was significantly better than that of all other treatments for these cultivars. In Songold plums decay severity was reduced significantly when compared to the reference Iprodione treatment (industry standard of 11ml/L at volume of 1.2L per ton fruit), by increasing the volume to 3L/ton for Iprodione (T7 and T8) at both the full and half dosages (11ml/L and 5.5ml/L). Decay index was not improved by any of the Iprodione treatments compare to the reference Iprodione treatment. Contrary to earlier results, the high volume spray did not reduce decay. The results indicate that increasing the atomiser volume does not consistently improve decay control, and neither does the high volume spray, compared to the current atomiser application volume of 1.2L/ton. Best levels of decay control for all three cultivars were with the application Fludioxanil at a standard atomiser volume.

03 ASSESSMENT OF ACCUMULATIVE DPA RESIDUES THROUGHOUT STORAGE AND PACKING FACILITIES

Project Leader: P. van der Merwe

The aim of this project was to obtain additional information on the risk of DPA cross-contamination before the 2014 season commenced. Untreated fruit (no DPA) were sampled from new and old cold stores that did not store DPA treated fruit in the 2013 season. Fruit were also sampled from a cold store that stored DPA treated and untreated fruit. Untreated fruit were also sampled from the neighbouring cold store that shares the scrubber. Floor, wall and paint samples were sampled from ten cold stores to rank the cold stores according to the risk of cross-contamination from the DPA concentrations detected. Floor and wall samples were also sampled prior to and after a decontamination procedure of the cold stores with silver peroxide. The trial supports the finding of the previous trial that old wooden bins and old cold stores are a low to no risk of DPA cross-contamination. Unlike the 1st trial where levels of up to 0.30 ppm were noted on untreated fruit stored with DPA treated fruit, DPA residue levels in this trial were not detectable, regardless of whether treated and untreated fruit were stored together. Even with this result, it is still recommended not to store DPA treated with untreated fruit. It is not evident from the results that decontaminating a cold store with silver peroxide will work. However, if feasible, it could be to the owner's benefit of considering a decontamination procedure. Alternatives to DPA are important and in need for the South African market due to the production of high scald potential cultivars such as Packham's Triumph and Granny Smith. For this reason, research for alternatives is important and should be a priority.

04 OPTIMUM HARVEST MATURITY DETERMINATION FOR AFRICAN DELIGHT PLUMS PLANTED IN DIFFERENT PRODUCTION AREAS

Project Leader: H. Viljoen

2012

The highest scald occurred in fruit from Harvest 1, followed by Harvest 2, with the lowest scald occurring on Harvest 3 fruit. Due to area differences, TSS, flesh firmness and malic acid (MA) were not accurate indicators of optimum maturity in terms of scald development. TSS : MA : firmness ratios can possibly be used to determine optimum harvest maturity.

After cold storage, the lowest scald occurred in fruit stored for 35 days and it increased the longer the cold storage.

After shelf life, higher scald occurred in fruit stored for 35 days than in fruit stored for longer periods, possibly due to poorer skin colour.

Shortening the cold storage of African Delight will therefore not solely solve the problem of scald

2013

Scald occurred at higher levels on fruit from Robertson and Franschhoek productions areas and decreased with increased maturity. Ceres fruit exhibited lower levels of scald across maturities.

Due to area differences, individual TSS, flesh firmness and malic acid measurements were not accurate indicators of optimum harvest maturity, and hence, could not be used as tools to reduce scald incidence and improve eating quality.

It is possible that a TSS : MA : firmness indicator calculation could be used in conjunction with these individual indicators to determine the optimum harvest maturity.

An indicator calculation for TSS : MA : flesh firmness in the order of 2.0 was re-confirmed as optimal. This calculation should be used in combination with the existing minimum harvest indicators to determine the correct harvest maturity.

2014

Yet again, using TSS, flesh firmness and malic acid as sole measurements were not sufficient indicators of optimum harvest maturity, and could not be used solely as tools to reduce scald incidence and improve post-storage quality of African Delight plums.

Generally, scald could be reduced across all three the areas included in the study could be reduced by harvesting the fruit at a slightly more advanced maturity, particularly on fruit from Robertson, which exhibited higher levels of scald than Franschhoek and Simondium.

TSS : MA : firmness ratio calculation in the order of >2.0 was re-confirmed as an optimal indicator to be used along with other maturity parameters such as TSS at ≥ 15%, a flesh firmness of ≤ 9kg and a TSS : MA ratio of > 16.

05 TEMPERATURE PRE-CONDITIONING TO ADDRESS COLD-STERILISATION REQUIREMENTS OF JAPANESE PLUMS

Project Leader: M. Jooste

We examined the impact of different low temperature pre-conditioning treatments and SmartFreshSM application to allow cold-sterilisation of Japanese plums.

Three plum cultivars were subjected to three different low temperature pre-conditioning treatments. A subset of each pre-conditioning treatment received SmartFreshSM treatment. For 'African Rose' plums two harvest maturities were tested to examine the influence of fruit maturity on the success of the pre-conditioning and SmartFreshSM treatments.

Mixed maturity in cartons of all three plum cultivars was observed.

Stepwise pre-conditioning at 10°C followed by 4 °C (Treatment 3; T3) resulted in more internal and external quality problems compared to the other two treatments. The lower flesh firmness and more advanced colour development of T3 fruit shortened the shelf life and marketability of the plums. Therefore, pre-conditioning with T3 for all three plum cultivars is not recommended. The lower chilling injury levels which manifested in fruit preconditioning at 7.5 °C were still too high according to commercial standards.

SmartFreshSM treatment had variable effects on fruit quality of all three plum cultivars. Its effectiveness were strongly influenced by fruit maturity with H1 fruit (harvested less mature) having better quality compared to H2 fruit (harvested more mature). Mixed maturity in the cartons will, therefore, have to be dealt with before SmartFreshSM can be used as an aid to prevent chilling injury in plums. It was also observed that while SmartFreshSM prevented the development of gel breakdown, it did not prevent the development of internal browning in plums.

None of the treatments can be recommended for commercial use.

06 THE RELATIONSHIP BETWEEN CRIPPS PINK INTERNAL BROWNING AND VARIOUS ENVIRONMENTAL FACTORS IN DIFFERENT GROWING AREAS AFTER EXTENDED CA STORAGE AND THE EVALUATION OF THE NIR TECHNIQUE FOR DETECTING INTERNAL BROWNIN

Project Leader: E. Crouch/ H. Bergman

Australian research related the type of internal browning development to growing day degrees above 10 °C (GDD10°C). Two climatically different production regions were used to establish if and how browning incidence differ over two seasons.

Fruit were harvested at a starch breakdown of > 50% from five farms in each region (Elgin and Koue Bokkeveld) and stored under CA conditions (7 months at -0.5°C) + RA (4 weeks at -0.5 °C) + shelf-life (1 week at ambient) and examined for internal browning incidence and type. Accumulated GDD10°C, average maximum (max) and minimum (min), and max - min temperatures were measured for growth stages and correlated to type of browning incidence.

Temperature differences between years rather than temperature differences between regions affected browning incidence. Diffuse browning incidence did not differ between seasons. Radial browning was found for the 2011/2012 season but not for the 2012/2013 season. Small max-min temperature differences during cell division (0 to 50 dafb) contributed to an increased incidence of diffuse browning. Low maximum temperatures during the early cell expansion stage (50-100 dafb) led to an increase in radial browning incidence. Fruit maturity affected diffuse browning susceptibility but did not influence radial browning.

Radial and diffuse browning development in South Africa seems to be driven by different processes during the growing season and the influence of temperature on cell development during these growth stages. The cause of radial browning is bound by season while diffuse browning seems related to harvest maturity and storage. Incidence of browning types cannot be predicted by the Australian prediction model.

NEW PROJECTS APPROVED 2015

1. Non-chemical storage technologies for apple and pear superficial scald prevention
Project Leader: K. Van der Merwe

2. The prevalence of Botrytis spp. In and on plums, and alternative host plant tissue: A preliminary investigation on the occurrence of the fungus pre-and post-harvest, using molecular technology, in order to elucidate pathogen ecology, for new decay control strategies.
Project Leader: I. Paul

3. Moisture loss studies in nectarines
Project Leader: M. Jooste

4. 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
Project Leader: E. Crouch

5. Production of antimicrobial lipopeptides by Bacillus spp. For biological control of post-harvest phytopathogens in the perishable fruit industry
Project Leader: K. Clarke

6. The development of the industrialization process for various ideas towards optimization (space, mass, packaging, refrigeration) in refrigerated shipping containers to reduce logistic costs while maintaining product quality
Project Leader: K. Bouwer

7. Detection and quantification of Botrytis cinerea incidence and severity in harvested pears for the development of a monitoring system to support commercial exports
Project Leader: S. Ferreira

8. Revision of temperature tolerance at loading for plumbs
Project Leader: A. de Kock

9. Optimum cooling and transport temperature for plums from areas situated far from cooling facilities/deports
Project Leader: A. de Kock

10. The effect of temperature from orchard to cold store on apricot quality, specific to areas removed from cold storage facilities
Project Leader: A. de Kock

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

Horticulture:

Richard Hurndall - HORTGRO Science
Hugh Campbell - HORTGRO Science
Prof Wiehann Steyn - HORTGRO Science

Post-Harvest:

Richard Hurndall - HORTGRO Science
Hugh Campbell - HORTGRO Science
Prof Marius Huysamer - Consultant
Prof Karen Theron - US Horticulture
Prof Lizette Joubert - ARC
Prof Linus Opara - Research Chair in Post-HarvestTechnology (US)
Dr Paul Cronje - Citrus Research International
Dr Mariana Jooste - HORTGRO Science / US Hort

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

Dr Nigel Cook - Prophyta
Prof Gerard Jacobs - US Horticulture
Prof Karen Theron - US Horticulture
Dr Nicky Taylor - University of Pretoria
Dr Piet Stassen - ARC

Soil Science:

Richard Hurndal - HORTGRO Science
Hugh Campbell - HORTGRO Science
Prof Wiehann Steyn - HORTGRO Science
Dr Eduard Hoffmann - US Soil Science
Jan Lambrechts - US Soil Science
Dr Pieter Raath - Bemlab
Dr Nigel Cook - Prophyta
Louis Reynolds - Fruitfulcrop Consultant

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 - ARC
Dr Ruan Veldsman - SANBI
Welma Pieterse - DAFF
Prof Schalk Louw - Univ of Freestate
Prof Martin Hill - Rhodes University

Pathology:

Richard Hurndall - HORTGRO Science
Hugh Campbell - HORTGRO Science
Lindi Benic - HORTGRO Science
Prof Lise Korsten - University of Pretoria
Prof Altus Viljoen - US Pathology
Dr Johan Fourie - ExperiCo
Dr Paul Fourie - Citrus Research International
Ferdi van Zyl - SAPO

- Advisory to HORTGRO Science

Crop Production TAC :

Stephen Rabe - Grower / HORTGRO Science Director (Chairman)
Graeme Krige - Two-a-Day
Anton Muller - KROMCO
Tobie van Rooyen - Techways
Peter Dall - Peter Dall Consultancy
Nigel Cook - Prophyta
Pierre du Plooy - Prophyta
Andrew Hacking - Ad Lucem
De Kock Hamman - CFG
Hannes Laubscher - Dutoit Group
Christo Strydom - Wolfpack Pears
Chris Jurisch - Arbor Tech
Willie Kotze - HORTGRO Science
Prof Wiehann Steyn - HORTGRO Science

Fruit Route (Breeding) Advisory Committee:

Dr Mohammad Jeenah - ARC (Chairman)
Dr Johan van Zyl - ARC
Dr Hennie du Plessis - 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
Steven Versfeld - Grower
Dr Ken Pringle - HORTGRO Science / US Entomology
Fanie van der Merwe - Dow AgroSciences
Dr Jeanne de Waal - Dow AgroSciences

Post-Harvest TAC:
Grant Smuts - Grower / HORTGRO Science Director
Charl Stander - Franschhoek Marketing
Richard Hurndall - HORTGRO Science
Dr Mariana Jooste - HORTGRO Science / US Hort
Jacques du Preez - HORTGRO
Dr Malcolm Dodd - Consultant
Henk Griessel - TruCape
Jaco Moelich - Fruitways
Angelique Marais - Fruitways
Petro Conradie - Dutoit Group
Margaret Reineke - CFG / (now Bayer)
Karin van Rensburg - Capespan

Elizabeth Downes - Capespan
Pieter Neethling - Two-a-day
Dr Mdunzi Ngcobo - PPECB (now ARC)
Petru du Plessis - Consultant

Technology Transfer Advisory Committee:
Hugh Campbell - HORTGRO Science (Chairman)
Stephen Rabe - HORTGRO Science Director
Erin Morkel - HORTGRO Science (until March 14)
Elise-Marie Steenkamp - HORTGRO Science
Matthew Addison - HORTGRO Science
Prof Wiehann Steyn - HORTGRO Science
Peter Dall - Grower / Peter Dall Consultancy
Keith Bradley - Grower
Robert Zulch - Grower
Linde du Toit - Grower
Pierre du Plooy - Prophyta
Dr Nigel Cook - Prophyta
Dr Mias Pretorius - Two-a-Day
Dr Ian Crouch - ExperiCo
Charl Stander - Franschhoek Marketing
Christo Strydom - Wolfpack
Marinus van der Merwe - Future4Growers
Tobie van Rooyen - Techways

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:
Soil health
Dormancy
Reproductive biology
Rootstock committee
Growing season climate
Irrigation and Nutrition
Farming efficiency
Orchard of the future
Rest breaking and Fruit thinning

Breeding:
Culdevco Advisory - Pome fruit
Culdevco Advisor - Stone fruit

Crop Protection:
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
Forelle research focus group
DPA focus group
Irradiation group (FIAT)

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

INFORMATION DAYS, WORKSHOPS AND SYMPOSIUMS:

DATE	TITLE	NO PEOPLE ATTENDED	WHERE HELD
15 October 2013	Stone Fruit Field Day	40	Worcester
3 December 2013	Seminar and Field Day	44	Langkloof
3 June 2014	Hort.Sc Pome Fruit Field Day	208	EGVV
4 June 2014	Hort. Sc Symposium Day 1	350	Drakenstein
5 June 2014	Hort. Sc Symposium Day 2	315	Drakenstein
6 June 2014	Hort. Sc Stone Fruit Field Day	115	Simondium
4-6 & 18-20 August 2014	Horticultural Short Course	41	Elgin
7 August 2014	Free State Apple Symposium	65	Bethlehem
8 August 2014	Free State:Apple Field Day	42	Bethlehem
3 September 2014	Crop Protection Seminar	135	Ceres
9 September 2014	Workshop: Entomopathogenic Nematodes (EPNs)	53	Stellenbosch

SAFJ PUBLICATIONS LIST

Oct/Nov 2013:

Rabe, A. & Campbell, H.: Onafhanklike evaluasie van kultivars, p.10
Duvenage, E.: Jong garde is 'n besliste bate, p. 42
Crouch, I. & Bergman, H.: Feedback on the 2012 Forelle early market access programme, p. 72 – 80.
Hurndall, R., Van der Merwe, K. & Gouws, A.: Controlled Atmosphere/ Modified Atmosphere Conference Report Italy, p. 82-84
Hurndall, R. & Van der Merwe, K.: Post Conference visits to Production & Research Facilities in Italy, p. 88-89.
Brodie, L.: Crop Protection Technical Advisory Committee, p. 92 – 93.
Duvenage, E.: Orchards of the Future, p.95-97.

Dec2013/Jan 2014

Campbell, H.: HORTGRO Science evaluates apple rootstocks in the Langkloof, p. 37
Rabe, S.: Orchards of the Future: Focus on Fruitways, p. 50 -51
Jooste, M.: Wees slim wanneer jy pruime stoor, p. 53

Feb/March 2014

Morkel, E.: Dankie-sê Ontbyt, p. 10
Steyn, W.: HORTGRO Science boordstap en seminaar in die Langkloof, p. 42-43
Van Schoor, L. & Bezuidenhout, K.: Introduction apple replant disease, p.43
Oak Valley, Paardekloof deel van OoF-projek, p. 48 – 51
Morkel, E.: Washington State apple industry observed, p. 53-55.
Brodie, L.: HORTGRO Science TAC members, p. 68 – 69.
Van Schoor, L. & Bezuidenhout, K.: Effect of organic material and biological amendments on pear tree performance in the Vyeboom region, p. 71-75.

April/May2014

Duvenage, E.: More buzz needed about SA's honeybee research, p. 24 - 25
Steyn, W.: The Crop Production Research Programme, p. 26-29
Brodie, L.: TAC Members, p. 34-35

Stassen, P.: Higher density peach orchards according to the central leader concept, p. 48 – 50
Van Schoor, L. & Bezuidenhout, K.: Managing apple replant disease in Vyeboom region with biological soil amendments vs fumigation, p. 58 – 63

June/July 2014
Steenkamp, E.: Growing the Future, p. 42 – 43
Brodie, L.: TAC Members, p. 50
Mutawila, C., Fourie, P.H., Halleen, F. & Mostert, L.: 'n Oorsig oor wingerd snoeiwond beskerming in Suid-Afrika, p. 52 – 55
Mutawila, C., Mostert, L., Halleen, F. & Fourie, P.H.: Wat is Trchoderma?, p. 56 – 57
Lötze, E.: Taking the mystery out of mulching, p 60 – 61
Van Schoor, L. & Bezuidenhout, K.: Potential use of compost extract and Bacillus inoculants in combination with compost in managing apple replant disease, p. 62 – 67
Stassen, P. & Van Zyl, F.: Dieback of stone fruit trees associated with wet weather conditions in the Western Cape fruit region, p. 68 – 73
Duvenage, E.: Keeping our honeybees fit and healthy, p. 74 – 75

Aug/Sept 2014
Campbell, H.: Step back and consider the benefits of Research, p. 4
Steenkamp, E.: FEMA – a blushing success, p. 8 -11
Addison, M.: Fruit Fly Symposium in Thailand, p. 15
Steenkamp, E.: Beste Professor, p. 16 - 17
Steenkamp, E.: Global hunger challenges and fresh fruit, p. 17
Duvenage, E.: Zimbabwiese student beste in hortologie, p. 22
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