ANNUAL REPORT

Oct 2012 - Sept 2013

HORTGRO science

the technology collective

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LETTER FROM THE CHAIRMAN

Dear fellow deciduous fruit growers

I would like to start off by expressing our sincere sympathies to all our fellow producers who have experienced severe crop and orchard losses inflicted by the recent hail storms in various parts of our industries production areas. Our wishes go out to you and all those dependent upon your businesses and may you all experience a sound recovery in the times ahead.

Not only has Hortgro Science changed its name again from Fruitgro Science, for hopefully the last time, but the structures and strategies that have been put in place to improve research and its returns to industry are slowly but surely showing just rewards. There is just so much more and beter communication and participation between all role players and the model is generating inclusivity.

This must and will result in beter returns for the funding producers. These signs are reason for us as Hortgro Science board and staff to feel excited.

Soos voorheen genoem, behoort hierdie organisasie aan ons produsente. Ons voortbestaan en sukses is grotendeels afhanklik van produsente deelname en dus weereens my versoek dat ons betrokke sal wees by hierdie aktiwiteite. Hortgro Science kan nie in 'n vakuum funksioneer nie en ons het produsente insette en deelname nodig (van watter aard ook al) om te verseker dat ons die beste rendement vir ons geld uit navorsing ontvang.

Ons dank aan Hugh Cambell en sy span by Hortgro Science vir hul bydraes en insette gedurende die afgelope jaar. Ons as bedryf is bevoorreg om vir Hugh as bestuurder van Hortgro Science te hê.

Aan al ons navorsers, personeel en ander rol spelers in ons bedryf, baie dankie vir jul toewyding en insette in 'n omgewing waar dit nie al dag maklik is nie en wat menige uitdagings bied.

This will be my last report as Stephen Rabe will be taking over from me as chairman. My sincere thanks to my fellow board members for your valued support over the past few years. Your unselfish contribution to industry is greatly appreciated.

Grant Smuts

GENERAL MANAGER'S REPORT

1. BOARD OF DIRECTORS

Grant Smuts (Chairperson)
Bruce Huxter (Vice-chair)

Joseph Hendricks	Charl Stander
William Myburgh	Steven Versveld
Stephen Rabe	Louis von Broembsen

2. INTRODUCTION

The shareholders of Fruitgroscience, the South African Apple and Pear Producers' Association (SAAPPA) and the South African Stone Fruit Producers' Association (SASPA), underwent a review process of the organisational structures of the industry organisations with which they are directly involved in order to align, streamline and simplify the structures. As a result of this process, Fruitgro Science has been incorporated into HORTGRO as a division of HORTGRO and will assume the name: HORTGRO Science.

The existing board remained and transformed into the HORTGRO Science Advisory Board and will maintain its structure. All the existing support structures (e.g. peer work groups, technical advisory committees etc.) will remain in place. The management team of HORTGRO Science will continue to operate from their offices in Stellenbosch (63 Dorp Street) as an alliance based structure in close association with a network of role-players who have the common interest in improving the competiveness of the South African pome and stone fruit industry through the development and utilisation of technology and competent people.

The purpose of HORTGRO Science remains the same and 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's core function is therefore the implementation of relevant research and the technology transfer of the outputs of that research back to the end user. In addition, its mandate extends to endeavour to reduce industry business risk through enhanced technical/science based market access related activities in sync with trade policy, commercial priorities and requirements. This trade and market access arena has been managed by Lindi Benic under the HORTGRO Science banner. This function will shift to the Trade and Market Development Division of HORTGRO in the 2013/14 financial year.

3. PERSONNEL / MANAGEMENT

The staff of HORTGRO Science is as follows:

Hugh Campbell	- General Manager
Lindi Benic	- Trade & Market Access Manager
Suzette Poole	- Personal Assistant to Trade & Market Access Manager
Richard Hurndall	- Research & Technology Manager
Dr Wiehann Steyn	- Programme Manager Crop Production
Matthew Addison	- Programme Manager Crop Protection - based at the Department of Entomology and Conservation Ecolog, Stellenbosch University
Erin Morkel	- Technology Transfer Manager (5/8 appointment)
Theresa Sonnenberg	- Research Administrator
Willie Kotze	- Regional Fruit Production Researcher

The seconded staff to Stellenbosch University is as follows:

Dr Ken Pringle	- Department of Entomology and Conservation Ecology
Dr Shelley Johnson	- Department of Entomology and Conservation Ecology
Dr Elmi Lötze	- Department of Horticultural Science
Dr Mariana Jooste	- Department of Horticultural Science (5/8 appointment from 1 April 13)

Contract positions funded through research projects:

Dr Juanita Heunis	- Department of Entomology and Conservation Ecology (2/3 appointment)
Ms Juanita Liebenberg	- Department of Entomology and Conservation Ecology (3/4 appointment)
Ms Laura Allderman	- Dormancy Projects (5/8 appointment)

Willie Kotze joined the staff on 1 October 2012 on a 3 year contract as the regional Fruit Production Researcher based in Grabouw. He replaced Daan Brink who took up a position with the Two-a-Day technical team. Willie has been a great asset to the business and has conducted extensive applied research trials in the Grabouw and Ceres areas on pome fruit. Some of these trials have been expanded to the Langkloof.

In April 2013, Matthew Addison's post was upgraded to 'Crop Protection Programme Manager'. Previously he was the IPM Research Manager. In January 2013, Theresa Sonnenberg was appointed to the post of Research Administrator in the place of Samantha Khiba.

Mariana Jooste completed her PhD in December 2012 after a long haul. Our congratulations are extended to her.

As a result of internal restructuring, Lindi Benic and Suzette Poole have been moved into the Trade and Market Development Division within HORTGRO offices in Paarl. HORTGRO Science will still keep a close association with Lindi and Suzette within the new structure.

Programme management / technology transfer services:

The different research programmes are each led by a programme leader/manager 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:**
   The Crop Production Programme Manager is Dr Wiehann Steyn (HORTGRO Science) and Matthew Addison (HORTGRO Science) is the Crop Protection Programme Manager.
3. **Product integrity (Post Harvest)**:
   Dr Martin Taylor (ExperiCo) through an alliance agreement with ExperiCo.
   This alliance agreement terminated at the end of September 2013. Dr Taylor is thanked for the substantial contribution that he made to HORTGRO Science.
   From 1 October 2013 Richard Hurndall has taken over the reins of this programme and will be supported by Dr Mariana Jooste.
4. **Market Alignment and a Sustainable Supply Chain**:
   Lindi Benic, in her capacity as Manager of Trade and Market Access, leads the market alignment programme.
5. **Technology Transfer**:
   This programme is managed by Erin Morkel

4. RESEARCH PROJECTS

Funding shifts over time:
The following 2 figures (Figure 1 & Figure 2) demonstrate the shift on funding over the past 14 years:

Figure 1: 1998/99 Funding allocations

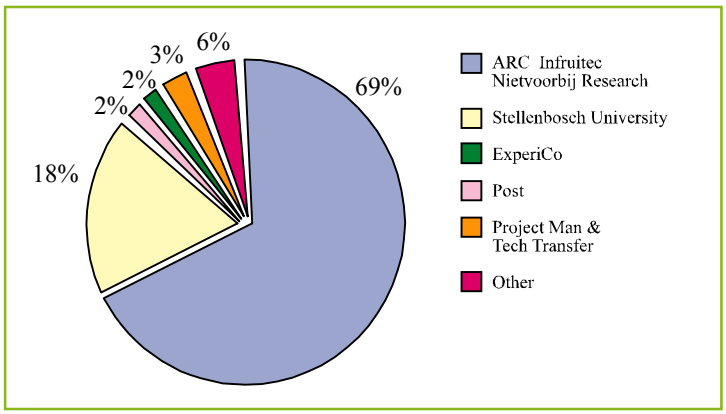
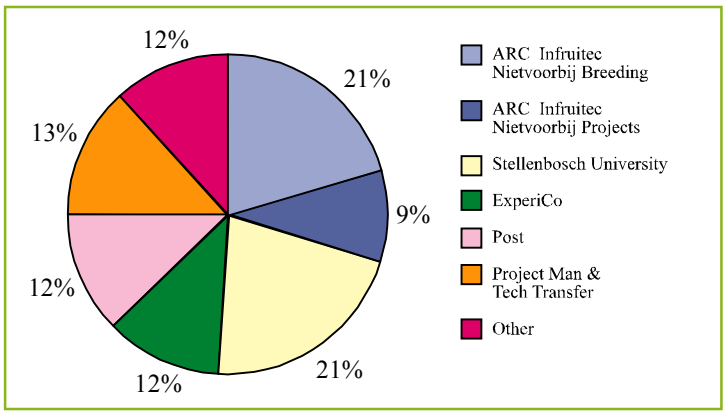


Figure 2: 2012/13 Funding allocations



The pie graph above 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. The number of breeding projects has remained fairly constant over the period so the decrease in investment has been at the expense of other research projects in the fields of pathology, entomology and horticulture.

Research projects conducted during 2012/13:

Table 1: 2012/13 research projects

PROJECTS	Total	Pome	Stone
Projects conducted in 2011/2012	103	75	38
Projects completed in 2011/2012	23	20	7
Projects continuing in 2012/2013	90	69	37
New projects initiated in 2012/2013	24	17	7
TOTAL PROJECTS in 2012/13	**114**	**86**	**44**

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

Research institution utilised in 2012/13:

Table 2: 2012/13 research projects per research institution

RESEARCH INSTITUTE	PROJECTS 2012/13	PROJECTS 2011/12
ARC Infruitec-Nietvoorbij	**(36)**	**(40)**
ARC Breeding	21	21
ARC Research Projects	15	19
Stellenbosch University	**(38)**	**(30)**
US - Horticulture	15	12
US - Pathology	5	3
US - Entomology	18	14
US Biochemistry		1
HORTGRO Science Technical Services	**20**	**16**
ExperiCo 15	**13**	
CA Science	**1**	**1**
Nemlab	**1**	
Blue North	**1**	**1**
University of Pretoria	**1**	**2**
CSIR	**1**	
TOTAL PROJECTS	**114**	**103**

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

The average cost per project came down in 2013. This is a factor of a number of variables that include the type of projects embarked up.

Funding allocation per research investment focus area:

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

Figure 3: Pome fruit 2012/13 investment per research investment focus area

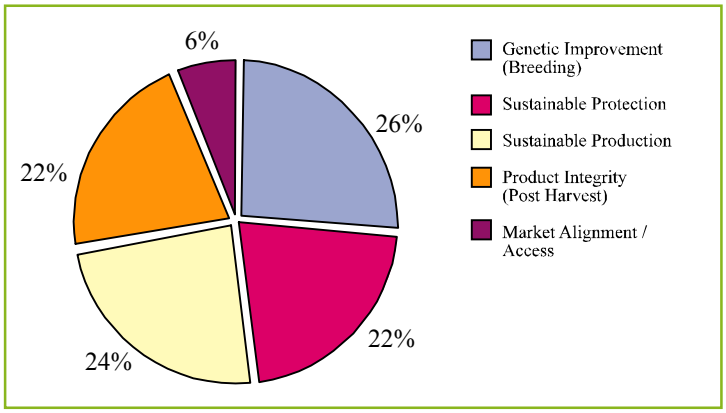
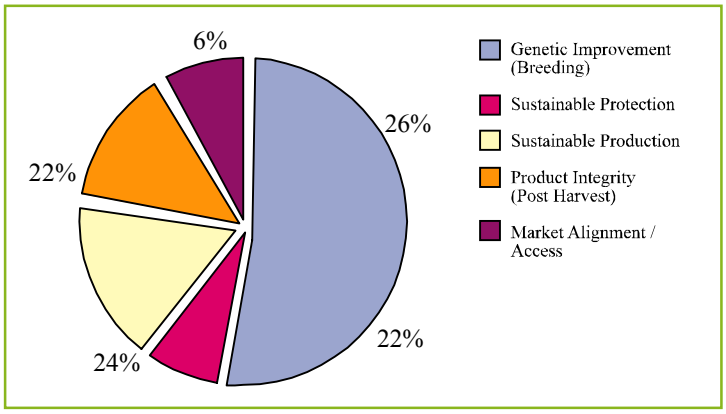


Figure 4: Stone fruit 2012/13 investment per research investment focus area



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 2012/13 financial year.

5. 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 15% of the projects have a black project leader, up from 11% last year. What is encouraging is that 38% of our projects involve the training of students at post graduate level and as noted below 41 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. A video series of 35 videos covering all the production aspects of production has been produced specifically focusing on new entrants. The videos are currently being translated 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

41 post-graduate students are funded through bursaries supplied by research projects. The full value of these bursaries amount to R2, 687 087 or 20% 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
41	23	16	2	2, 687 087

6. 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 185 different individuals involved in our different work groups:

6 Peer Work Groups - 32 scientists
5 Technical Advisory Committees - 53 technical / growers
30 focus workgroups - 100 scientists / technical / growers

Peer Work Groups (PWG's)

Objectives of PWG

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

Breeding & Evaluation

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

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
Dr Wolf Schwabe	Consultant
Ferdi van Zyl	SAPO

Post-Harvest:

Richard Hurndall	HORTGRO Science
Hugh Campbell	HORTGRO Science
Prof Marius Huysamer	Consultant
Prof Karen Theron	US Horticulture
Dr Martin Taylor	ExperiCo
Dr Paul Cronje	Citrus Research International

Soil Science:

Richard Hurndall	HORTGRO Science
Hugh Campbell	HORTGRO Science
Dr Wiehann Steyn	HORTGRO Science
Dr Eduard Hoffmann	US Soil Science
Jan Lambrechts	US Soil Science
Kobus Louw	SAPEX
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 Entom
Dr Ken Pringle	HORTGRO Science /US Entom
Dr Brian Barnes	ARC
Dr Ruan Veldsman	SANBI
Welma Pieterse	DAFF
Prof Schalk Louw	Univ of Freestate

Technical Advisory Committees (TAC's)

Objectives of TAC's

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

Production TAC:

Stephen Rabe	Grower / HORTGRO Science Director (Chairman)
Graeme Krige	Two-a-Day
Anton Muller	KROMCO
Tobie van Rooyen	Techways
Peter Dall	Peter Dall Consultancy
Nigel Cook	Prophyta
Pierre du Plooy	Prophyta
Andrew Hacking	Farmsecure
De Kock Hamman	CFG
Hannes Laubscher	Dutoit Group
Christo Strydom	Wolfpack
Chris Jurisch	Consultant

Post-Harvest TAC:

Grant Smuts	Grower / HORTGRO Science Director
Charl Stander	Franschhoek Marketing
Richard Hurndall	HORTGRO Science
Dr Martin Taylor	ExperiCo
Prof Malcolm Dodd	Consultant
Prof Linus Opara	US Horticulture / DST/NRF South African Chair in Postharvest Technology
Henk Griessel	TruCape
Jaco Moelich	Fruitways
Petro Conradie	Dutoit Group
Margaret Reineke	CFG
Karen van Rensburg	Capespan
Elizabeth Downes	Capespan

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

Technology Transfer Advisory Committee:

Hugh Campbell	HORTGRO Science (Chairman)
Erin Morkel	HORTGRO Science
Matthew Addison	HORTGRO Science
Dr 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	Ideafruit

Crop Protection TAC:

Richard Hurndall	HORTGRO Science (Chairman)
Matthew Addison	HORTGRO Science
Anton Muller	KROMCO
Bekker Wessels	ProCrop Trust
Andrew Hacking	Farmsecure
Nico Ferreira	Two-a-Day
Steven Versfeld	Grower / HORTGRO Science Director
Dr Ken Pringle	US Entomology
Fanie van der Merwe	Dow AgroSciences Southern Africa (Pty) Ltd

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
Labour efficiency
Orchard of the future

Breeding:
Culdevco Advisory - Pome fruit
Culdevco Advisory - 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

TECHNICAL TRADE & MARKET ACCESS

Technical trade and market access compliance requirements, including increasing sanitary/phytosanitary (SPS) regulatory requirements for various countries and non-regulatory private standard requirements, particularly within the EU and UK, continue to dominate and drive the market access agenda. Over the past four years the trend of increasing SPS requirements has extended to South East Asian countries (more specifically Indonesia, Malaysia, Thailand) making exports to these markets a growing challenge. This placed an increasing demand on resources to manage the risks relating to these markets as it requires more interaction between relevant industry and government role-players to achieve related requirements. In addition, the growth of imports of fruit and propagation material and the related risk associated with the introduction of quarantine pests of concern requires greater vigilance and increased inputs into the management of these risks. Given the challenges, it has become critical to put enabling systems / resources in place to support the market access function.

L Benic represents **SAAPPA** and **SASPA** as follows:

Committee / meeting	**Description of function (relevance to the Producer Assoc)**
INTERNATIONAL:	
GLOBALGAP Fruit & Vegetable Sector Committee & sub-group meetings (Integrity; IPM; Resource Management; Standard Efficiency; Microbiology)	Key focus areas that are driven: Supporting the ongoing efforts towards achieving a realistic approach to global harmonisation relating to GAP, traceability, MRL, Minor Use (unprovided use), audit certification, worker welfare and environmental issues, with a strong emphasis on cost efficiency and reducing constraints related to cost of compliance to suppliers to ensure overall sustainability.
GLOBALGAP Crop Protection Working Group	With the core mission of creating increased confidence amongst all GLOBALGAP stakeholders regarding GLOBALGAP policy towards crop protection issues, this working group was established to consult widely with stakeholders and debate the various crop protection issues, to arrive at a consensus that could be presented to the GLOBALGAP committees etc.
SHAFFE Technical / Asia Task group	This forum established between Southern Hemisphere suppliers, allows for ongoing information transfer on critical matters relevant to suppliers via scheduled teleconference meetings / electronically or at meetings, coordinated during conferences etc.
SHAFFE	Participation at SHAFFE meetings, to share information on mutually relevant Southern Hemisphere trade/market access issues and challenges, in the fruit industry in general.
Various ad hoc meetings	These meetings provide critical networking, to engage directly with relevant parties regarding ongoing Trade/ Market Access matters, particularly changing EU legislation, MRLs, minor use and related crop protection/ food safety matters. The DPA issue was a point of extensive consultation European Commission - DG Sanco / UK Chemical Regulation Directorate / FRESHFEL Europe / Crop Life International / COLEACP

NATIONAL:

DAFF Market Access Work Group	The group is convened by the Dept. of Agriculture, Forestry and Fisheries, Plant Health (DAFF, PH) and represents DAFF (PH, APIS, PRA/other), industry, PPECB and related representatives. The group meets six-weekly throughout the year to discuss all technical aspects of market access and to monitor progress.
DAFF Phytosanitary Risk Task Group	This task group, under DAFF Plant Health, provides an ongoing forum between Government and industry to engage on critical biosecurity matters.
DAFF National Exotic Fruit Fly Steering Committee	Coordinates all aspects relating to the monitoring and management of exotic fruit flies
Various ad hoc meetings with relevant Government departments (DAFF / DIRCO) / Other	Various meetings have been scheduled to engage directly with relevant parties regarding ongoing Trade/ Market Access matters, particularly changing SPS related requirements for existing (Indonesia, Vietnam, India / other) and new markets (China apple / other)
DAFF Joint Food Safety Forum and MRL Task Group	The task group is convened by DAFF, Food Safety Quality Assurance (FSQA) to ensure compliance (nationally and internationally) of agricultural food products to food safety (chemical maximum residue limits, microbial and other hazards) in order to ensure consumer safety and market access.
Technical Working Group	This work group, comprising PPECB, DAFF, FSQA, DAFF Analytical Services and industry, has a mandate as subgroup under the Joint Food Safety Forum and MRL Task Group to update, review and evaluate implementation and related food safety risk management aspects relating to the Official Export Safety System and other export and local issues, as required.
DAFF Annual Deciduous Industry Coordinating Meeting	The Annual Deciduous Industry Coordinating Meeting is convened by DAFF, Plant Health and represents DAFF (PH, APIS/other), industry (deciduous), PPECB and related logistics/other representatives. It serves to coordinate and inform all stakeholders regarding the previous and forthcoming seasons' deciduous special export programmes.
DAFF Annual Grading Standards meetings	Annual grading standards meetings are convened by DAFF, FSQA to revise export standards. It represents DAFF, FSQA, industry and PPECB. Work groups have finalised local pome fruit regulations and will finalise stone fruit regulations at the end of the season. Make inputs specifically relating to MRL issues, as required.
Food Safety Risk Management Workshop	This follow up workshop was coordinated between DAFF, FSQA and represents DAFF, FSQA, industry stakeholders and PPECB. Its key objectives are to: 1) Identify key risks affecting export of primary agricultural products from South Africa. 2) Discuss and agree on pest risk management model/plan that clearly sets

	out the responsibilities of all the stakeholders over the entire food chain. 3) Develop an action plan for the implementation of recommendations made or decisions taken during the workshop. Outcomes of this workshop are ongoing.
Fruit Irradiation Action Team (FIAT)	This task group provides an on-going forum between Government and industry to engage on critical matters relating to irradiation as a phytosanitary mitigation option for fruit exports.
Berg River Task Group	The Premier's Coordinating Forum resolved that a task team be established relating to the water quality situation in the Berg River valley. The task team reported to the Premier and put forward proposals with regard to immediate, short and medium term actions for the improvement of water quality in the river system. A final task team report was presented to the Premier following four in-depth meetings. This task group was re-established to monitor interventions / other
SA GLOBALGAP National Technical Work group	The group comprises all interested South African stakeholders and its main purpose is to harmonise interpretation of the Control Points Compliance Criteria (CPCC) and to develop a South African Interpretation Guideline. Specific matters, particularly minor use issues and current revision sub-group issues were also highlighted for discussion.

INDUSTRY - POME & STONE

Peer Work Groups (PWGs)	The PWGs (one each for the different disciplines in fruit production) consist of a number of technical experts and academics. They evaluate the scientific content, viability and budgets of new project proposals; and evaluate the progress of running research projects.
Pome Fruit and Stone Fruit	Facilitation of technical issues.
Technical Forums	Facilitation of technical and market access issues.
Pome Fruit and Stone Fruit Joint Marketing Forums	This group was established under Hortgro Science and provides a vital role towards enhancing all aspects of industry crop protection risk management. It engages with various international parties requesting collective technical industry inputs about crop protection matters.
Crop Protection Advisory Group Industry MRL Work Group	The group provides a representative forum of technical experts who cover all deciduous fruit crops (i.e. representatives from exporters, technical departments, DAFF, FSQA and PPECB). It informs and takes collective decisions on critically reviewed MRL and related aspects of industry MRL Guideline updates.

TECHNOLOGY TRANSFER

The Hortgro Science Technical Symposium this past year was a resounding success, as attested by the attendance of 393 producers, technical experts, researchers, chemical company representatives, exporters and government officials on the first day and 252 on the second day.

The symposium presents them with the opportunity to stay abreast of new developments, and as a forum for interaction and exchange of ideas. 175 Delegates attended the pome fruit field day and 95 the stone fruit field day.

This year the theme was "Increasing farming efficiency and profitability in a challenging environment" and the programme addressed applicable topics of relevance to the audience. It included sessions on successful high density plantings, influences on decisions regarding new orchard developments, life without DPA and decay and increasing farming efficiency. Presentations were delivered on new technology and applicable research funded by SAAPPA and SASPA, new futuristic innovations and technical knowhow accumulated over many years by various technical experts.

The international key note speaker was Paul Stiekema, the director of orchard operations from Zirkle Fruit Company in Washington State. He spoke about increasing farming efficiency and how to use mechanisation as an aid to achieve this.

The short course in fruit production was hosted for the 6th time this year and 40 people attended. We were involved in information days in the Langkloof, Bethelehem and the Northern Province and made it possible for researchers and technical experts to present at these events.

Another 9 videos clips on the basics of fruit production for training purposes were developed, bringing the total in the series to 35. These videos can be viewed at www.saorchard.co.za . The first 26 videos are also being translated into Afrikaans and Xhosa

We published 15 popular articles in the SAFJ and 17 Fresh Notes newsletters were sent out electronically on topical technical topics.

GENERAL STATISTICS

Website Statistics

Table 1:
Visitors to the Website

	Visitors Sessions	Average Page views Per Day	Average Page views Per Session
Oct-12	67.00	10.39	4.81
Nov-12	36.00	5.70	4.75
Dec-12	21.00	3.35	4.95
Jan-13	106.00	14.13	4.13
Feb-13	128.00	21.11	4.62
Mrch-13	193.00	27.68	4.45
Apr-13	197.00	31.77	4.84
May-13	143.00	22.65	4.91
Jne-13	110.00	16.13	4.40
Jly-13	127.00	20.90	5.10
Aug-13	139.00	18.90	4.22
Sep-13	184.00	21.87	3.57
Total Average Oct.-12 - Sep.13	**120.92**	**17.88**	**4.56**

Information Days, Workshops and Symposiums

Table 2:
Attendance at Information days

DATE	TITLE	NO PEOPLE ATTENDED	WHERE HELD
2 October 2012	Mechanical pruning orchard walk	open day	EGVV
11 October 2012	High yields orchard walk	open day	Ceres
14 February 2013	Young tree seminar & fieldday	61	Langkloof
7 March 2013	Harvesting systems orchard walk	open day	Ceres
30 April 2013	Soil health - where are we now?	91	EGVV
8 May 2013	Harvesting systems orchard walk	open day	EGVV
22 & 23 May 2013	SU Sustainable production Seminar (in association with Hortgro Science)	156	Stellenbosch
4 June 2013	Hortgro Science Pome fruit field day	175	Ceres
5 June 2013	Hortgro Science Symposium Day 1	393	Drakenstein
6 June 2013	Hortgro Science Symposium Day 2	252	Drakenstein
7 June 2013	Hortgro Science - Stone fruit field day	93	Montague
8 August 2013	Bethelehem apple symposium	54	Free State
13 - 15 & 16 - 18 August 2013	Horticultural short course	40	EGVV
28 August 2013	Crop Protection Seminar	88	Stellenbosch

Publications in SAFJ

Okt/Nov 2012:

- Overview of the Fruitgro Science Technical Symposium 2012
  (SAFJ Vol 11 Part 5 p 60 - 66)

- Developing a biological control method for terrestrial molluscs in South Africa
  Jenna Ross
  (SAFJ Vol 11 Part 5 p 69 - 71)

Des/Jan 2013:

- Consumer acceptance study of early marketed Forelle pears in the UK and Germany -
  Ian Crouch and Heleen Bergman
  (SAFJ Vol 11 Part 6 p 64 - 67)

- Cost-effective culturing of the yellow mealworm and greater wax moth larvae, for the in vivo production of a biological control agent: entomopathogenic nematodes
  Carolien van Zyl and Antoinette Malan
  (SAFJ Vol 11 Part 6 p 68 - 71)

Feb/March 2013:

- Crop Production Research Programme
  Wiehann Steyn
  (SAFJ Vol 12 Part 1 p 53 - 55)

- VIIth International Symposium on Irrigation of Horticultural Crops, 15 - 20 July 2012, Geisenheim, Germany
  Theresa Volscheck
  (SAFJ Vol 12 Part 1 p 56 - 58)

- Selecting the right host and diet for in vivo culturing of entomopathogenic nematodes, using nematode yield as one of the deciding variables
  Carolien van Zyl, Antoinette Malan & Matthew Addison
  (SAFJ Vol 12 Part 1 p 60 - 63)

- Evaluation of modified atmosphere packaging and other technologies to assist in decreasing the 12 week mandatory cold storage period of Forelle pears
  Ian Crouch, Heleen Bergman, Sybrand van Zyl & Dawie Moelich
  (SAFJ Vol 12 Part 1 p 66 - 69)

April/Mei 2013

- Visual identification of damage control associated with lenticels in apples after cold storage
  Sandy Turketti and Elmi Lotze
  (SAFJ Vol 12 Part 2 p 63)

- Irrigation strategies for apple production in the Koue Bokkeveld region
  Theresa Volschenk
  (SAFJ Vol 12 Part 2 p 64 - 67)

June/July 2013

- Survey on mycorrhizal fungi in apple orchards
  Andre Meyer
  (SAFJ Vol 12 Part 3 p 48 - 49)

- Postharvest decay on stone fruit…what, when and how to reduce (part 1)
  Johan Fourie
  (SAFJ Vol 12 Part 3 p 50 - 54)

- Storing requirements of entomopathogenic nematodes
  Carolien van Zyl, Antoinette Malan & Matthew Addison
  (SAFJ Vol 12 Part 3 p 56 - 59)

Aug/Sept 2013

- Mechanisation is no "silver bullet" to increase productivity -
  Overview of Hortgro Science Technical Symposium, 4 - 7 June 2013
  (SAFJ Vol 12 Part 4 p 70 - 71)

- Postharvest decay on stone fruit - what, when and how to reduce (part 2)
  Johan Fourie
  (SAFJ Vol 12 Part 4 p 76 - 80)

- Using near-infra red (NIR) spectroscopy to predict quality in plums
  Esme Louw and Karen Theron
  (SAFJ Vol 12 Part 4 p 81 - 85)

Fresh Notes

Article number	Title	
Fresh notes 67	Industry Guideline Information on Restrictions on the Use of Plant Protection Products on Deciduous fruit for 2012/13 -	October 2012
Fresh notes 68	EU - DPA Developments Update. Status Report: October 2012	October 2012
Fresh notes 69	Surveillance monitoring of *Bactrocera invadens* (Bi) per registered Production Unit Code (PUC)	November 2012
Fresh notes 70	Packhouse Action Group (PAG) Fresh Notes	November 2013
Fresh notes 71	Maturation trends of stone fruit in the 2013 season	November 2012
Fresh notes 72	Harvest, packing and storage considerations for over-mature peaches and nectarines	November 2012
Fresh notes 73	Derogations for deciduous fruit crops	November 2012
Fresh notes 74	EU - DPA Developments Update. Status Report: December 2012	December 2012
Fresh notes 75	Industry Guideline Information on Restrictions on the Use of Plant Protection Products on Deciduous fruit for 2012/13	December 2012
Fresh notes 76	Quality management of plums with a post-harvest focus	December 2012
Fresh notes 77	Exports to Indonesia	January 2013

Fresh notes 78	Forelle Early Market Access (FEMA) Programme	January 2013
Fresh notes 79	Packhouse Action Group CA Manual	March 2013
Fresh notes 80	Update on the status of *Bactrocera invadens* in South Africa	March 2013
Fresh notes 81	Industry Guideline Information on Restrictions on the Use of Plant Protection Products on Deciduous fruit for 2013/14 - Version 1: July 2013	July 2013
Fresh notes 82	Packhouse Action Group	August 2013
Fresh notes 83	QUICK GUIDE *Bactrocera invadens*: Your region's status and what you should do	September 2013

Breeding and Evaluation

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BREEDING AND EVALUATION RESEARCH PROGRAMME

The Breeding & Evaluation programmes for the major deciduous fruit crops that Hortgro Science co-sponsors lie within the 'Research Investment Focus Area' of Genetic Optimisation. They are developing new cultivars for the South African industry that are easy to grow and easy to sell. Particular attention is paid to adaptability to the warm winters and hot summers of the South African climate, resistance to pests and diseases, yield and fruit quality - including cold-storage ability necessary for export or suitability for drying or canning. There is also the programme to breed stone-fruit rootstocks resistant to nematodes and other soil problems. The projects are conducted in the Cultivar Development Division of ARC Infruitec-Nietvoorbij. Most of the projects are presented each year to Culdevco, when objectives and progress are discussed, and promising Phase 2 selections are displayed at periodic Fruit Exhibitions held at the Infruitec campus in Stellenbosch. And the Fruit Route Steering Group, with representatives from ARC and Industry, reviews the programme twice a year.

Table 1 provides a list of Breeding & Evaluation research projects funded during the 2012/13 financial year. The industry funding (35%) and parliamentary grant (65%) covers the costs of the traditional stages of the programmes: setting objectives, 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 which commenced in 2012. The actions and outputs are described briefly in the summaries of the various annual reports.

ARC and Hortgro Science have been keen to recruit promising staff and develop existing staff to boost the complement of personnel. Three important appointments have recently been made. Carl Horstmann, formerly a student, was appointed as the apricot and plum breeder in April 2013 to fill the vacancy created by Luigia Kotze's resignation at the end of 2012. Maanda Mulaudzi joined as a technician to support the stone-fruit breeding programmes in May 2013. And Johan Kriel took up the post of deputy apple breeder in August 2013. They join Khashief Soeker, who started as the pome-fruit evaluator in April 2012, as part of the new wave of talented researchers and technicians joining Cultivar Development. Five staff are registered for further degrees: Sonwabo Booi (mapping the red-skin gene in pear), 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).

Training up the next generation of plant breeders is also important. Four students are currently working on projects combining plant breeding with molecular skills. Solomon Ntladi (NRF-funded) and Zama Mbulawa (THRIP funded) are undertaking PhDs on mapping and improving genetic understanding of important traits in pome-fruit and Khethani Mhelembe (Hortgro Science) and Thembeka Nyawo (Hortgro Science) are pursuing MSc's on fingerprinting the pome-fruit and stone-fruit genebanks. Very sadly, another MSc student, Fetsang Moima, passed away in May 2013.

Over the past year, the realignment and re-invigoration of the Breeding and Evaluation programmes that was initiated with the Fruit Route review in 2010 has proceeded well. This 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 for degrees at Stellenbosch University - in the Departments of Horticulture, Genetics and Plant Pathology and at the Institute of Wine Biotechnology - and, of course, the support received from ARC, THRIP and the industry.

Ken Tobutt, ARC Infruitec-Nietvoorbij

Table 1. Breeding & Evaluation running projects, all conducted at ARC Infruitec-Nietvoorbij.

Project title	Fruit kind	Researcher
Breeding high quality disease resistant apples for first and second economies.	Apple	Ken Tobutt
Breeding of pear cultivars.	Pear	Taaibos Human
Breeding of peaches and nectarines for commercial and emerging farmers.	Peach	Werner Pieterse
Breeding of new peach rootstocks.	Plum, peach, apricot	Sonwabo Booi
Breeding of Japanese plums for commercial and emerging farmers.	Plum	Carl Hörstmann
Breeding of apricot cultivars for commercial and emerging farmers.	Apricot	Carl Hörstmann
Phase II evaluation of apple cultivars.	Apple	Khashief Soeker
Phase II evaluation of pears in the Western Cape.	Pear	Khashief Soeker
Phase 2 evaluations of peach and nectarine cultivars in the Winter rainfall region.	Peach	Chris Smith
Phase 2 evaluations of plum cultivars in the Winter rainfall region.	Plum	Chris Smith
Phase 2 evaluations of apricot cultivars in the Winter rainfall region.	Apricot	Chris Smith
Evaluation of stone fruit in the Summer rainfall area.	Plum, peach, apricot	Irwin Meintjies
Planting and maintenance of germplasm of pome fruit, stone fruit and alternative deciduous fruit crops.	Apple, pear, plum, peach, apricot	Werner Pieterse
Three studentships to apply molecular markers to the pome-fruit and stone-fruit breeding programmes.	Apple, pear, plum, peach, apricot	Ken Tobutt
Determination of cross pollinators for plum varieties.	Plum	Jannie de Klerk
Evaluation of newly bred stone fruit rootstock hybrids.	Plum, peach, apricot	Sonwabo Booi
Cold storage characteristics of new cultivars and selections.	Apple, pear, plum, peach, apricot	Ester Lotz
Evaluation of newly developed stone fruit cultivars and training in fruit growing for the Second Economy.	Plum, peach, apricot	Trevor Koopman
Evaluation of newly developed pome fruit cultivars and training in fruit growing for the Second Economy.	Apple, pear	Trevor Koopman
Determination of apple scab races occurring in South African apple growing regions to underpin breeding for resistance.	Apple	Trevor Koopman

BREEDING AND EVALUATION PROJECTS - PROGRESS REPORTS

Project leader: KR Tobutt (ARC Infruitec-Nietvoorbij)

Breeding high quality disease resistant apples for first and second economies

Research Organisation Project Number: 2100-01

Objective

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.

Methodology

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.

Results

Budwood of eight selections in the Phase I orchards at Drostersnes that were earmarked in 2012 was collected for propagation by SAPO to raise trees for Phase 2. Over 8000 seedlings in Phase 1 were assessed for crop, appearance, and season and 39 were harvested for assessment of storage performance; twelve selections were short-listed for promotion to Phase 2. Some 30 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; 6 000 of the resulting 18 000 seeds were sown. Further mislabellings in the Elgin and Drostersnes genebanks were noted. DNA was extracted from 540 accessions for fingerprinting. Arrangements were made for the importation of 20 accessions in vitro from the UK. Discussions were held with various colleagues to initiate a breeding database. Two staff members are pursuing PhDs.

Conclusion / Recommendations

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.

Project leader: CU Hörstmann (Mrs L Steyn) (ARC Infruitec-Nietvoorbij)

Breeding apricot cultivars for commercial and emerging farmers

Research Organisation Project Number: 210007

Objective

This project aim 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.

Methodology

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.

Results

Budwood of eight promising selections from 2011 was provided to SAPO for propagation. Thirteen promising selections, harvesting from week 47 to week 49, were identified in Phase I orchards and will be promoted to Phase II. During the 2012 season, hand pollinations yielded a total of 1141 embryos. Budwood from genebank accessions had previously been provided to SAPO for propagation and trees are expected for planting in July 2013. In the complementary THRIP project launched in April 2012, leaf material was collected and initial DNA extractions performed for fingerprinting germplasm and seedlings were screened for a marker indicating resistance to Plum-Pox Virus. The breeder (LS) attended the 6th Rosaceous Genomics Conference in Italy. Two presentations were made to representatives of the stone-fruit industry.

Conclusion / Recommendations

Significant progress was made during the past season: several promising selections were made from Phase 1, 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

Project leader: JP Human (ARC Infruitec-Nietvoorbij)

Breeding of pear cultivars

Research Organisation Project Number: 2100-02

Objective

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

Methodology

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

Results

Budwood of 14 Phase 1 selections and three selections for Inter-Phase Evaluation (promoted the previous year) were supplied to SAPO. Forty-four new selections were identified and harvested and, after storage evaluations, 27 were short-listed for Phase 2 evaluation. These comprised five yellow selections, 14 blush and seven blush-on-russet selections. Among the outstanding selections identified are the blush selection P13-21 (1 Feb) with excellent appearance, very attractive colour, and good texture and taste scoring 24/30; blush selection P13-43 (1 Mar) with excellent appearance, very attractive colour and with good crunchy texture and taste, scoring 24/30. Ninety-one cross combinations were made producing 16,587 seeds, of which 33% were for blush, 16% for miniature pears, 9% for green, 3% for fully reds, 2% for tri-coloured, 23% for intergeneric and 14% for future genetic studies. About 3 500 new seedlings will be planted this winter (July '13) in seedling blocks at Drostersnes. A PhD student is using four seedling progenies at Drostersnes for his project on mapping traits like blush and flavour.

Conclusion / Recommendations

Seven very promising new selections are showing valuable potential for the future and they will follow the "fast track" route with the collaboration of Culdevco as well as the assistance of co-operatives for further evaluation.

Project leader: S. Booi (ARC Infruitec-Nietvoorbij)

Breeding of new peach rootstocks

Research Organisation Project Number: 2100-04

Objective

The ultimate 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 nematodes (root-knot, *Meloidogyne javanica*, ring, *Criconemella xenoplax*, and the combination of both), adapted to South African climate and soil conditions.

Methodology

In the 2012/13 season, 16 ARC-bred stone-fruit rootstock selections and eight commercial rootstock varieties were screened in the revamped Nematode glasshouse at Bien Donné Experimental Farm to check for resistance/tolerance to ring nematodes and the combination of ring plus root-knot nematodes. Two progenies from controlled crosses (Nemared x Kakamas and OSM99-1 x Katera) of 33 and 158 seedlings respectively were screened for resistance/tolerance to root-knot nematodes only.

Results

In the ring nematode trial, four ARC-bred selections were found to be resistant. Where both species of nematodes were inoculated on the selection rootstocks, three ARC-bred selections were resistant to the combination. In the two progenies inoculated with root-knot nematodes, twenty nine and hundred and twenty four seedlings were resistant.

Conclusion / Recommendations

For the 2012/13 season, two ARC-bred selections (OSK99-3 and OSR006) were promoted to Phase 2 for having resistance to the combination of both species of nematodes (*M. javanica* and *C. xenoplax*), bringing to 43 the total number of selections promoted to Phase 2 since 2004.

Project leader: CU Hörstmann (Mrs L Steyn) (ARC Infruitec-Nietvoorbij)

Breeding of Japanese plums for commercial and emerging farmers

Research Organisation Project Number: 210005

Objective

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.

Methodology

Methodology: In addition to the traditional breeding approaches - maintaining genebanks, crossing and selecting - work on molecular breeding was initiated.

Results

Results: Budwood of four promising selections from 2011 was provided to SAPO for propagation. Eleven promising selections, harvesting from week 2 to week 5, were identified in Phase I orchards for promotion to Phase II. During the 2012 season, hand pollinations yielded a total of 1336 embryos. Budwood from genebank accessions had previously been provided to SAPO for propagation, and trees are expected for planting in July 2013. Initial work on the THRIP project launched in April 2012 included collection of leaf material from the genebank accessions and extraction of DNA for fingerprinting. The breeder attended the 6th Rosaceous Genomics Conference. One presentation was made to representatives of the Stone Fruit Industry.

Conclusion / Recommendations

Conclusions and Recommendations: Significant progress was made during the past season: several promising selections were made from Phase I, successful crosses were performed generating seedlings to satisfy breeding objectives and genetic studies, important contacts were made. In addition, THRIP funding is allowing the fingerprinting of the genebank.

Project leader: JAT de Klerk (ARC Infruitec-Nietvoorbij)

Determination of cross pollinators for plum varieties

Research Organisation Project Number: IT2100-22

Objective

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.

Methodology

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.

Results

During the past season, the cross-pollination requirements of one cultivar, Ruby Crunch, and one promising selection, Autumn Sun (PR00-30), were tested at Bien Donné Research Farm, Simondium. The cultivar Ruby Red was tested as a cross pollinator for both Ruby Crunch and Autumn Sun. The self-compatibility trial of Ruby Sun was repeated and a promising selection, PR05-26, was also tested for self-compatibility. The trials started at the end of August and were completed at the beginning of October. Based on the results obtained in the cross-pollination trials it can be concluded that Ruby Red is not a suitable cross-pollinator for Ruby Crunch and Autumn Sun. The results of the self-pollination trials indicate that both Ruby Sun and the selection PR05-26 are self-incompatible.

Conclusion / Recommendations

It is recommended that the cross-pollination requirements of Ruby Sun should be tested and those of Ruby Crunch and Autumn Sun retested with different cross pollinators in the next season. Self-compatibility of a promising selection, Ruby Prince (PR03-15), should also be tested. The general cross-pollination chart of Japanese plums planted in South Africa has been updated.

Project leader: W-M Pieterse (ARC Infruitec-Nietvoorbij)

Breeding of peaches and nectarines for commercial and emerging farmers

Research Organisation Project Number: 2100 03

Objective

This project aims to breed a full range of well adapted, reliably cropping, disease resistant, high quality peach and nectarine cultivars with good cold storage ability, ripening from very early to very late for the fresh market as well as cultivars suitable for canning or for drying. Also to make crosses to facilitate genetic studies towards marker assisted selection.

Methodology

Conventional breeding approaches are used involving genetic resources, crossing and appropriate selection.

Results

Fifteen dessert nectarines were selected for Phase 2. Six have 80% or more red skin coloration and nine are yellow nectarines. Fifteen peaches were selected for dessert, twelve with a red blush and three non-melting ones which should also be suitable for canning. Nine yellow nectarines were selected, in weeks 4, 5 and 6, which should be tested for drying. The crossing season was very successful ~ 10 200 seedlings being reared. Crosses were made to address industry needs i.e. early dessert varieties, varieties ripening in January, white flesh dessert varieties and, for drying, mid to late season varieties and yellow nectarines, and also to facilitate genetic studies and future marker assisted breeding.

Conclusion / Recommendations

The gap in the ripening spectrum of dessert peaches and nectarines in January, identified by the Stone-Fruit Advisory Committee, has been partially addressed by promoting 24 peach and nectarine selections to Phase 2. Nine yellow nectarine selections were promoted to Phase 2, which should alleviate the shortage of yellow nectarines for the drying industry.

A literature review on carotenoids was conducted and the project leader intends to register for a PhD on fruit quality traits involving molecular genetic research

Project leader: Mr W-M. Pieterse (ARC Infruitec-Nietvoorbij)

Planting and maintenance of existing and new germplasm of pome fruit, stone fruit and alternative deciduous fruit crops

Research Organisation Project Number: 2100-18

Objective

This project maintains a genebank of existing and newly imported cultivars and selections of pome, stone and alternative fruit crops as a source of breeding material, for conservation and for exchange, with special emphasis on the development of improved deciduous fruit cultivars.

Methodology

Normal orchard maintenance and management were performed and steps were taken to eliminate false entries, to improve documentation and to introduce useful new accessions.

Results

Twenty peach accessions imported from the USDA repository in California were delivered to the quarantine station in Stellenbosch. An import permit was obtained for a low-chill apricot variety, which will be supplied by CEBAS-CSIC in Murcia, Spain. Land was prepared for establishing new pear and apricot genebanks. The plot plans of three apple genebank plots in the Elgin Valley, one at Drostersnes and two at Grabouw, were updated. Two students (KG Mhlelembe and Ms FP Moima) began work on fingerprinting accessions in the pome- and stone-fruit genebanks.

Conclusion / Recommendations

Progress has been made with the sourcing of new accessions from sources overseas to bolster the genebank collection. Establishing new apricot and pear genebanks should safeguard these collections. The fingerprinting will help rationalise the collections. Documentation needs further improvement.

Project leader: Ms E Lotz (ARC Infruitec-Nietvoorbij)

Cold storage characteristics of new cultivars and selections

Research Organisation Project Number: 2600/09

Objective

The project aims to evaluate new stone and pome fruit cultivars and Phase 2 selections from the ARC Infruitec-Nietvoobij's Cultivar Development Division programmes for cold storage ability and to supply the researchers of that division with the storage data which will help them and other stakeholders decide on the future of new selections.

Methodology

The fruit is stored according to crop-specific cold storage protocols, designed in consultation with stakeholders. Appropriate maturity and quality evaluations are performed according to protocol. Data (e.g. for harvesting maturity, maturity after storage, quality defects and general comments) are stored in MS Excel. Data are 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.

Results

Fruit were received from November 2012 to April 2013. A total of 694 fruit samples were received for cold storage during the 2012/13 season. Data were shared with Cultivar development researchers and are presented in the relevant Phase 2 reports. Feedback aimed at improving production practices (relating to decay, insect damage and harvesting maturity) were also shared.

Conclusion / Recommendations

Recommendations on the storage ability of 694 samples were made to the researchers of the Cultivar Development Division and incorporated into relevant reports.

Programme leader & Project leader: KR Tobutt (ARC Infruitec-Nietvoorbij)

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

Objective

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.

Methodology

Young leaves were collected in spring from the apple and pear genebanks at Elgin, Drostersnes and Bien Donne. DNA was extracted using a variation of the CTAB method and quantified with a Nanodrop. After discussions with overseas researchers, sets of microsatellite primers recommended internationally for fingerprinting were obtained along with primers for the agronomic genes S (incompatibility), ACS (ripening) and endoPG (stone adhesion).

Results

Khethani Mhelembe was recruited to the MSc studentship starting on 1st March 2012 and Carl Horstmann to the PhD studentship and Fetsang Moima to an associated MSc studentship starting on 1st July.

Registration at Stellenbosch University was arranged. The MSc students received extensive training in Cultivar Development and attended courses at Stellenbosch University. DNA was extracted and quantified from 540 apples, 220 pears and 130 apricots and plums from the genebanks. PCR conditions were optimised for the microsatellites and agronomic genes.

Conclusion / Recommendations

The first year of this project paid particular attention to student recruitment and training. The second year will focus on data generation and collation. The project has benefited, and will continue to benefit, from collaboration not only with Stellenbosch University but also with overseas researchers.

Special mention

Very sadly, Fetsang Moima passed away in May 2013.

Project leader: TA Koopman (ARC Infruitec-Nietvoorbij)

Evaluation of newly developed stone fruit cultivars/varieties and training in fruit growing for the Second Economy

Research Organisation Project Number: 282031

Objective

The aim of the project is to 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 address the aim of food security within specific communities.

Methodology

Liaison is maintained with the communities by giving them advice on cultural practices needed to grow stone-fruit successfully and helping them to plant new cultivars that are suitable for their fruit growing regions.

Results

Eight nectarines, two peach and ten plums were evaluated at Koekedou, Ceres. Fruit at Mgwali were eaten by birds and bats and no fruit were available for evaluation at this site. One hundred trees of Bonni Gold, De Wet and Nova Donna were planted at Mgwali. Ongoing informal training on pruning and thinning was given.

Conclusion / Recommendations

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. The hundred plants of three cultivars planted at Mgwali will help the community to establish a larger orchard.

Project Leader: TA Koopman (ARC Infruitec-Nietvoorbij)

Evaluation of newly developed pome fruit cultivars and training in fruit growing for the Second Economy

Research Organisation Project Number: 282032

Objective

The overall objective of this project is to 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.

Methodology

Liaison with communities was maintained and advice given on cultural practices needed for growing pome-fruit. Plantings were made and new selections evaluated at communities to select the well adapted selections for those regions.

Results

Twenty four apples selections were evaluated during the 2012/13 apple growing season at Koekedou, Ceres. Colour development was good during this season and the best performing apple selections were the following summer apples:
DN 1-12-180, DN 1-12-113, DN 1-12-113, DN 2-4-81R, DN 4-22-69R, DN 1-13-246, DN 2-8-136R and DN 4-77-8R, and the late apple Elegant.

Conclusion / Recommendations

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 in those climatic conditions.

Project leader: MK Soeker (ARC Infruitec-Nietvoorbij)

Phase II evaluation of apple cultivars

Research Organisation Project Number: 2100/08

Objective

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.

Methodology

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

Results

A total of 98 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 eight and twelve weeks in cold storage, for low chill and medium chill selections, respectively. Of these, 41 stored well, 16 showed average storage ability, 19 were below average, 19 had no storage potential and three needed to be re-evaluated due to decay. The best selections, after quality assessment, from each category were: 8E-2-28, fully red, scoring 68%; 8D-5-22, fully yellow, scoring 64%; 4A-16-37, green 58%; 8A-6-15, pink blush, 70% with good storage potential, good texture and liquorice-like flavour; 8E-2-36, bi-colour, 70%; 1-14-8, striped, 76% with balanced taste and good flavour and texture. Eleven new selections were planted at Elgin Experimental Farm in December 2012. 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 13 SSR markers, as part of an on-going THRIP genotyping project.

Conclusion / Recommendations

After comparing evaluation data of the last five years, 31 locally bred selections and eight imported selections were identified for removal.

Project leader: MK Soeker (ARC Infruitec-Nietvoorbij)

Phase II evaluation of pears in the Western Cape

Research Organisation Project Number: 2100/09

Objective

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

Methodology

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

Results

A total of 193 selections and cultivars were harvested from Phase 2 plots at Elgin Experimental Farm and evaluated and tested for cold storage ability at the Post Harvest Division at ARC-Infruitec after eight in cold storage. Of these, 42 selections stored well, 70 did not store well, 22 had average storage ability, and 39 were below average and 22 needed to be re-evaluated. The best selections for each of the product types were as follows: P99-17(MP), yellow miniature scoring 85% for consumer traits; P98-10(MP), green/yellow miniature scoring 55%; P00-5(MP), blush miniature scoring 50%; P02-10, green, 66%; 4C-106-24, green/yellow, 59%; 4C-108-8, yellow, 64%; 'Grafin Gepa', blush, 75%, followed by P07-3 at 72%; P07-12, full red, 64% and 3D-41-5, brown, 51%. No selections were sent for canning and drying this year, but a few have been identified for the 2013/2014 season. Thirty-five Phase 2 and 24 ARC Interphase selections were planted at Elgin Experimental Farm in 2012. Leaves were collected from 170 selections and these were prepped for genotyping as part of the THRIP project.

Conclusion / Recommendations

Ninety-eight entries scored low marks in the past season during quality assessments and after comparison of evaluation data of the last five years, 61 will be discarded.

Project leader: WJC Smith (ARC Infruitec-Nietvoorbij)

Phase 2 evaluations of apricot cultivars in the winter rainfall region

Research Organisation Project Number: IT2100-12

Objective

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

Methodology

Fruit samples were harvested each week from November 2012 to February 2013 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.

Results

During the past winter, Bien Donné Research Farm received more chilling units than Robertson Research Farm. Eleven selections, harvested to test cold storage ability, scored 80% (cut-off point) or more, two canning selections scored more than 60% (cut-off point) and none of the drying selections scored 60% (cut-off point) during evaluation. Several promising apricot cultivars and/or selections were given special attention at request of Culdevco with regards to horticultural traits. Three new cultivars (Solitaire, Rustic and Ambiance) were released to the fruit industry in May 2012. 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.

Conclusion / Recommendations

Evaluations and exhibitions should continue in 2013/2014.

Project leader: WJC Smith (ARC Infruitec-Nietvoorbij)

Phase 2 evaluations of plum cultivars in the winter rainfall region

Research Organisation Project Number: IT2100.11

Objective

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

Methodology

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

Results

The evaluation results were supported by climate information; there was a significant variation in accumulation over years on Bien Donné (405 to 897 ICU) and Robertson (440 to 722 ICU) farms. Twenty-four new plums selections were planted at Bien Donne, Robertson and Ceres in 2012. One hundred and sixty plum selections were evaluated for cold storage and 34 obtained more than 80%,with three obtaining 90% or more. Culdevco requested a reduction in the threshold for cold storage ability from 90% to 80%. Various promising plum selections were given special attention at Culdevco'request. Three new varieties received PBR and VL registrations and were released for commercial plantings. 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.

Conclusion / Recommendations

Horticultural and post-harvest evaluations and fruit exhibitions should continue in 2013/14. Selection and varieties for removal from evaluation blocks should be identified.

Project leader: WJC Smith (ARC Infruitec-Nietvoorbij)

Phase 2 evaluations of peach and nectarine cultivars in the winter rainfall region

Research Organisation Project Number: IT2100.10

Objective

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

Methodology

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

Results

Twenty-four peach and nineteen nectarine selections were planted at Simondium, Robertson and Ceres in 2012. Twenty-eight peach and twenty-five nectarine selections were evaluated for cold storage. Five peach and seven nectarine selections scored 90% or more. Eight canning peach selections received scores of more than 70% from the industry panel. Varieties harvesting from week 5 onwards are still considered as a high priority. White flesh peaches for canning will no longer be a priority. Sixteen nectarine samples were evaluated for drying ability. Four selections scored higher than 70% and one 90%. Thirty peach selections were tested for drying. Six varieties scored more than 70% of which five exceeded 80%. Several promising selections were given special attention at the request of Culdevco. Three peach and five nectarines received Plant Breeders' Rights and Variety Listings. 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 ones in Mozambique.

Conclusion / Recommendations

Horticulture and post-harvest evaluations and fruit exhibitions should continue in 2013/14. Selections and varieties for removal from evaluation blocks should be identified.

Project leader: IJ Meintjes (ARC Infruitec-Nietvoorbij)

Evaluation of stone fruit in the summer rainfall area

Research Organisation Project Number: 2100-13

Objective

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

Methodology

Fruit samples were harvested weekly from October to January at the two 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 whereafter the data were captured on a MS Access database.

Results

Evaluations were conducted on 293 phase 2 selections (6 or 3 trees each) at the three evaluation sites. From the 293 selections, 106 peach, 121 nectarine, 24 plums and 8 apricot selections could be sampled and were evaluated on the standard evaluation data forms. Currently there are 37 promising selections, 9 peach, 14 nectarine, 11 plum, and 3 apricot selections, which will be re-evaluated in the 2013 season. Possible promotion of these 37 selections to Phase 3 will be discussed with Culdevco in order to make final decisions regarding the high amount of promising selections. Some 51 newly identified selections (22 peach, 17 nectarine, and 12 apricot) were planted in Phase 2.

Conclusion / Recommendations

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 37 promising selections in order to create a short-list for possible cultivar releases to the summer rainfall producers.

Crop Production

HORTGRO science
the technology collective

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CROP PRODUCTION RESEARCH PROGRAMME

The Crop Production Research Programme within the Sustainable Farming Investment Area aims to increase the profitability of deciduous fruit farming by increasing marketable yield per hectare and by decreasing input costs in a sustainable manner. The Programme encompasses, but is not limited to horticultural science and soil science. Research needs are determined within seven Workgroups on Reproductive Biology, Rootstocks, Growing Season Climate, Dormancy, Soil Health, Irrigation and Nutrition, and Labour efficiency. These workgroups consisting of researchers, technical advisors and fruit growers determine and communicate research needs to researchers and resultant project proposals are prioritised by the Crop Production Technical Advisory Committee. This structure ensures that the Crop Production Research Programme is grower-driven, industry-focused, relevant and optimally utilises limited funds and research capacity. Some workgroups are shared with other Research Programmes to facilitate and ensure the necessary cross pollination and multidisciplinary collaboration.

Tables 1 and 2 provide a list of Crop Production research projects funded and completed during the 2012/13 financial year at Stellenbosch University and ARC Infruitec-Nietvoorbij. Since we realise that research not published is research not done, we aim to feature at least one Crop Production article stemming from HORTGRO Science-funded Crop Production research in each issue of the South African Fruit Journal. This way, you will get the opportunity to read all about the completed research projects in the journal. Refer to the section on Technology Transfer for information on extension actions during the 2012/13 financial year. Efforts are underway to rebuild a strong multidisciplinary team to research dormancy physiology and rest breaking. To further this goal, Dr Esmé Louw (SU Horticultural Science) will be attending an International Dormancy Workshop during Nov 2013.

Table 3 lists the 12 new projects approved for the 2012/13 financial year. Water scarcity, a long-term drying trend and increasing competition for water are going to be major limitations to future deciduous fruit production in the winter rainfall regions. Irrigation research can be quite expensive and therefore HORTGRO Science is investigating co-funding possibilities with agencies such as the Water Research Commission (WRC) with their much deeper pockets. Our involvement in specific WRC projects will ensure that the best interests of fruit growers are taken into account. An example of such collaboration with the WRC is the new project proposal that is aimed at establishing maximum water use of apple trees. Once we know the maximal water use, subsequent research may address the impact of water conservation practices such as mulching, shade netting and drip irrigation. This project is still under review at WRC and we will probably learn the outcome towards Dec. Upon acceptance of the project by the WRC, HORTGRO Science will investigate further international co-funding opportunities with industries experiencing similar pressures on irrigation water.

History was made on 18 September when HORTGRO Science planted the first apple rootstock evaluation trial site in the Langkloof at Helderwater farm of Dutoit Agri. The Helderwater trial site forms part of a trio of identical plantings - the other two evaluation sites are located at Breëvlei and Oak Valley Estate in Grabouw. These trials were designed with input from the Rootstock Evaluation Committee (REC), SAPO Trust and the Crop Production Technical Advisory Committee in order to assess the performance of the new Geneva® range of rootstocks compared to industry standard rootstocks such as MM109, M793 and M7. M9 clones and M9 and G222 interstems are also assessed. In addition to the planting of evaluation sites, various research projects have been initiated to screen apple rootstocks for their adaptability to South African conditions, i.e., high summer temperatures (Elmi Lötze and Michael Schmeisser), lack of winter chilling (Laura Allderman), as well as their resistance and tolerance to woolly apple aphid (Carlo Costa, Ken Pringle) and replant disease (Karien Bezuidenhout). The ultimate aim is to, together with stakeholders such as SAPO Trust, Stargrow and other nurseries, identify a shortlist of rootstocks of varying vigour

that will be appropriate for South African conditions, and will fit with the need for designing increasingly more efficient orchards.

Research on the cost effectiveness of mechanical thinning, platform utilization and mechanised harvesting systems is in progress and has been reported on at the HORTGRO Science Technical Symposium - this was the theme for the second day - while orchard walks were held in Ceres and Grabouw. Gerrit van Merwe and Karen Theron, respectively evaluating platforms and mechanical thinning, showed that tree structure is one of the major impediments to mechanisation in South African deciduous fruit orchards. Mechanization cannot be seen - and should not be studied - in isolation. It makes up the orchard system together with a diverse range of factors such as the management philosophy, farming and production objectives, operational systems, labour organisation, climate, orchard design and topography. To increase efficiencies in the orchard, we need to move towards more dwarfing rootstocks and fruiting walls, as is the trend elsewhere in the world and as is being advocated by various technical consultants - see the article about the Future Orchards on p95 of the Oct/Nov 2013 issue of the SAFJ for an indication of current thoughts on the matter. Netting may form part of the "Orchard of the Future" considering that it will significantly decrease sunburn and rub marks, allow the utilisation of more dwarfing rootstocks, decrease irrigation needs, decrease heat stress and thereby potentially increase tree productivity, preclude the need for hail insurance and improve spray application efficiencies. One may assume that rootstocks like that M9 that apparently do not enjoy high soil temperatures and drought stress may benefit from the "climate control" brought about through netting. On the downside, netting is very expensive (especially if the North-westerly and South-easterly winds rip it apart), may increase some diseases and pests, may decrease fruit set (particularly on vigorous rootstocks) and decrease fruit colour. We need research to determine the growth and fruiting responses of trees on dwarfing rootstocks under nets and we also need to quantify the benefits and negative effects of nets in order to determine the feasibility of netting different cultivars. The effect of nets on pests and diseases also requires elucidation.

Low research capacity for pre-harvest horticultural research and training was identified as a critical threat to our industry. Willie Kotze is the HORTGRO Science Fruit Production Researcher placed within the Two-a-Day Technical Department in Grabouw to conducted applied research projects. In the 2012/13 financial year, Willie conducted 7 projects of which many included more than one cultivar and orchard.

We thank SAAPPA and SASPA, HORTGRO Science management, the research organisations and researchers active in the Crop Production Programme for their support of Crop Production Research. I would like to especially thank the members of the Crop Production Technical Advisory Committee as well as the members of the Horticulture and Soil Science Peer Workgroups for the selfless contribution of their time and effort in service of the deciduous fruit industry.

Dr Wiehann Steyn

Table 1. Final project reports received in 2013

Project title	Fruit kind	Researcher
Evaluating the effect of CropBiolife on fruit size and yield	Apple	W.P. Kotze
The progression of endo- and paradormancy in apple buds as affected by different climatic regions.	Apple	Laura Allderman & Nigel Cook
Effect of fruit removal on entrance into bud dormancy in apples and plums.	Apple, plum	Laura Allderman & Nigel Cook
Reports due 2014		
Comparing synthetic cytokinins by the amount of cells developed in the pulp of 'Abate Fetel' and 'Forelle' pears.	Pear	Karen Theron
Using combinations of GA3, GA4+7, AVG and Pro-hexadione-Ca to improve fruit set on 'Abate Fetel' and 'Forelle' pears.	Pear	Karen Theron
Evaluation of soil surface and mulching practices for organic production of deciduous fruit.	Apple	John Wooldridge
Evaluate pear rootstocks and planting systems.	Pear	Mike North
Apple rest breaking linked to dormancy model.	Apple	Mike North
Inherent and acquired resistance to fruit sunburn and poor colour in various apple and pear cultivars.	Apple, pear	Wiehann Steyn
Effect of shade nets on the productivity of 'Granny Smith' and 'Fuji' apples in the EGVV region.	Apple	Willie Kotze

Table 2. Running projects

Project title	Fruit kind	Researcher
Effect of different cover crop management practices on the soil and performance of apple trees.	Apple	Johan Fourie
Apple rootstock evaluation at Paardekloof, Witzenberg Valley.	Apple	Willie Kotze
Plum rootstock evaluation.	Plum	Piet Stassen
Evaluation of peach rootstocks.	Peach, nectarine	Piet Stassen
Evaluation of apricot rootstocks.	Apricot	Piet Stassen
Evaluation of new apple rootstocks for tolerance to woolly apple aphid	Apple	Carlo Costa
Tolerance and susceptibility of commercial stone fruit rootstocks for plant parasitic nematodes.	Plum, peach, nectarine, apricot	Piet Stassen
Ecophysiological assessment of the effect of different apple rootstocks on scion performance.	Apple	Michael Schmeisser
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.	Apple	Esmé Louw
Establish the effect of rest breaking agents on vegetative and reproductive development of apples in the Koue Bokkeveld/ Witzenberg valley.	Apples	Willie Kotze
Rest breaking programmes for warm winter regions	Apple	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 and pear	Laura Allderman
The application of sucrose to enhance fruit set in 'Packham's Triumph' pear.	Pear	Willie Kotze
Evaluation of mechanical thinning and GA application on crop load of stone fruit.	Plum, nectarine	Karen Theron
Chemical thinning of apples.	Apple	Willie Kotze
Chemical thinning of Abate Fetel in Ceres.	Pear	Willie Kotze
NAA and Ethephon to increase return bloom in apples and pears	Apple & pear	Willie Kotze
Water relations and sunburn in pome fruit.	Apple, pear	Wiehann Steyn
Heat stress in plums.	Plum	Wiehann Steyn
Cost effectiveness of picking platforms and the Hermes harvesting system relative to conventional labour intensive farming practise.	Apple, pear, plum, nectarine	Wiehann Steyn

Table 3. New projects approved for 2013.

Project title	Fruit kind	Researcher
Mechanical thinning of pome fruit.	Apple & pear	Karen Theron
Chemical thinning of stone fruit.	Peach/ nectarine & plum	Karen Theron
Apple rootstock evaluation at Helderwater, Langkloof.	Apple	Willie Kotze
Apple rootstock evaluation at Oak Valley Estate, Grabouw.	Apple	Willie Kotze
Apple rootstock evaluation at Breëvlei, Grabouw.	Apple	Willie Kotze
Apple rootstock evaluation at Vergelegen, Grabouw.	Apple	Willie Kotze
Determining the chill requirement of important stone fruit rootstocks available to the South African fruit industry.	Peach, plum & apricot	Laura Allderman
Quantifying water use of high performing commercial apple orchards in the winter rainfall area of South Africa.	Apple	Sebinazi Dzikiti
The effect of climate on split pit in plums	Plum	Mariana Jooste
Nematode community structure and function as a bio-indicator of the effects of soil amendments on soil health	Apple	Sheila Storey
Validation of an enzyme-based soil alteration index for testing soil health in local apple orchard soils.	Apple	André Meyer
Apple root dynamics.	Apple	Elmi Lötze

Table 4. Extended projects.

Project title	Fruit kind	Researcher
Apple replant rootstock trials for determining a screening technique.	Apple	Karien Bezuidenhout
Quantifying the effect of selected ambient summer temperatures on rootstock growth in a pot trial in environmental chambers.	Apple	Elmi Lötze

CROP PRODUCTION PROJECTS - PROGRESS REPORTS

Project leader: Dr J.C. Fourie (ARC Infruitec-Nietvoorbij)

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

Research Organisation Project Number: 280020

Methodology

Pre-treatment data was collected for all the objectives of the trial and the treatments commenced during April.

Conclusion / Recommendations

It is suggested that the project should be allowed to continue in order to determine the effect of the different cover crop management practices on the growth, yield and water use of apple trees, the occurrence of nematodes in the soil, weed control efficacy, soil nutrient status and organic matter content, supply the fruit industry with scientifically based guidelines, which will result in the sustainable use of cover crops and cover crop mixtures for effective nematode and weed suppression and supply the fruit industry with scientifically based soil management guidelines which will be beneficial to the economically sustainable production of apples.

Project leader: Mrs K Bezuidenhout (ARC Infruitec-Nietvoorbij)

Apple replant rootstock trials for determining a screening technique

Research Organisation Project Number: 250016

Objective

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

Methodology

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

Results

It was concluded that the pot trial growth results was not an accurate indication of results in the field, possibly due to growth restriction. From the percentage increase in total shoot growth in the field plots at Oak Valley, MM109

seemed to be most tolerant. For Graymead, G222 and possibly MM109 (only after two growing seasons) seemed to be most tolerant. G228 seemed more susceptible at both sites. Therefore, the only rootstock that consistently showed tolerance to ARD conditions in the field sites was MM109. CG4202 showed highest total plant mass within the Geneva range. Plant nutrient content showed no simple trends and results from these analyses could not be related to plant growth. Lesion nematode results from the field sites were not significant, possibly due to spatial variation. The Oak valley soil in the pot trial showed MM109 as most tolerant while in the Graymead soils CG4202 and G228 performed best. The qPCR results obtained from the pot trial root and soil samples showed high levels of Cylindrocarpon DNA in comparison to Pythium irregulare and P. sylvaticum. However, the performance of the rootstocks could not be directly related to the presence and levels of the aforementioned fungi.

Conclusion / Recommendations

Rootstocks differ in response to ARD conditions and current findings should be confirmed with future repeated trials.

Project leader: Mr W.P. Kotze (Hortgro Science)

Apple rootstock evaluation in the Witzenberg valley

Research Organisation Project Number: A-11-HOR-CP16

Objective

The objective of this project is to assess and compare the performance of various new dwarfing and semi-dwarfing apple rootstocks from the Geneva range against the industry standards M793, MM106, M25 and MM109.

Methodology

Trees grafted to 'Rosy Glow' were planted during winter 2010 at Paardekloof in the Witzenberg Valley. Dwarfing (Cepiland, G222, CG3007, CG6210, Lancep, M793, M9, MM106, MM109/M9, RN29) and semi-vigorous rootstocks (G222, G228, G778, CG934, M 25, M793, Maruba, MM109) were grouped together in two adjacent plots that are managed separately. M793 and G222 were included in both plantings as internal controls. The 2013 yield was recorded and tree height and trunk diameter measured during winter 2013.

Results

The CG range of rootstocks shows promise after the first year of production. The yield efficiency of these rootstocks generally surpassed that of the industry standard rootstocks at both sites. M793 in particular, performed below par. There were minor differences in fruit quality, but differences may become more prominent as trees increase in size.

Conclusion / Recommendations

It is way too soon for conclusions and recommendations from this trial. Data collection over subsequent seasons and from more trial sites is required.

Project leader: Dr P.J.C. Stassen (ARC Infruitec-Nietvoorbij)

Plum rootstock evaluation

Research Organisation Project Number: 220035

Objective

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).

Methodology

Two trials with African Delight were planted during 2008 (Elkana, Simondium; 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 layre use.

Results

At Elkana trees on Maridon, GF 677, Marianna, Flordaguard and SAPO 778 performed well over a three harvest period, on low lying sandy soil that was well drained. At Sonskyn trees on GF 677, Atlas and Chuche Picudo performed good on calcareous soil with high numbers of ring and spiral nematodes. At Roodehoogte trees on GF 677 performed the best, but not significantly better than trees on Marianna on this high pH soil with moderate numbers of ring nematodes.

Conclusion / Recommendations

Results of trees on sandy soils (6.6% clay and silk) that was fumigated and well drained before plant, indicate that several rootstocks may be considered (Maridon, GF 677, Marianna, Flordaguard and SAPO 778). Results at Sonskyn (10.6% clay and silt) with high pH and moderate to high ring nematodes, indicate that GF 677, Atlas and Chuche Picudo performed well and that Cadaman may also be part of this group in future. At Roodehoogte (25% clay and silt), with high pH and moderate to high ring, GF 677 performed the best.

Project leader: Dr P.J.C. Stassen (ARC Infruitec-Nietvoorbij)

Evaluation of peach rootstocks

Research Organisation Project Number: 220039

Objective

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 borne diseases and replants problems, plant-parasitic nematodes as well as horticultural traits such as yield, yield efficiency, fruit size and climatic adaptability.

Methodology

Seven trials were planted in different areas and soil conditions on commercial farms, using recommended statistical lay-outs. Two trials at Bufland, Mookgophong (scion Alpine, planted 2008 and 2009) and Artic Star at Excelsior, Worcester, was harvested during report year.

Results

Trees at Mookgophong (low chill, moderate to high ring and spiral nematodes presence, 93.3-95.8% sand and irrigation by micro sprinkler every third day) yielded their third crop. In terms of yield, yield efficiency and fruit weight, trees on Flordaguard, Cadaman and Atlas (planted in 2008) and Flordaguard, Viking and Atlas (planted in 2009) performed the best and did not differ significantly. Over three 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. ?Artic Star? on Cadaman yielded the best, but not significantly better than on Felinem and Viking while trees on Tsukuba 4, Chuche Picudo and Tetra had the lowest yield.

Conclusion / Recommendations

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.

Project leader: Dr. P.J.C. Stassen (ARC Infruitec-Nietvoorbij)

Evaluation of apricot rootstocks

Research Organisation Project Number: 220038

Objective

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.

Methodology

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.

Results

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

Conclusion / Recommendations

No recommendations at this stage.

Project leader: Mr C. Costa (ARC Infruitec-Nietvoorbij)

Screening of apple rootstocks for resistance to woolly apple aphid

Research Organisation Project Number: 220040

Objective

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).

Methodology

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. Trees need to be at least 40 cm high before inoculation with WAA to ensure accurate measure of resistance and tolerance.

Results

To date we have succeeded in establishing 18 of the 20 genotypes in vitro, 13 which have passed the proliferation stage, 11 which have passed the rooting stage and into the hardening off phase and 8 which have been transplanted into planting bags, of which 6 will reach the 40 cm minimum height in the spring of 2013 before inoculation with WAA can take place.

Conclusion / Recommendations

The work plan will therefore need to be extended to allow for repeated inoculation trials of the entire series.

Project leader: Dr P.J.C. Stassen (ARC Infruitec-Nietvoorbij)

Tolerance and susceptibility of commercial stone fruit rootstocks for plant-parasitic nematodes

Research Organisation Project Number: 220041

Objective

The objective of this project is to evaluate the growth performance of budded peach and plum trees on selected commercial rootstocks as well as unbudded selected 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. We also want to determine the long term effect on root development and the possible host status of commercial rootstocks.

Methodology

During mid-September of 2012, ?African Rose? plum trees budded on Marianna (immune to root-knot, but sensitive

to ring), Maridon, Guardian clone (tolerant to ring according to literature), Guardian seedling, Viking clone (resistant to root-knot and partial tolerant to ring) and Viking seedling, were planted in a sand/shale potting soil in 540 mm pots, using an automatic fertigation system. ?Alpine? nectarine trees budded on Guardian clone, Guardian seedling, Atlas, Viking, Flordaguard, SAPO seedling and Mr 2/5 were planted in the same potting soil in 250mm pots and kept in a glasshouse at recommended temperatures. Fertigation was done daily by hand. Inoculations were done during end-October 2012 and growth measurements from 9 November 2012 until 1 March 2013. Ring and root-knot evaluation and analysis was done during June 2013. New rootstocks cuttings were planted during autumn 2012 to be ready for spring 2013.

Results

Analysis and growth measurements indicated that both ring and root-knot inoculations failed to survive in glasshouse grown pots for the full growth period.

Conclusion / Recommendations

Changes in potting soil, glasshouse operation and focus are recommended for the coming season

Project leader: Dr M Schmeisser (SU)

Ecophysiological assessment of the effect of different apple rootstocks on scion performance

Research Organisation Project Number: A-12-USH-CP15

Objective

Ecophysiological parameters (photo-assimilation, stomatal conductance, transpiration, water status) and leaf morphological characteristics of 'Rosy Glow' grafted on different rootstock were evaluated to help explain the underperformance of certain rootstocks (CG222, CG228, CG 778, CG934, CG3007, M25, MM106, MM109/M9, MM109, M793, MARUBA, NIC29, RN29, CEPILAND, LANCEP, CG6210) under South African growing conditions.

Methodology

Rootstocks were planted in a randomised complete block design, however in two separate sites within the same orchard and were therefore analysed separately. The one plot contained the dwarfing rootstocks (DWARFING SITE), with M793 included to serve as the industry standard and the second plot contains vigorous rootstocks (VIGOROUS SITE), including M793 as the industry standard, but also CG222 as a semi-dwarf comparison. Photosynthesis, stomatal conductance and transpiration rates were measured using an infra-red gas analyser (LI-6400), from which water use efficiency was calculated. Pre-dawn leaf water potential and midday stem water potential were determined using a Scholander pressure bomb. Average leaf area, fresh weight, dry weight, stomatal density and length were determined. Complete leaf mineral analysis was conducted.

Conclusion / Recommendations

There are significant differences between the measured parameters, but with only 1 years data it is difficult to make any conclusions. The differences in yield, yield efficiency and tree size do not correlate with any ecophysiological parameter measured and no consistent pattern between vigorous and dwarfing rootstocks can be discerned. Another year's data is required to verify the consistency of the data

Project leader: Dr E. Lötze (SU)

Quantifying the effect of selected ambient summer temperatures on rootstock growth in a pot trial in environmental chambers

Research Organisation Project Number: EL Temp2

Objective

The performance of new CG apple rootstocks under warmer soil conditions were evaluated in controlled climate chambers as warmer temperatures are predicted for our growing regions.

Methodology

Rootstocks were all obtained from SAPO, placed at 4°C in the cold room for one month before being planted in pots. They were grown at moderate temperatures for a few months before application of differential temperatures in October 2012. Pathogens were noticed and CG 778 material was supplied to the Plant Pathology Disease Clinic, Stellenbosch University for identification. Plants were harvested at the end of December 2012 when the shoots reached the growth chamber ceilings. The highest temperature was only maintained for 10 days, with both soil and air temperatures reaching 38°C 24h per day.

Results

There were no interactions between rootstocks and temperatures (30, 34 and 38°C). CG 222 outperformed the other rootstocks at 38°C. CG 788 did not grow at all. M9 and M793 showed stress signs at 34°C, whereas M7 showed signs of stress only when temperatures reached 38°C.

Conclusion / Recommendations

The lack of interaction between temperature and rootstocks did not justify mineral analyses of the new growth. This trial has been repeated two seasons with similar results regarding rootstock: temperature interaction and can thus be accepted as a valid response for these rootstocks.

Project leader: Dr E.D. Louw (SU)

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

Research Organisation Project Number: A-13-USH-CP19

During the first quarter of 2013, the PhD student we had recruited for the project withdrew and we were unable to successfully replace her. This resulted in a delay in method development that was planned for 2013.

Objective

A literature review on apple bud dormancy was the major output for 2013.

Methodology

The literature review describes bud dormancy progression in terms of induction, maintenance and release as influenced by temperature. Physiological changes during dormancy are also discussed giving special reference to transformations in plasmodesmata, ATPase activity, oxidative stress, respiration pathways, hormonal involvement and bud anatomy during dormancy. Bud dormancy progression in warm winter climates is also discussed in terms of studies done in South Africa, especially the Western Cape apple producing areas.

Results

The literature review emphasises the lack of information on the physiological changes in bud dormancy progression under natural warm winter orchard conditions. Insufficient chilling is a reality in most of the Western Cape apple producing areas and understanding the physiological effects thereof will bring us closer to finding a successful practical management tool. Contrasting regions with sufficient and insufficient chilling conditions within the Free State and Western Cape borders were identified and proposed to be used as a model study site for comparable research on the physiological dynamics of bud dormancy in areas with low winter chilling.

Conclusion / Recommendations

The objectives and milestones of the project were redefined to include the study of physiological aspects such as respiration pathways, oxidative stress and auxin concentration and movement opposed to gene expression studies that was included in the initial proposal.

Project leader: Mr W.P. Kotze (Hortgro Science)

Establish the effect of rest breaking agents on vegetative and reproductive development of apples in the Koue Bokkeveld and Witzenberg valley

Research Organisation Project Number: 2011 - DBRusbreek

Objective

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

Methodology

The following rest breaking treatments are applied to the same trees from winter 2011 to winter 2013: 3% oil, 6% oil, 4% Lift and, 0.5% Dormex + 4% oil. Rest breaking treatments are compared to an untreated control.

Results

Despite the accumulation of 1856 Infruitec chilling units during winter 2013, rest breaking treatments were able to influence rest breaking of 'Cripps' Pink' in the Koue Bokkeveld. Lift at 4% increased the percentage vegetative bud break, while 3% and 6% oil were able to condense flowering. No effects were observed on 'Golden Delicious' in the Witzenberg valley.

Conclusion / Recommendations

It is too soon for general recommendations regarding the effectiveness of rest breaking agents in the Koue Bokkeveld and Witzenberg Valley.

Project leader: Mrs L.A. Allderman (Hortgro Science)

The efficacy of rest breaking chemicals on apples as a function of cultivar, chill unit accumulation, time of application and temperature, under laboratory conditions

Research Organisation Project Number: A-12-HOR-CP23

Objective

The response of rest breaking agents (RBA) application on apple trees is not consistent from year to year. By studying RBA effectiveness under laboratory conditions, we will be able to better understand the processes involved which will intern lead to increased efficiency in the field.

Methodology

One-year-old apple shoots were cut prior to RBA orchard application and treated with various concentrations of Dormex, Lift, Oil and a Dormex/oil combination. Ten shoots of each treatment were then forced in buckets containing a mild bleach solution at various temperature regimes which aim to replicate different spring climatic scenarios. The time to budbreak, rate of budbreak and percentage budbreak of the shoots give an indication of the efficacy of the RBA under the different temperature regimes.

Results

The 2013 season's data capture will be completed by the end of September. Results for the 2013 season are therefore not yet available.

Conclusion / Recommendations

The trial is progressing according to plan

Project leader: Mrs L.A. Allderman (Hortgro Science)

The efficacy of rest breaking chemicals on pears as a function of cultivar, chill unit accumulation, time of application and temperature, under laboratory conditions

Research Organisation Project Number: P-12-HOR-CP24

Objective

The response of rest breaking agents (RBA) application on pear trees is not consistent from year to year. By studying RBA effectiveness under laboratory conditions, we will be able to better understand the processes involved which will intern lead to increased efficiency in the field.

Methodology

One-year-old pear shoots were cut prior to RBA orchard application and treated with various concentrations of Dormex, Lift, Oil and a Dormex/oil combination. Ten shoots of each treatment were then forced in buckets containing a mild bleach solution at various temperature regimes which aim to replicate different spring climatic senarios. The time to budbreak, rate of budbreak and percentage budbreak of the shoots give an indication of the efficacy of the RBA under the different temperature regimes.

Results

The 2013 season's data capture will be completed by the end of September. Results for the 2013 season are therefore not yet available.

Conclusion / Recommendations

The trial is progressing according to plan.

Project leader: Mrs L.A. Allderman (Hortgro Science)

The efficacy of rest breaking chemicals on plums as a function of cultivar, chill unit accumulation, time of application and temperature, under laboratory conditions

Research Organisation Project Number: PL-12-HOR-CP25

Objective

The response of rest breaking agents (RBA) application on plum trees is not consistent from year to year. By studying RBA effectiveness under laboratory conditions, we will be able to better understand the processes involved which will intern lead to increased efficiency in the field.

Methodology

One-year-old pear shoots were cut prior to RBA orchard application and treated with various concentrations of Dormex, Lift, Oil and a Dormex/oil combination. Ten shoots of each treatment were then forced in buckets containing a mild bleach solution at various temperature regimes which aim to replicate different spring climatic senarios. The time to budbreak, rate of budbreak and percentage budbreak of the shoots give an indication of the efficacy of the RBA under the different temperature regimes.

Results

The 2013 season's data capture will be completed by the end of September. Results for the 2013 season are therefore not yet available.

Conclusion / Recommendations

The trial is progressing according to plan.

Project leader: Mrs L.A. Allderman (Hortgro Science)

Determining the chill requirement of important apple rootstocks available to the South African fruit industry

Research Organisation Project Number: A-12-HOR-CP21

Objective

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, both Dormancy Progression Curves (DPC) and the Chill Requirement (CR) of available rootstocks are currently being determined.

Methodology

All commercially viable rootstocks available from layer beds at two climatically different locations have been included in this study. To determine DP of the rootstocks, ten shoots of each rootstock are presently being collected at three week intervals from each location. The shoots are forced (25 ºC 24hrs light) in buckets containing a mild bleach solution. Percentage bud break(BB) per bundle is determined three times a week until 50% BB is reached. The shoots are then discarded. Graphs depicting DP will be plotted when the data capture is complete. The DP of all the rootstocks at both sites can then be compared. To determine the CR of the rootstocks, shoots from all the rootstock samples were collected in autumn and stored at 4 ºC. Three replications of ten shoots of each sample are presently being removed at two week intervals and forced and scored as for DP. This data will be used to determine the amount of cold necessary for dormancy release i.e. CR.

Results

The 2013 winter season's data capture will be completed by mid-September, therefore results for the 2013 season are not yet available.

Conclusion / Recommendations

The trial is progressing according to plan.

Project leader: Mrs L.A. Allderman (Hortgro Science)

Determining the chill requirement of important pear rootstocks available to the South African fruit industry

Research Organisation Project Number: P-12-HOR-CP22

Objective

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, both Dormancy Progression Curves (DPC) and the Chill Requirement (CR) of available rootstocks are currently being determined

Methodology

All commercially viable rootstocks available from mother blocks at two climatically different locations have been included in this study. To determine DP of the rootstocks, ten shoots of each rootstock are presently being collected at three week intervals from each location. 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% BB is reached. The shoots are then discarded. Graphs depicting DP will be plotted when the data capture is complete. The DP of all the rootstocks at both sites can then be compared. To determine the CR of the rootstocks, shoots from all the rootstock samples were collected in autumn and stored at 4°C. Three replications of ten shoots of each sample are presently being removed at two week intervals and forced and scored as for DP. This data will be used to determine the amount of cold necessary for dormancy release i.e. CR.

Results

The 2013 winter season's data set will be completed by mid-September, therefore results for the 2013 season are not yet available

Conclusion / Recommendations

The trial is progressing as planned

Project leader: Mr W.P. Kotze (Hortgro Science)

The application of sucrose to enhance fruit set in Packham's Triumph pear

Research Organisation Project Number: P-11-HOR-CP07

Objective

The aim of this project is to evaluate the effectiveness of sucrose applications to improve fruit set in 'Packham's Triumph' pear.

Methodology

Sucrose was applied at full bloom to a mature orchard in the Elgin region at rates of 1, 5, 10 and 20% and compared to an unsprayed control in regard to fruit set, yield and fruit size.

Results

The same trend as in 2011/12 was observed in that sucrose at 10% increased yield. However, in 2012/13, the treatment effect on yield was not statistically significant. Sucrose application did not affect fruit size.

Conclusion / Recommendations

We recommend that the project is extended for one more season to verify the effectiveness of sucrose in increasing fruit set in 'Packham's Triump' pear.

Project leader: Mr W.P. Kotze (Hortgro Science)

Evaluation of apple thinning programmes

Research Organisation Project Number: A-09-HOR-CP01

Objective

The objective of this project is to evaluate different thinning programmes for apple.

Methodology

In the 2012/13 season, we included the new chemical thinning agent, Brevis (Metamitron), in the programme. Treatments applied to 'Fuji' in both the Koue Bokkeveld and Vyeboom were: 1) Brevis at 4 mm fruit diameter and 7 days later, 2) NAA at petal drop and Brevis 7 days later, and 3) NAA at petal drop, NAA and 6-BA 7 days later and Sevin 3 days later. Treatments applied to 'Golden Delicious' in both Ceres and Elgin were: 1) Brevis at 4 mm fruit diameter, 2) Brevis at 14 mm fruit diameter and 3) 500 ml 6-BA at 8-12 mm fruit diameter. Fruit set, yield and fruit quality were assessed and compared with a control hand thinned-only treatment.

Results

Brevis reduced the amount of hand thinning required in 'Golden Delicious' in both regions. No significant results were obtained in 'Fuji'.

Conclusion / Recommendations

Brevis shows potential as a chemical thinner on especially on 'Golden Delicious'. However, care should be taken to not apply Brevis at an early stage in bad weather. Cloudy weather before, and sunny conditions after applications at an early stage resulted in over thinning. It is too soon to make any conclusions for 'Fuji' trials. 'Golden Delicous' and 'Fuji' trials will be repeated in the 2013/14 season.

Project leader: Mr W.P. Kotze (Hortgro Science)

Chemical thinning of Abate Fetel

Research Organisation Project Number: 2011 - DBUitdunP

Objective

The objective of this project is to develop a chemical thinning programme for Abate Fetel that will minimize hand thinning and result in regular, good quality yields.

Methodology

The following 5 treatments were applied to an 'Abate Fetel' orchard in the Ceres region in the 2012/13 season: Planofix (11 ml/100 L) at petal drop + (750 ml/1000 L/ha) MaxCel 7days later, Brevis (1167 ml/1000 L/ha) at 4 mm fruit size, and Brevis (1167 ml/1000 L/ha) at 14 mm fruit size. These treatments were compared with an unsprayed control that was hand thinned only.

Results

None of the chemical treatments thinned 'Abate Fetel' pears, but the optimal application window for Planofix, MaxCel and Brevis at 4 mm fruit diameter coincided with low daily temperatures.

Conclusion / Recommendations

It is too soon, however, for general recommendations regarding the potential to chemically thin 'Abate Fetel'.

Project leader: Mr W.P. Kotze (Hortgro Science)

Using NAA and Ethephon to increase return bloom in apples and pears

Research Organisation Project Number: 2012 NAA

Objective

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

Methodology

The following treatments were applied in the 2012/13 season: Four NAA applications two weeks apart from 40 days after full bloom (DAFB), three NAA applications two weeks apart from 40 DAFB, two NAA applications two weeks apart from 40 DAFB, and two NAA applications two weeks apart from 68 DAFB. NAA was applied at 5 ppm. No Ethephon applications were made. Return bloom and yield will be assessed in the 2013/14 season and NAA treatments compared to the unsprayed control.

Project leader: Dr W.J. Steyn (Hortgro Science)

Tree water relations and sunburn in pome fruit

Research Organisation Project Number: PO-11-USH-CP11

Objective

The overall objective is to determine how tree water relations affect the occurrence of sunburn in pome fruit.

Methodology

We aim to relate fruit surface anatomy to cooling capacity of the fruit, determine water movement patterns into the fruit over the growing season, and assess how different cultural practises affect tree water status and fruit surface temperature.

Results

Stomata and lenticels were counted in five apple cultivars over the growing season (results pending). Fruit transpiration and conductance decreased over the growing season in all cultivars and production regions. Latent heat loss from evaporation followed a similar pattern, but the values are too low to make a significant contribution to the fruit heat balance. Computational modelling showed that high levels of solar radiation cause fruit surface temperature to exceed the sunburn temperature threshold. Sap flow into the fruit fell within the error margins of equipment used to measure. In contrast, stem sap flow showed clearly distinguishable patterns. The use of dendrometers to separate xylem and phloem flow was unsuccessful (data not shown). S-ABA did not reduce sunburn under South African conditions. Irrigation pulsing had no effect on sunburn development and fruit surface temperature, but improved the plant water status and photosynthesis.

Conclusion / Recommendations

The external heat ratio method should be used to quantify sap flow in fruits and for the separation of xylem and phloem flow. An irrigation pulsing trial will establish the effect of irrigation pulsing on the canopy environment, plant photochemistry and sunburn development. The effect of drought stress on fruit photochemistry and sunburn development requires further study.

Project leader: Dr W.J. Steyn (Hortgro Science)

Heat damage in plums

Research Organisation Project Number: MJ01/13

Objective

We set out to establish whether irrigation level and tree water status are linked to sunburn and heat damage development in Japanese plums.

Methodology

Irrigation was manipulated at Sandrivier Estate to achieve a control (farm practice), half irrigation and double irrigation treatments. Plant water status, photochemistry and fruit temperature were assessed for 'Laetitia'. Sunburn and fruit quality were assessed for 'Laetitia' and 'African Delight'. Glutathione and ascorbic acid were assessed at harvest, after cold storage and after shelf life.

Results

Sap flow increased with an increase in soil moisture content. No clear trends were discernible from photochemical measurements. Sunburn was negligible in 'Laetitia', but much more prominent in 'African Delight'. Half irrigation increased sunburn, the more severe classes in particular, and total soluble solids (TSS), but double irrigation did not significantly decrease sunburn. No internal heat damage or storage problems were observed in either cultivar. Antioxidant data may prove more illuminating in a warmer season than after the mild 2012/13 season.

Conclusion / Recommendations

The benefit of pulsed irrigation for sunburn and heat damage control needs to be assessed. The suggestion that drought stress increases sunburn requires further study. The relationship between environmental factors (light and temperature) and sunburn and internal heat damage development in plums should be established.

Project leader: Dr W.J. Steyn (Hortgro Science)

Cost effectiveness of worker platforms and harvesting systems relative to conventional, labour intensive farming practise

Research Organisation Project Number: V-12-USH-CP12

Objective

Evaluate the use of platforms and harvesting systems in the South African deciduous fruit industry. Determine their effect on harvesting injuries and cost effectiveness of orchard tasks requiring the use of ladders.

Methodology

Platforms and harvesting systems made available by Hortgro, private owners and agricultural equipment supplier Southtrade were used for tree training, pruning, hand thinning and harvesting in the Koue Bokkeveld, Worcester and Grabouw. The performance of these systems was compared to conventional ladder-based operations. A full bearing 'Golden Delicious' orchard was adapted for the use of platforms to evaluate the cost and feasibility of doing so.

Results

Summer pruning of 'Flavourtop' nectarines and harvesting of 'Laetitia' and 'Sun Supreme' plums with platforms increased productivity by up to 300% and 45%, respectively. Productivity of harvesting 'Red Chief' apples was decreased by 40% while no productivity gain was achieved in 'Golden Delicious' and 'Cripp's Pink'. The only effect on harvesting injuries was a 4% drop in stem injuries on 'Abate Fetel' pears.

Conclusion / Recommendations

Tree size, shape and uniformity, fruit distribution on the tree, fruit size and quality, orchard floor condition and aspect, labour team dynamics, harvesting incentives, bin condition, operational system employed and harvest logistics all affect the feasibility and ease of mechanization.

Mrs Shelly Fuller, Blue North Sustainability

Confronting Climate Change

Objective

To ensure the South African fruit & wine industry members are:
- informed about relevant climate change related issues;
- are able to measure their carbon footprint and benchmark against best practice;
- is in the a position to implement carbon reduction practices that incorporate mitgation and adaptation strategies to meet the energy and market challenges.

Methodology

A website has been developed as the information platform and to house the CCC carbon footprint tool. Free regional training workshops are provided for industry members and approved datasets are added to the CCC industry benchmark database. This database is being developed over a three year period (2012-2014) to account for seaonal variation and will serve to establish regional averages for individuals to benchmark against and to identify best practice.

High energy/carbon activities within the supply chain include electricity usage for irrigation and cooling activities; synthetic fertilizers and agrochemical usage; packaging material and diesel usage during transport.

The CCC project is moving in to it's Phase 3 cycle from February 2014 and will build on the successes of the previous two phases; with particular focus on the Train-the-Trainer elements to ensure skills transfer.

Conclusion / Recommendations

There are two key drivers to industry members measuring their carbon footprint - one, energy related costs are increasing and people are wanting to improve their energy usage; and two, export companies and retailers are putting pressure on their suppliers in order to meet their sustainability criteria.

Carbon footprinting is not going away and is only going to become more in demanded to meet the energy and exporting measurement requirements.

CROP PRODUCTION PROJECTS - FINAL REPORTS

Project leader: Mr W.P. Kotze (Hortgro Science)

Evaluate the effect of CropBiolife on fruit size and yield

Research Organisation Project Number: 2011 - 5

CropBioLife had no significant effects on any of the parameters assessed in 'Royal Gala' over two consecutive seasons. No results were obtained for "Golden Delicious" in the first year of the project.

The 2012/2013 results showed no beneficial significant effects with the use of CropBioLife. CropBioLife, however, slightly increased the incidence of sunburn and russetting.

Due to a lack of results, we advise the termination of the project.

Project leader: Mrs L.A. Allderman (Hortgro Science)

The progression of endo- and paradormancy in apple buds as affected by different climatic regions

Research Organisation Project

In order to determine whether delayed foliation problems are related to the paradormancy component of dormancy, the endo- and paradormancy components of dormancy were determined for Granny Smith and Royal Gala shoots from three climatic regions during the dormancy periods of 2011 and 2012.

The results showed that cultivars varied in their depths of dormancy and that the depth of dormancy of both cultivars increased with increased chilling. However, there were no differences between the general patterns of endo- and paradormancy for each cultivar in relation to climatic region or year. It is therefore evident that climatic conditions do not influence the paradormancy component of dormancy independently of the endodormant component.

However it should be noted that in relative terms, Granny Smith shoots exhibited a high paradormancy in the lower sections of the shoot late in the season. This phenomenon could possibly play a part in the susceptibility of the Granny Smith cultivar to blind wood.

Project leader: Mrs L.A. Allderman (Hortgro Science)

Effect of fruit removal on entrance into bud dormancy in apples

Research Organisation Project

In order to determine whether low temperatures influenced the entrance into dormancy of apple shoots to a greater extent once the fruit had been harvested, fruit was stripped from mature Granny Smith apple trees growing in a commercial orchard in Elgin, Western Cape at four different times during the growing season. In the fifth treatment natural fruit drop occurred.

There was no treatment x time interaction in either 2011 or 2012 and it can therefore be concluded that the absence of a crop does not influence apple shoots to enter dormancy more easily under conditions of low temperatures.

Project leader: Mrs L.A. Allderman (Hortgro Science)

Effect of fruit removal on entrance into bud dormancy in plums

Research Organisation Project

In order to determine whether low temperatures influenced the entrance into dormancy of plum shoots to a greater extent once the fruit had been harvested, fruit was stripped from mature Laetitia plum trees growing in a commercial orchard in Banhoek, Western Cape at four different times during the growing season. In the fifth treatment natural fruit drop occurred.

There was no treatment x time interaction in either 2011 or 2012 and it can therefore be concluded that the absence of a crop does not influence plum shoots to enter dormancy more easily under conditions of low temperatures.

Crop Protection

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CROP PROTECTION RESEARCH PROGRAMME

The Crop Protection research program during the last year has been successful and productive. A variety of applied and basic research was carried out in a number of disciplines including pathology, nematology and entomology.

A total of fourteen crop protection projects were due to end in 2013, however three projects were extended for one year to allow for additional research to be carried out. Of the completed projects (see Table 1 and reports below) a number involved research on alternative management strategies for insect pests and diseases. The development of an integrated management strategy for codling moth is ongoing and a number of projects are aligned to this theme. The completion of the detailed study of the integrated management of apple scab is welcome and the results are promising. In addition, research on entomopathogenic nematodes (EPN's) is progressing and the completion of the research on the *in vitro* culture of one species of EPN forms part of the development of a local commercial EPN facility

Table 1. List of completed industry funded Crop Protection projects.

Project title	**Fruit kind**	**Researcher**
Generating a taxonomic database of deciduous pests in the Western Cape.	Various	P. Addison
Inundative release of *Trichogrammatoidea lutea* in apple and pear orchards treated with sterile codling moth. (extended)	Pome	M. Addison
Integrated use of sterile codling moths and fruit flies in apple and pear orchards.(extended)	Pome	M. Addison
Monitoring mites in pear orchards. (extended)	Pears	J. Heunis
Controlled atmosphere temperature treatment system (CATTS) as a post harvest treatment for phytosanitary pests of deciduous fruit.	Various	S. Johnson
Host specificity, pathogenicity virulence and resistance of various Penicillium species on table grape and other deciduous fruit crops.	Various	L. Korsten
Evaluation of industry needs with respect to postharvest diseases of stone fruit in South Africa.	Stone	C. Lennox
Integrated management of apple scab.	Apples	C. Lennox
Pilot study on the potential of implementing biological control strategies and soft products for post-harvest control of plant pathogens of pome fruit in South Africa.	Pome	C. Lennox
Bioprospecting of natural ecosystems for entomopathogenic nematodes. (extended)	Various	A. Malan
In vitro mass culture of *Heterorhabditis zealandica* strain SF41.	Various	A. Malan
Impacts of climate variability on fruit fly (*Ceratitis spp*) performance and population dynamics.	Various	J. Terblanche
Bactrocera Environmental Niche Modelling	Various	J. Terblanche

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. The increased number of pre-harvest pathology projects is important to the industry as is the research being carried out on spray application. The bioprospecting for new entomopathogenic nematodes is in progress and new species have been found. Research on fruit flies is ongoing and new insights into their biology and genetics have been gained.

Table 2. List of currently running industry funded Crop Protection projects.

Project title	**Fruit kind**	**Researcher**
Identification of inoculum sources of oomycetes, a major contributor to apple replant disease, and the management thereof.	Apples	JA. McLeod
A survey of *Rosellinia* in apple orchards and nurseries in South Africa.	Apples	K. Bezuidenhout
Molecular analysis and biodiversity survey of fruit flies associated with deciduous fruit and vines, with focus on economically important species.	Various	P. Addison
Landscape effects and ecological factors affecting bollworm populations in deciduous fruit orchards.	Various	J. Terblanche
Investigating the use of semiochemicals for integrated management of Western flower thrips.	Various	E. Allsopp
Control and management of lesion nematodes in apple layer beds and nurseries.	Apples	A. De Klerk
Development of monitoring methods and optimisation of a pheromone lure for the grain chinch bug (*Macchiademus diplopterus*).	Various	S. Johnson
Grain chinch bug (*Macchiademus diplopterus*) thermal biology and the implications for post-harvest control measures.	Various	S. Johnson
Bin and orchard treatment with entomopathogenic nematodes and short and long term monitoring for codling moth.	Various	A. Malan
Potential control of the woolly apple aphid (*Eriosoma lanigerum*) using entomopathogenic nematodes.	Apples	N. Stokwe
Monitoring insect pest activity in apple orchards under codling moth sterile insect releases.	Apples	K. Pringle
Dispersal capacity of *Bactrocera invadens*.	Various	C. Weldon
Factors affecting chemical application to improve pome and stone fruit disease and pest management	Various	S van Zyl.
Monitoring and database maintenance of *Bactrocera invadens*.	Various	L. Brown

The proposed Crop Protection projects are listed in Table 3. The projects again cover a variety of topics ranging from biological control to fungicide performance. The majority of the proposed projects are applied. In addition, there are two new research projects on *Bactrocera invadens*, the invasive fruit fly. Both projects are designed to generate information that will allow for the effective management of the insect. The research will address aspects such as the risks associated with the insect, the likelihood of invasions, physiology, biology and the susceptibility of various fruit kinds to attack.

Table 3. List of proposed industry funded Crop Protection projects for 2013.

Project title	Fruit kind	Researcher
Pest and disease monitoring in orchards under shade net.	Apples	M. Addison
Biological control: Banded fruit weevil (*Phlyctinus callosus*) culture methods.	Pome	M. Addison
Chemical control: Determination of insecticide resistance levels in scale and mealy bug populations.	Various	M. Addison
Forecasting *Bactrocera invadens* potential using trait-based modeling approaches.	Various	P. Addison
Determining the rainfastness of mancozeb on apple leaves, and its correlation with fluorescent pigment particle deposition and suppression of apple scab.	Apples	A. McLeod
Bactrocera invadens: Pest risk analysis for the deciduous fruit industry in the South Western Cape.	Various	K. Pringle
Temperature-dependent flight performance of fruit flies.	Various	J. Terblanche

The structure and function of the Crop Protection program has changed and I believe that the research effort is more efficient and productive. The program has attracted significant outside funding from a number of institutions thus allowing for the purchase of capital equipment and financial support of research projects and students. It is encouraging to see the development of Crop Protection research at Stellenbosch University as a number of other agricultural industries are now contributing significant funding into the Department of Conservation Ecology and Entomology. This strengthens our research effort and allows for the development of much needed personnel and students. In addition to this, more Departments are getting involved in industry funded Crop Protection research that further strengthens the system. For example, engineering, microbiology, biochemistry and polymer science were involved in a recently completed nematology project.

The demands on Crop Protection research will be high in the near future. Aspects such as the potential invasion of the Western Cape by *Bactrocera invadens* and the current debate in Europe on false codling moth could have significant impacts on the industry. Both insects represent a serious economic threat to both the pone and stone fruit industries. I believe the industries are relatively well positioned to deal with the threats thanks to past and present industry funded research. 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 effort for their hard work and dedication.

Matthew Addison

CROP PROTECTION PROJECTS - PROGRESS REPORTS

Project leader: Dr K L Pringle (SU)

Monitoring insect pest activity in apple orchards under codling moth sterile insect releases

Research Organisation Project Number: US44

Objective

An area of about 35 ha of apple orchards has been under mating disruption and sterile insect release (SIR) for controlling codling moth.

Methodology

This area has been subjected to intensive scouting and monitoring for pest arthropods, their damage, pathogen infection and physiological defects.

Results

During the early stages of the investigation, there was no detectable codling moth damage. However, during the second season codling moth from an outside source caused damage. It took three seasons of intensive spray applications to reduce the population to the point of no detectable damage. During the course of the study it appeared as if the fruit weevil stem barriers interfered with mealybug control. When the stem barriers were in place, mealybug infestations increased, while fruit weevil damage remained low. When the stem barriers were removed, mealybug infestations declined, but fruit weevil damage increased. During the past season there were no fruit weevil stem barriers, but there was a lot of mealybug infested fruit at harvest.

Conclusion / Recommendations

The intensified spraying against codling moth did not disrupt the biological control of mites or woolly apple aphid. It appears as if problems with mealybug control are developing.

Project leader: Dr C.L. Lennox (SU)

Integrated management of apple scab in South Africa

Research Organisation Project Number: US PP CL2

Objective

The effect of leaf-shredding alone on fruit and leaf scab was tested against a positive control (full fungicide programme), negative control (fungicides withheld and no shredding) and a combined treatment (leaf-shredding with full fungicide programme), with two repetitions per treatment in two orchards. Leaf-shredding reduced scab incidence significantly (40-80 %) on fruit in the following season, but not on leaves, compared to the negative control.

However, efficacy of the treatment is highly depended on when and how shredding is applied. The combined treatment did not differ significantly from the positive control, but applying shredding reduces the risk of disease if fungicide sprays are missed in spring.

Methodology

To investigate temperature and moisture effect on pseudothecial density (PD) and ascal density (AD) under field conditions in 2012, scabbed apple leaves collected in Koue Bokkeveld, a cold winter region, and in Elgin, a warm winter region were overwintered in their region of origin and in the other region. PD in Koue Bokkeveld agreed with a previous study, but PD in Elgin was lower (various reasons). AD in both regions was higher than in previous studies and did not differ significantly when leaves were moved to another region.

Results

Results indicate that the winter stage of V. inaequalis is dependent on prevailing weather conditions in a climatic region, which agrees with previous studies. PD and AD constants should be determined for each climatic apple-growing region.

Conclusion / Recommendations

Both the leaf-shredding and this trial will be repeated in 2013.

Project leader: Dr A de Klerk (Private)

Control and management of lesion nematodes in apple layer beds and nurseries

Research Organisation Project Number: ADK4

Objective

The root-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.

Methodology

In the first step to solve this problem, a non-chemical hot-water treatment was evaluated. Highly infested M109 and Supporter IV rootstocks from rooted layer blocks were treated at different temperatures and for different duration times. Temperatures ranged from 35ºC to 55ºC and duration times from 10 min to 50 min. Best results were obtained with a treatment at 50ºC for 30 minutes.

Results

In the case of M109 a 73% control was obtained with this treatment and 81% with Supporter IV. Higher temperatures and longer duration times did not significantly increase the level of control. In the case of M109 a treatment of 50ºC for 30 minutes, however, had a high detrimental effect on the growth of the rooted layers. Only 10% were alive after 5 months. In the case of Supporter IV, 88% were alive. It seems that the physical type of root system could play a role in the resistance against the treatments. The Seasonal occurrence of lesion nematodes in rooted layer nursery blocks was determined for the first time in South Africa. Nematodes occur in the soil throughout the growing season with a peak in the population during February. They are also present throughout the season in the roots, at almost the same level and no prominent peaks were visible. Larvae in the roots were four times greater than adults and their population reached a peak during April.

Conclusion / Recommendations

The project is progressing well according to plan and further research will continue to verify these results of the first season.

Project leader: Dr. C. Lennox (SU)

Etiology and Epidemiology of *Neofabraea spp*. on pome fruit

Research Organisation Project Number: USPP CL3

Objective

Bull's eye rot (BER) is a latent disease complex compromising four Neofabraea species, of which *N. alba* was found to be a major postharvest pathogen of the 'Cripp's Pink' apple cultivar in the Western Cape. Morphological and molecular analysis currently indicate N. alba to be the only BER species on 'Cripp's Pink'.

Methodology

Evaluation of disease incidence and distribution was continued for this season; asymptomatic 'Cripp's Pink' apples were collected at harvest from 37 producers in the Ceres, Grabouw, Hemel-en-Aarde Valley regions and placed in 4 month cold storage. In addition, N. perennans was recently identified from pear fruit in the Western Cape and asymptomatic 'Packham's Triumph' pears were collected at harvest for evaluation of possible BER symptoms.

Evaluation of rapid detection for BER in the orchard was continued for the 2012/2013 season and 'Cripp's Pink' fruit and leaves were collected 1 month post-full bloom until harvest from two farms, one in Ceres and one in Grabouw, washed and DNA extracted. Weather data for all sampled seasons is currently being collected for the development of a concept disease prediction model.

Results

In vitro fungicide sensitivity of *N. alba* isolates was conducted using flusilazole and pyrimethanil. Flusilazole is

used to control apple scab pre-harvest, while pyrimethanil is used overseas for post-harvest control of *Neofabraea*. Flusilazole inhibited conidial germination, but 100% inhibition of mycelial growth was not achieved.

Conclusion / Recommendations

Pyrimethanil successfully inhibited mycelial growth. Flusilazole and pyrimethanil could therefore be beneficial to pre- and post-harvest management control strategies for *Neofabraea* in South Africa.

Project leader: Trevor Koopman (ARC Infruitec-Nietvoorbij)

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

Research Organisation Project Number: 2100-33

Objective

The aim of the project is to determine which apple scab causing Venturia inaequalis races occur in the different apple growing regions of South Africa and also to investigate the population genetic structure, pathogenicity and virulence of the pathogen on different apple cultivars.

Methodology

Apple scab samples are being collected from four different apple growing regions; single spore lines are being established and inoculations done on differential cultivars to determine the *V. inaequalis* races.

Apple scab samples (N= 169) were collected from the Ceres, Grabouw, Lower and Upper Langkloof apple growing regions. After single sporing, samples were genotyped with six microsatellite markers. Four scab isolates were inoculated at Alba Labs (Atlantis) on five *in vitro* apple plantlets, derived from accessions from ARC genebank, some of them known to carry resistance genes, and, surprisingly, all the plantlets were found to be susceptible to the disease.

Results

Minor population differences were found between Ceres and the two Langkloof populations and moderate differences between the other populations. This indicates that the Ceres and the Langkloof populations are closely related to each other.

Conclusion / Recommendations

Susceptibility of *in vitro* plantlets may be due to lack of expression of resistance genes at this early developmental stage of plantlets. Hardened off plants from tissue culture are currently being prepared for inoculation.

Project leader: Mrs Karien Bezuidenhout (ARC Infruitec-Nietvoorbij)

A survey of Rosellinia in apple orchards and nurseries in South Africa

Research Organisation Project Number: 220042

Objective

This project aims to sample dying apple trees from various growing regions, including orchards and nurseries, to determine the extent of Rosellinia root rot infection in South Africa.

Methodology

In the past four months 13 farms in 3 regions were visited to collect infected plant material (from trees exhibiting defoliation, small fruit, chlorosis, stem lesions and root rot). One sample was sent in to ARC from the Langkloof. Isolations were made and 260 isolates were collected from 5 farms. No isolates were collected from Ceres or Langkloof, but sampling during spring might rectify this. Apple nurseries will also be visited during spring 2013.

Results

It is difficult to make conclusions at this stage, since the project has only been running for four months, but from the orchard collections it seems that this disease is associated with old orchards (although exceptions do occur).

Conclusion / Recommendations

The biggest challenge of Rosellinia in South African apple orchards is to clean old infected orchards before replanting, since fumigation is the only known effective control measure at this stage.

Project leader: Ms N. Stokwe (ARC Infruitec-Nietvoorbij)

Potential control of woolly apple aphid (*Eriosoma lanigerum*) using entomopathogenic nematodes

Research Organisation Project Number: 230077

Objective

To evaluate the virulence of endemic EPN species against WAA using laboratory bioassays and to determine the effect of imidacloprid on the infectivity of the nematodes.

Methodology

Seven entomopathogenic nematodes, namely Steinernema khoisanae, *S. yirgalemense, S. citrae, S. feltiae, Heterorhabditis zealandica, H. bacteriophora* and *H. safricana*, were tested for their pathogenicity against woolly apple aphid (WAA). Nematodes were cultured in vivo by infecting wax moth (*Galleria mellonella*), then recovering infective juveniles (IJs) using White traps. Different stages of WAA were collected in the field and maintained on apple roots in the laboratory. An established twenty four well bioassay protocol was used to test the effect of WAA size on nematode infectivity, the biology and development of *S. yirgalamense* and *S. feltiae* in WAA, the optimal

concentration of Steinernema yirgalamense, *S. feltiae* and *H. zealandic*a and time to be used for further tests and the effect of imidacloprid on infectivity and survival of EPN.

Results

Steinernema yirgalamense is the most promising EPN isolate for the control of WAA, but control is only achieved for adults and intermediates, not for the crawlers. The EPNs cannot be cannot complete their life cycle in the WAA, mainly because the EPNs' symbiotic bacteria cannot grow in the haemolymph of WAA.

Conclusion / Recommendations

In an attempt to improve nematode efficacy, entomopathogenic fungi will be combined with *S. yirgalamense* and *H. zealandica* in the forthcoming pot and glasshouse trials.

Project leader: Dr. A. McLeod (SU)

Identification of inoculum sources of oomycetes, a major contributor to apple replant disease, and the management thereof

Research Organisation Project Number: AM06

Objective

The major replant pathogens in South Africa consist of oomycetes, with parasitic nematodes also sometimes forming part of the complex. The project will determine whether nursery propagated planting stock and irrigation water are inoculum sources of pathogenic oomycetes. The second aim will be to determine whether a combination of phenylamides, fenamiphos and phosphonates are effective in managing apple replant disease under field conditions on non-fumigated and fumigated replant soils. The third aim will be to determine what the effect of time and dosage of phosphonate applications are on root phosphite concentrations, and whether all oomycete replant pathogens are sensitive to phosphite.

Methodology

Inoculum sources will be investigated using conventional isolation and DNA based methods. The efficacy of phenylamides, fenamiphos and phosphonates in managing apple replant will be evaluated under field condition, where tree performance and pathogen root- and rhizosphere 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.

Conclusion / Recommendations

DNA methods are in the process of being optimized for quantification of oomycete pathogens from rhizosphere soil, and a glasshouse trial has been initiated. Sampling of water and nursery material will start at the end of September.

Project leader: Dr Juanita Heunis (SU)

Monitoring mites in pear orchards

Research Organisation Project Number: P-12-USE-PM19

Objective

The phytophagous and predatory mite populations on pear leaves were determined on four different farms (3 blocks (A, B and D) where mites were reported to be a problem and one (Block C) where mite control is not a problem) in the Ceres area. No spray programmes was specified.

Methodology

Two leaves were picked from 25 evenly spaced trees through the orchard every two weeks. Adult mites and predatory mites were recorded in the orchard and all leaves transported to the laboratory in a coolbag. All mite stages and predators were removed from leaves with a leaf brushing machine and counted under a microscope. The predatory mite species were determined under a microscope after clearing mites in Nesbitt's fluid and mounting them on a microscope slide.

Results

Tetranychus urticae was recorded on all the farms, however it only appeared later in the season in Block C. Mostly *Panonychus ulmi* was recorded here and reached high numbers (2.5 per leaf), where after the block was treated. Mite numbers stayed relatively low with equal number of predators per leaf in Block B and no control measures were taken and only few mites were found in Block D.

Numerous sprays were applied on Block A and after the first two sprays mite numbers increased drastically and predatory mite numbers dropped. Although relative low numbers of mites were recorded early in the season the farmer reported that sprays were applied after mite numbers increased drastically during the week after or before our next monitoring took place. *Neoseiulus californicus* and *Euseius rubicolus* (=Amblyseius addoensis) were recorded.

Conclusion / Recommendations

The infestation levels varied on farms and the level at which farmers applied control were unclear as monitoring methods differed or were not done at all.

Project leader: M F Addison (SU)

Inundative release of Trichogrammatoidea lutea in apple and pear orchards treated with sterile codling moths

Research Organisation Project Number: MA 2012 TRIC

Objective

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.

Methodology

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.

Results

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.

Conclusion / Recommendations

The treatment of commercial orchards with wasps in combination with and without the release of sterile codling moth will be assessed.

Project leader: M.F Addison (SU)

Integrated use of sterile codling moths and fruit flies in apple and pear orchards

Research Organisation Project Number: MA 2012 CM

Objective

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.

Methodology

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.

Results

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 appeared to be more suitable. 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.

Conclusion / Recommendations

Additional releases with pheromone treated flies will be attempted. In addition, releasing pheromone treated codling moth and false codling moths will be assessed.

Project leader:Dr P Addison (SU)

Generating a taxonomic database of fruit pests in the Western Cape

Research Organisation Project Number: US/ENT-08-A1

Objective

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. In addition, data associated with specimens will be collected.

Methodology

During 2013, a total of 103 samples have already been processed, which makes this year the one with the most specimens.

Conclusion / Recommendations

The database is developing and will be an ongoing objective of this service, which we hope will become a formal user-pay service by 2014 - together with the Department of Plant Pathologies Disease Clinic.

Project leader: Ms. E. Allsopp (ARC Infruitec-Nietvoorbij)

Investigating the use of semiochemicals for integrated management of western flower thrips on stone fruit and table grapes

Research Organisation Project Number: 230071

Objective

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 repeat the bio-assay with carvacrol, begin screen house tests with semiochemicals and collect volatiles from plum and clover flowers.pull system.

Methodology

Bio-assays with 0.1%, 1% and 5% carvacrol were repeated. Screen house trials began to test if treating potted, flowering plum trees with 0.5% and 1% methyl-Salicylate reduced egg-laying by WFT. Volatile compounds of plum and clover flowers were collected by means of air entrainment.

Results

Both 5% formulations and the 1% Carvacrol in Citrex/ethanol/water + Triton and 0.1% Carvacrol in ethanol/water

+ Triton formulations reduced the number of eggs laid per WFT female in 24h significantly compared to the controls. Carvacrol resists going into suspension, even with wetting agents. Carvacrol, thymol and methyl-Salicylate all cause some petal burn and do not remain in suspension easily. Late spring cold and rain hampered screen house trials, but there was evidence from one trial that methyl-salicylate did reduce egg-laying. Plum and clover flower volatiles were collected and processed for GC-MS analysis.

Conclusion / Recommendations

Alternative formulations of semiochemicals will be tested in screen house trials to obtain more stable suspensions, even application, sustained release of volatiles and to avoid petal burn. Flower volatiles will be analysed and used in olfactometer tests to determine if clover is a suitably attractive trap crop for WFT to use in conjunction with a semiochemical in a push-pull system.

Project leader: Dr Shelley Johnson (SU)

Controlled atmosphere temperature treatment system (CATTS) as a postharvest treatment for phytosanitary pests of deciduous fruit

Research Organisation Project Number: USSJ06

Objective

The objective of this project is to evaluate the effect of heated controlled atmosphere postharvest treatments on key phytosanitary insect pests of the South African deciduous fruit industry, and to determine for which species CATTS technology is a feasible postharvest mitigation option.

Methodology

Using a model system that simulates CATTS treatments we tested heated CA treatments on the eggs, and 2nd and 3rd larval instars of *Ceratitis capitata* and adult *Planococcus ficus* and *Psuedococcus longispinus* mealybugs. Ramping heat rates of either 12°C/h or 24°C/h, starting at 23°C and increasing to 45°C, combined with one of the following gas compositions: regular air (RA); 1 % O_2, 15% CO_2, balance N_2 (low oxygen/high carbon dioxide - CATTS gas mixture); 15% O_2, 15% CO_2, balance N_2 (high carbon dioxide) and 1 % O_2, balance N2 (low oxygen).

Results

The combination of heat and a modified atmosphere increased mortality, as opposed to heat alone. Also, except for *C. capitata* eggs, the faster heat ramping rate improved treatment efficacy by reducing treatment time. Results from this project, together with previous CAWB studies, indicate that of the species and life stages tested, *C. capitata* eggs are the most resistant to heated CA treatments, followed by *Thaumatotibia luecotreta* larvae and *Macchiademus diplopteurs* adults, and then *C. capitata* larvae. External pests, *P. ficus*, *P. longispinus* and *Phlyctinus callosus* are the least resistant species.

Conclusion / Recommendations

CATTS treatments on infested fruit will now be performed in the CATTS unit to confirm treatment times and efficacy, and evaluate fruit quality after treatment.

Project leader: Dr AP Malan (SU)

Field and bin application of entomopathogenic nematodes for the control of codling moth (*Cydia pomonella, Lepidoptera: Tortricidae*)

Research Organisation Project Number: PN7

Objective

The impact of inundative semi-field aerial application of commercially available entomopathogenic nematodes (EPNs) and the effect of environmental conditions on the mortality of diapausing codling moth larvae were investigated in an apple orchard.

Methodology

Codling moth 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 codling moth larvae were used as the containment method. For each treatment, eight trees, in a randomised design, were used. Cages dipped in different nematode species and concentrations were kept moist, while temperature and moisture levels were recorded for 24 h after application. In the laboratory, 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.

Results

Five different *S. yirgalemense* concentrations were used. No significant differences were found between any of the concentrations applied. The three nematode species that were used in the trials included *S. yirgalemense, Steinernema feltiae* and *Heterorhabditis bacteriophora*. *Steinernema yirgalemense* caused the highest level of mortality of codling moth larvae (94-99%), followed by H. *bacteriophora* (28-54%) and *S. feltiae* (9-31%). There was a significant difference between all three treatments applied, and between the formulated and recycled commercially available nematodes.

Conclusion / Recommendations

At a concentration of 250 IJs/ml, *S. yirgalemense* was the most effective against codling moth. The commercially available *H. bacteriophora* and *S. feltiae* did not perform well, and these trials will be repeated.

Project leader: Dr A.P. Malan (SU)

Bioprospecting of natural ecosystems for entomopathogenic nematodes

Research Organisation Project Number: EPN8

Objective

The objective of this study is to determine the occurrence and distribution of endemic entomopathogenic nematodes (EPNs) in natural habitats in South Africa. The study also aims at 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 to select for a more cold-tolerant EPN.

Methodology

EPNs are 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 are being identified using morphological and molecular methods. A total of 254 soil samples have been analysed and 22 EPN species were isolated, of which 13 were identified to species level and one species described as a new for South Africa. The LD50 curves for eight different temperatures (ranging from -10°C to + 14°C) for *Steinernema yirgalemense* have been calculated and these will be used to artificially select nematodes populations with which to breed.

Results

Most common species found during the survey thus far have been *Heterorhabditis bacteriophora*, and three unidentified *Steinernema spp*. from the Fynbos biome. One new species of Steinernema is currently in the process of being described as a new species for South Africa.

Conclusion / Recommendations

Commercially available species, such as *S. feltiae* and *S. carpocapsae*, have not yet been found. All EPN isolate will be subjected to low-temperature activity and tested for their infection capability, while *S. yirgalemense* will be artificially bred to be active at low temperature.

Project leader: Prof. J.S. Terblanche (SU)

Impacts of climate variability on fruit fly (*Ceratitis spp*.) performance and population dynamics

Research Organisation Project Number: US-APE-CTT-2012-01

Objective

This project investigates the population dynamics of Ceratitis under different environmental temperature and moisture variation conditions, and relates these conditions back to field estimates of fitness in order to increase our knowledge of variation in population abundance and improve estimates made with predictive models.

Methodology

Eggs of *C. capitata* and *C. rosa* were reared under different environmental temperatures and the number of individuals progressing to the next developmental stage recorded. Adult flies were also reared under the same environmental temperatures and released under spring and winter conditions at three different localities and recaptured using pheromone lures.

Results

As expected, cooler environments significantly slowed development; however this is more pronounced in *C. capitata* (Medfly) than *C. rosa* (Natal fly). The proportion of egg hatch during peak timing (within the first 3 days) was higher in C. rosa than *C. capitata*, particularly for the cooler (20°C) treatment. There also appears to be a benefit of low temperature acclimation on dispersal ability at low ambient temperatures. However, low recapture rates (<1% of 3000 flies) discouraged us from continuing using this methodology and alternative approaches are now being pursued.

These results show that development and performance (e.g. dispersal) are not static and can be influenced by recent thermal history conditions. Further testing of combined effects of temperature and humidity together with improved methodology for assessing field performance are needed to update current predictive models.

Conclusion / Recommendations

We recommend predictive models for peak abundance be scaled to account for current temperature conditions rather than focusing on a calculations of a static development time.

Project leader: Dr Shelley Johnson (SU)

Development of monitoring methods and optimisation of a pheromone lure for the grain chinch bug, *Macchiademus diplopterus*

Research Organisation Project Number: USSJ07

There is no progress to report for this project yet since the research is being done on aestivating grain chinch bugs, and the aestivating period has not yet begun.

Project leader: Dr Shelley Johnson (SU)

Grain chinch bug (*Macchiademus diplopterus*) thermal biology and the implications for post-harvest control measures

Research Organisation Project Number: USSJ08

There is no progress to report for this project yet since the research is being done on aestivating grain chinch bugs, and the aestivating period has not yet begun.

Project leader: Prof. J. S. Terblanche (SU)

Thermal physiology and population dynamics of bollworm (*Helicoverpa armigera*) in South African fruit orchards.

Research Organisation Project Number: V-13-USE-PM21

Objective

Predicting how climate affects pest insects such as the Bollworm (*Helicoverpa armigera*) requires an understanding of the environments to which they are exposed, and so we plan to develop a mechanistic model to translate broad-scale meteorological datasets into their microclimatic conditions.

Methodology

We will then run model simulations, at different spatial resolutions, across deciduous fruit growing regions within South Africa. These results will provide an indication of the spatial scale at which future studies focusing on Bollworm, and on insect pests in general, should be conducted. These models will also provide a first indication of likely climate change impacts of Bollworm in South African agricultural landscapes.

We also hope to better understand how temperature affects *H. armigera* fitness by conducting physiological trials on specimens in the laboratory. Susceptibility to thermal extremes is expected to be a key trait that affects population outbreaks and population declines, and so we plan to characterise the lower and upper thermal tolerances of several life-history stages. Identifying particularly vulnerable life-history stages, as well as the thermal conditions that limit survival, will enable us to better predict Bollworm geographic distribution and temporal variation in abundance.

Results

To date, we have developed a microclimate model that translates broad scale GIS datasets of climate and terrain into the conditions actually experienced by Bollworm in an apple orchard. Within this framework, we have incorporated a degree-day model to describe how temperature affects development rate of this species.

Conclusion / Recommendations

While Bollworm does not emerge in the Western Cape until October, researchers on the project have made plans to obtain Bollworm samples from a research group in Potchefstroom, which will be used in the laboratory trials. This will be further supplemented by field sampling efforts in Grabouw

Project leader: Prof. J. S. Terblanche (SU)

Entomopathogenic nematode thermal tolerance and performance: experimental manipulation for increased efficacy

Research Organisation Project Number: US-APE-NTT-2013-01

Objective

Entomopathogenic nematodes (EPN) are sensitive to environmental temperatures and their field efficacy is linked to thermal tolerance. By exploring thermal tolerance across a range of EPN species and attempting to improve and modify these limits, it should be possible to increase field performance in biocontol programmes. We also aim to investigate host dietary effects on cold tolerance for entomopathogenic nematodes, as well as across-generation selection responses.

Methodology

We developed assay techniques for lower and upper lethal thermal traits of EPNs. We also examined the addition of L-proline and trehalose to codling moth larval diets in an attempt to modify and improve cold tolerance for EPN. Here for convenience we focused mainly on *Steinernema yirgalemense* on a codling moth host as this resulted in a faster life-cycle.

Results

We assessed lethal lower temperatures by exposing approximately 1-200 nematodes per temperature to set subzero temperatures for one hour and then scoring survival 24 hours post treatment. We have now established that proline supplementation has limited effect on low temperature tolerance for S. yirgalemense and have therefore continued to assess these effects across a range of 5 other EPN species, including our original focal study species, *H. zealandica*. We reared all these EPNs on codling moth larvae, *Cydia pomonella*, hosts to then investigate baseline cold temperature tolerance across the EPN genera, Heterorhabditis and Steinernema.

Entomopathogenic nematodes have a range of lower temperature tolerances across the species investigated, though Steinernema found in South Africa (*S. yirgalemense* and *S. citrai*) are less cold tolerant. We found no significant difference between different diet treatments in our thermal assays of *S. yirgalemense*.

Conclusion / Recommendations

Our results give indication of large ranges of evolved thermal tolerance for the EPNs investigated. Further research will investigate acclimation and inter-generation effects and guidelines for exploitation of thermal tolerance limits for pest insect control strategies.

CROP PROTECTION PROJECTS - FINAL REPORTS

Project leader: Mr H.J. Hugo (ARC Infruitec-Nietvoorbij)

Comparison of the host status of different rootstocks to ring nematode (*Criconemoides xenoplax*)

Research Organisation Project Number: 230075

The objective of this project was to evaluate some of the commercial stone fruit rootstocks' status as hosts for ring nematode (RN) (*Criconemoides xenoplax*).

This was done by inoculating rootstocks with a known number of RN and determining the increase in populations over time. The reproduction factor (RF) was then calculated and used to rank the rootstocks according to their host status.

Seven rootstocks were evaluated. All the rootstocks tested were hosts for RN. However, there were differences and this information should be used when deciding on a rootstock in a specific situation. The results support observations that poor hosts for *Meloidogyne spp*. (root-knot nematode), such as Flordaguard and Maridon, are good hosts for RN. There also seems to be a trend that apricot rootstocks are less successful as RN hosts than rootstocks originating from peach and plum origin.

Based on their RF values the rootstocks tested were ranked as follows:

1. Flordaguard Very good host
2. Maridon Very good host
3. Kakamas Very good host
4. GF 677 Good host
5. Viking Host
6. Royal Host
7. Soldonné Host

One of the outcomes of this project is that we now have a reliable protocol to determine the RF values of RN for stone fruit rootstocks. This protocol, with small adjustments, could also be used to determine the RF values for other nematodes.

In future all commercial stone fruit rootstocks should be tested and ranked for their nematode host status. This will be a huge benefit to growers in making informed decisions when choosing a rootstock.

Program leader: AP Malan (SU)

Project title: Characterisation of nematode symbiotic bacteria and the *in vitro* liquid culture of *Heterorhabditis zealandica* and *Steinernema yirgalemense*

Research Organisation Project Number: EPN5

Entomopathogenic nematodes (EPNs), in combination with their associated bacterial symbionts, have proven to be effective against numerous insect pests.

In this project, the associated symbiotic bacteria of three EPN species were isolated, and the potential of two nematode species to be mass cultured in liquid media was evaluated. Bacteria species from *Heterorhabditis noenieputensis, Steinernema khoisanae* and *Heterorhabditis zealandica*, which were found to be new species, have been described as such.

Using *in vitro* mass culture techniques, it was illustrated that *H. zealandica* and its *Photorhabdus* symbiont, as well as *Steinernema yirgalemense* and its *Xenorhabdus* symbiont, can be successfully cultured in a liquid medium. However, the number of nematodes per ml of medium was found to be much higher for *S. yirgalemense*, with 77 000 IJs/ml (13 days), in comparison to the 41 000 IJs/ml (15 days) obtained for *H. zealandica*.

The final aim of the project was to determine when *Xenorhabdus* reached the stationary phase, when grown in a 20-L fermenter, as this would be the time most suited for adding the infective juveniles (IJs) of *S. yirgalemense* for mass culture. The step concerned would also be the first taken toward the liquid mass culture of *S. yirgalemense* in industrial-size fermenters.

Results from this experiment indicated the optimum amount of time required for adding nematodes to the bacterial culture in the fermenter and for ensuring the optimum recovery of IJs, as well as a subsequent high yield of nematodes within a minimum amount of processing time.

This is the first report of its kind to investigate comprehensively the successful liquid culture of two South African EPN species for the sole purpose of evaluating potential commercialisation. Future research goals should be to increase the percentage IJ recovery directly after inoculation into liquid culture, which would increase the number of nematodes produced per ml medium, which would, therefore, significantly reduce the amount of processing time required.

Project leader: Mrs S.G. Storey (Nemlab)

The role of nematodes and their use as bio-indicators in soil health under local conditions

Research Organisation Project Number: NEM002

Nematodes form an integral part of the soil food web at several trophic levels. Their rapid responses to changes within their environments provide them with the potential to impart insight into the condition of the soil food web.

Three objectives were set to determine the practical use of nematode community structures as a tool for the measurement of soil health: describing the nematode community structure, biodiversity and functionality within Fynbos soils; the characterization of organic and conventional orchards; and the differences in nematode soil communities in differently managed soils in an apple orchard.

The number of nematodes in each soil sample was quantified and identified to family level. The functional guild analysis of Fynbos samples indicated that the enrichment and the structure of any given sample was not bound to a certain area, but was representative of each of the four quadrats within the faunal analysis.

The characterisation of nematode communities in organic and conventionally managed orchards indicated that herbivores were dominant in all the orchards. All orchard soils were located within Quadrat B of the faunal analysis, indicating enrichment and structure. Different management practices did not show marked differences in community composition and structure.

The species richness of Fynbos soils and deciduous fruit orchards was comparable. Soil samples from eight different soil surface treatments were collected from an apple orchard (chemical control of cover crops and weeds, mulch and mulch + effective micro-organism spray). Clear differences in nematode community structure and composition were observed between the different soil applications in the orchard.

Post Harvest

HORTGRO science
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POST HARVEST RESEARCH PROGRAMME

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

Table 1 gives a summary of the stone and pome fruit projects that were completed in the 2012/2013 financial year.

Stone Fruit

Two of these final projects focussed on post-harvest pathology, which is probably the most important research focus area for stone fruit. One of these projects comprised a comprehensive survey of effective, alternative control strategies that can be used to reduce dependency on synthetic fungicides on stone fruit. These strategies will be tested in the coming season. In the other study new information was generated on the host specificity and the importance of Penicillium spp. on plums and nectarines - information that stone fruit handlers must seriously consider.

Regarding the apricot work, extension has been granted since the technology tested to prevent moisture loss from this high value product was so promising that it warrants semi-commercial testing. The basic work done on the development of chilling injury in plums greatly contributed to our knowledge of this important defect in this fruit kind. The two projects which addressed two themes of the post-harvest programme, namely transportation systems (shipping containers in this case) and prediction of fruit quality (Radio Frequency Identification Technology in this case) provided much needed information on air flow in the integral container and temperature and relative humidity patterns in the post-harvest handling chain. It was found that, although there is some variation in temperature and relative humidity, that the fruit quality was not adversely affected by it. Not only do the six completed stone fruit projects provide new knowledge to develop more optimal post-harvest technologies, but it also built capacity in the form of one doctorate being awarded in Horticultural Science. A number of talks have also been given at producer/information days and short courses and articles had been published in the SA Fruit Journal and Farmers Weekly to ensure that the new information is transferred back to the producers.

Table 2 lists the stone fruit projects which are currently in progress. These projects address three of the eight main themes of the focus area, namely (1) decay control, (2) protocols and fruit quality maintenance, and (3) market access.

Table 3 lists the new stone fruit projects approved for the 2013/14 financial year. These projects aim to shed light on moisture loss in plums, the stone fruit industry's second most important post-harvest problem, and the replacement of the intermittent warming regime with technologies that will maintain good fruit quality, but which will be easier to manage post-harvest.

The small number of projects and the little funding available for stone fruit research, a high value, but very perishable product, has been of concern in the previous financial year. This past year a great effort was made by role players in the stone fruit industry and the management of Hortgro Science to address this issue by a strategic look at pre- and postharvest research needs for this product group. The findings are currently under review by SASPA.

Pome Fruit

The big post-harvest news was the lowering of the tolerance of DPA in the EU, thereby excluding its use for that market in 2014. Alternatives to DPA has been a focus of research since 2008, and Kobus van der Merwe and his team at ARC Infruitec-Nietvoorbij have shown that Dynamic Controlled Atmosphere (DCA) technology works to control superficial scald and maintain eating quality of apples and pears under our conditions. Current research is focussing on the length of DCA storage required to control scald. Experico has conducted sterling work on DPA cross-contamination and risk management to minimise the risk of DPA exceedances. While the findings are still interim, an Industry focus session was held.

Dr Ida Paul of Experico conducted a survey of packhouse chlorination and found that chlorine provided adequate pathogen control if the chlorine concentration levels were tracked. Dr Cheryl Lennox (SU) conducted a pilot study to identify biological control strategies and soft products for postharvest control of pathogens. The next phase of testing these products will be conducted by Experico. Bulls-Eye rot has proved to be a challenge for many Cripps' Pink producers, and research by Dr Cheryl Lennox is aimed at providing a management strategy for the disease. The final report on host specificity, pathogenicity virulence and resistance of various Penicillium species has been received, and valuable technology transfer on sanitation to manage this pathogen has been provided to participants.

Abate Fetel storage trials are still underway to lengthen storage, determine optimum storage regimes to minimise superficial and soft scald. The Forelle SmartFreshSM research has manifested in the successful third commercial export trial of 750 000 cartons. Not only has the early marketing resulted in premiums for that period, but the smoothing of Forelle volumes over time has had a hugely beneficial effect. The value of this to the Industry is estimated at R15 million. Research on astringency on pears to date has indicated that Cheeky appears not to be a susceptible variety.

More fundamental research on the development of mealiness of Forelle and internal browning on Cripps' Pink is improving our understanding of these issues and will be of benefit in solving future problems. New projects (Table 3) for 2014 include variations on the Forelle SmartFreshSM theme and an investigation into internal browning of Rosy Glow.

Acknowledgements

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. Please make sure that you read the summaries of each project attached to familiarise yourself with the newest information available to our 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 read through numerous project proposals and reports, is gratefully recognised. Thanks are also expressed to the management team of Hortgro Science for their hard work and support throughout the year to the different research institutions, work groups and committees. Ultimately, the work would not have been possible without the support of SASPA and SAAPPA, and by the Postharvest Innovation Programme of the Department of Science and Technology and the Fresh Produce Exporters Forum. Your contribution to this important work is gratefully acknowledged.

Dr Mariana Jooste and Richard Hurndall

Table 1. Final project reports received in 2013

Project title	Fruit kind	Researcher	Research Institution
Determine the optimal harvest maturity for late harvested Forelle pears to establish early market access with SmartFresh.	Pear	Heleen Bergman	ExperiCo
Early market access of Forelle pears to EU market using SmartFresh and targeted maturity fruit.	Pear	Ian Crouch	ExperiCo
Pilot study on the potential of implementing biological control strategies and soft products for post-harvest control of plant pathogens of pome fruit in South Africa.	Pome	Cheryl Lennox	Dept of Plant Pathology, Stellenbosch University
Evaluation of industry needs with respect to postharvest diseases of stone fruit in South Africa.	Stone	Cheryl Lennox	Dept of Plant Pathology, Stellenbosch University
Effect of irradiation as a mitigation treatment on storage quality of plums.	Plum	Dawie Moelich	ExperiCo
Using Radio Frequency Identification Technology (RFID) to get an understanding of the storage air and fruit pulp temperatures and relative humidity in a typical S A fruit export supply chain from the very beginning to the very end over 2 seasons.	Pome/Stone	Malcolm Dodd	Dept of Horticultural Science, Stellenbosch University
Optimisation of the cold chain with particular focus on cooling within containers.	Pome/Stone	Malcolm Dodd	Dept of Horticultural Science, Stellenbosch University
Membrane studies in Japanese plums (*Prunus salicina* Lindl).	Plum	Mariana Jooste	Hortgro Science/ Dept of Horticultural Science, Stellenbosch University
Host specificity, pathogenicity virulence and resistance of various *Penicillium* species on table grape and other deciduous fruit crops	Nectarines and plums	Lise Korsten	Dept of Microbiology and Plant Pathology, University of Pretoria

Table 2. Running projects.

Project title	Fruit kind	Researcher	Research Institution
Effect of pre-conditioning of apples at high temperatures and low 02 as an alternative for DPA treatment for the prevention of superficial and bitter pit development on Granny Smith and Braeburn apples during cold storage.	Apple	Kobus van der Merwe	ARC Infruitec-Nietvoorbij
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.	Apple	Kobus van der Merwe	ARC Infruitec-Nietvoorbij
Determine optimum controlled atmosphere storage conditions for Abate Fetel pears.	Pear	Kobus van der Merwe	ARC Infruitec-Nietvoorbij
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.	Pear	Kobus van der Merwe	ARC Infruitec-Nietvoorbij
Determine the critical minimum dynamic controlled atmosphere (DCA) storage exposure periods to inhibit superficial scald and the effects of CA and RA storage periods following DCA storage on superficial scald development of Packham's Triumph pears.	Pear	Kobus van der Merwe	ARC Infruitec-Nietvoorbij
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	ExperiCo
Effect of alternative application methods (electrostatic) of Iprodione for post-harvest decay control on plums.	Plum	Arrie de Kock	ExperiCo
Extended cold storage of Abate Fetel pears for EU market.	Pear	Ian Crouch	ExperiCo
Optimum harvest maturity determination for African	Plum	Arrie de Kock	ExperiCo
Delight plums planted in different production areas.	Pome	Ida Paul	ExperiCo
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.	Stone	Ida Paul	ExperiCo
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.	Apple	Prins van der Merwe	ExperiCo

Table 2. Running projects (*continued...*)

Project title	Fruit kind	Researcher	Research Institution
Assessment of accumulation DPA residues throughout storage and packing facilities.	Apple	Elke Crouch	Dept of Horticultural Science, Stellenbosch University
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.	Pear	Elke Crouch	Dept of Horticultural Science, Stellenbosch University
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.	Pome/Stone	Linus Opara	Dept of Horticultural Science, Stellenbosch University
Packaging of the Future: Integrated model-based design and performance evaluation of packaging for the SA fruit industry.	Plum	Mariana Jooste	Hortgro Science/ Dept of Horticultural Science, Stellenbosch University
Heat damage in plums (Post-Harvest) Determination of optimum packaging with the view to reduce moisture loss on Charisma apricots.	Apricot	Arrie de Kock	ExperiCo

Table 3. New projects approved for 2014

Project title	Fruit kind	Researcher	Research Institution
Moisture loss studies in Japanese plums	Plum	Mariana Jooste	EHortgro Science/ Dept of Horticultural Science, Stellenbosch University
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.	Plum	Handré Viljoen	ExperiCo
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.	Pear	Ian Crouch	ExperiCo
To determine the maximum delay in SmartFresh application from harvest to room filling for fruit destined for the FEMA programme.	Pear	Ian Crouch	ExperiCo
Physiological profiling on Rosy Glow apples harvested at different maturities, with special reference to internal browning development potential.	Apple	Heleen Bergman	ExperiCo
Harvest and storage conditions duration influencing internal browning and fruit quality of Rosy Glow.	Apple	Elke Crouch	Dept of Horticultural Science, Stellenbosch University
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	ExperiCo

**Funded by Forelle Producer Association levy*

POST HARVEST PROJECTS - PROGRESS REPORTS

Project Leader: Dr E.M. Crouch (SU)

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

Research Organisation Project Number: A2-09

Objective

The study objective was to determine the relation between 'Cripps' Pink' internal browning development and pre-harvest temperatures, mineral nutrition, tree age and soil type in two production areas after long term CA storage. The second objective was to evaluate the NIR technique as a possible non-destructive sorting tool for internal brown fruit. 'Cripps' Pink' were CA stored at 1.5% O2, 1% CO2 and 0.5°C, for 7 months + 4 weeks RA (- 0.5°C) + 1 week shelf life (20°C).

Methodology

The Elgin and Koue Bokkeveld regions proved to be climatically different according to growing day degrees (GDD), minimum temperatures as well as the difference between maximum and minimum temperatures in 2012. Browning in the form of diffuse and radial browning was identified in fruit. A third browning type which shows affected cortex as well as the vascular tissue has been identified within this study. As the type of browning shows characteristics of both radial and diffuse browning, it was named combinational browning.

Results

Browning did not differ between the two areas and did not correlate with temperature parameters. Type of browning also did not differ between areas and did not correlate with temperature parameters except for combinational browning which correlated with maximum temperatures. Mineral content of fruit was influenced by soil type and tree age. Fruit from young trees and sandy soils were the most susceptible to browning. Brown fruit on sandy soils had lowest K content, whereas the highest content was found in non-brown fruit from a clay orchard. K:Ca was also lowest for brown fruit from a sandy soil. Mineral composition of fruit from various orchards in two climatic regions also showed that brown fruit had a low K:Ca level compared to non-brown fruit. Combinational browning as well as incidence of diffuse browning was higher in young orchards, whereas radial browning was not affected by tree age. Fruit from young trees with highest levels of browning had the highest levels of N and non-brown fruit from old trees had lowest levels of browning and N. Brown fruit from old trees had the lowest levels of K. K for fruit from young trees that turned brown was also lower compared to non-brown fruit but this difference was not significant. Other minerals seem to be more related to soil type or tree age rather than internal browning.

Conclusion / Recommendations

This trial is repeated in 2013 and findings will be evaluated after storage, ripening and statistical analysis in March 2014.

Project title: Project leader: Dr C Lennox (SU)

Etiology and Epidemiology of *Neofabraea spp.* on pome fruit

Research Organisation Project Number: USPP CL3

Objective

Bulls eye rot (BER) is a latent disease complex compromising four Neofabraea species, of which *N. alba* was found to be a major postharvest pathogen of the Cripps' Pink apple cultivar in the Western Cape. Morphological and molecular analyses currently indicate *N. alba* to be the only BER species on Cripps' Pink.

Methodology

Evaluation of disease incidence and distribution was continued for this season; asymptomatic Cripps' Pink apples were collected at harvest from 37 producers in the Ceres, Grabouw and Hemel-en-Aarde Valley regions and placed in 4 month cold storage. In addition, *N. perennans* was recently identified from pear fruit in the Western Cape and asymptomatic Packham's Triumph pears were collected at harvest for evaluation of possible BER symptoms.

Evaluation of rapid detection for BER in the orchard was continued for the 2012/2013 season and Cripps' Pink fruit and leaves were collected 1 month post-full bloom until harvest from two farms, one in Ceres and one in Grabouw, washed and DNA extracted. Weather data for all sampled seasons is currently being collected for the development of a concept disease prediction model.

Results

In vitro fungicide sensitivity of *N. alba* isolates was conducted using flusilazole and pyrimethanil. Flusilazole is used to control apple scab pre-harvest, while pyrimethanil is used overseas for post-harvest control of *Neofabraea*. Flusilazole inhibited conidial germination, but 100% inhibition of mycelial growth was not achieved. Pyrimethanil successfully inhibited mycelial growth.

Conclusion / Recommendations

Flusilazole and pyrimethanil could therefore be beneficial to pre- and post-harvest management control strategies for *Neofabraea* in South Africa.

Project leader: Dr Elke Crouch (SU)

The influence of cell number and size (indirectly cell division) and cell wall bound and free Ca^{2+} on the development of 'Forelle' pear. As well as the evaluation of NIR as an early detection method for mealiness

Research Organisation Project Number: FOR1

Objective

'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.

Methodology

X-ray computed tomography (X-ray CT) was used to examine internal cellular differences between mealy and non-mealy pears. PLS models based on Fourier Transform NIR spectroscopy was used for a possible prediction of mealiness related parameters.'Forelle' pears were harvested from four farms in the Ceres and Wolseley 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.

Results

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 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.

Conclusion / Recommendations

'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.

Project leader: Dr I Crouch (Experico)

Identification of factors involved and control of astringency in pears

Research Organisation Project Number: P 02-12

Objective

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.

Methodology

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 H2 and H3 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.
Astringency levels generally decreased the longer Forelle were stored.

Results

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.

Conclusion / Recommendations

Continue trial according to specified milestones.

Project leader: H Viljoen (Experico)

Optimum harvest maturity determination for African Delight plums planted in different production areas

Research Organisation Project Number: PL 01-12

Objective

Optimum harvest maturity determination for African Delight plums planted in different production areas

Methodology

African Delight plums were harvested in Robertson, Franschhoek and Ceres at four harvest maturities each at weekly intervals. Plums were cold stored for 8 weeks at -0.5°C and subjected to shelf life of 5 days at 10°C, after which the fruit were examined for internal and external quality as well as taste.

Results

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.

Conclusion / Recommendations

Harvest at a specific maturity cannot be used to prevent skin scald. Sufficient skin colour development, a minimum TSS at first harvest of 15% and a maximum flesh firmness of 9 kg is required for best quality. An indicator calculation for TSS/MA/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. This concept must be confirmed on other populations in these 3 production areas.

Project leader: Mr A de Kock (Experico)

The effect of alternative application methods of Iprodione for post-harvest control of *Botrytis* decay on plums

Research Organisation Project Number: PL 02-10

Objective

The effect of alternative application methods of Iprodione for post-harvest control of *Botrytis* decay on plums

Methodology

A high volume spray (HVS) applicator was compared to a standard atomiser on a commercial pack line in terms of residues of Iprodione (Rovral Aquaflo) on four plum cultivars. *Botrytis* decay control was quantified on one of these cultivars.

Results

Across cultivars, Iprodione residues were higher with the 1x Iprodione concentration (1ml/L) applied as a high volume spray (HVS), compared to an atomiser application. Residues ranged between 2.01 and 1.32 ppm. As the residues were higher than in 2012, a 0.5x concentration (0.5ml/L) was included on two of the plum cultivars, resulting in residues ranging between 1.18 and 0.9 ppm. Residues on fruit treated with the standard atomiser ranged between 1.14 and 0.25 ppm. All the residues were lower than the maximum permissible residue of 3 ppm. Southern Belle plums were wounded (2 x 2 mm) with a sterile needle and inoculated with a Botrytis cinerea spore suspension of 20,000 spores/ml. Decay incidence and severity was reduced significantly with the HVS at the 1x concentration compared to the atomiser. Compared to the untreated control, sporulation was reduced significantly by both the HVS treatments, as well as the atomiser treatment.

Conclusion / Recommendations

In conclusion, the variation in residues in fruit treated with a standard atomiser was larger than in fruit treated with a HVS. The higher volume water applied with the HVS system, using a lower concentration of Iprodione, resulted in better decay control, possibly due to better fruit coverage, however, excessive wetness after treatment.

Project leader: Dr Mariana Jooste (SU/Hortgro Science)

Heat damage in plums

Research Organisation Project Number: MJ01/13PH

Objective

The effect of heat wave conditions in the orchard on fruit respiration rate and internal fruit quality and the role of temperature and delay period before stepwise cold-storage was investigated in relation to harvest maturity.

Methodology

Respiration rate, ethylene and ethanol evolution and glutathione and ascorbic acid concentration of 'Laetitia' plums were progressively assessed twice weekly at 09h00 and 13h00 from 3 weeks before harvest in Wellington. Pulp and ambient temperatures and RH were recorded in the orchard. Further assessments were conducted at harvest, and again after cold storage and shelf life.

Results

Preharvest respiration proceeded faster in the afternoon whereas ethanol and ethylene evolution rates did not have a direct relationship with time of day. No internal heat damage symptoms were observed at harvest or after storage. This could be why delay time and pre-storage temperature did not affect fruit quality. Less mature fruit had better fruit quality and were better acclimated to cold-storage regarding their antioxidant concentrations at harvest. No incidences of shrivel in both fruit maturities was observed.

Conclusion / Recommendations

Delay period and pre-storage temperature before stepwise cooling did not seem important, but further work should incorporate preliminary induction of internal heat damage to verify the results.

Project leader: Dr Ida Paul (Experico)

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

Research Organisation Project Number: A 03-13

Objective

Chlorine solutions are used in pome fruit pack-lines of the Western Cape for sanitising flume water. However, ineffective sanitising of flume water may result in fungal infection of, and subsequent post-harvest decay of pome fruit. The objective of this study was to assess if the use of chlorine solutions within pack-house flumes, currently used within the pome industry, is sufficient for control of postharvest decay of pome fruit.

Methodology

Twelve unique pack-line situations from seven pome pack-houses were identified. Using sterile techniques, flume water was sampled at 5 points in the pack-line. These points were:
1) Pack-house source water
2) A point in the flume where fruit first meets water
3) A point in the flume before sorting of fruit
4) A point in the flume before packing of fruit, and if present
5) The class 2 flume
To determine microbial load, water samples were plated out on Potato Dextrose Agar. To further determine the ability of the water to inhibit fungal growth, water samples were spiked with *Botrytis* and *Penicillium* spores respectively, and plated out. Source water amended with chlorine (with or without the addition of fungal spores) was plated out as positive control.

Results

Results indicate that efficacy levels of chlorine solutions within flumes vary. For the best pack-house, chlorine levels were sufficient to control microbes, while for two worst pack-houses chlorine levels were never sufficient to control microbes.

Conclusion / Recommendations

Notably, pack-houses that tracked and amended chlorine levels in flume water were those where microbial control was best. Such tracking systems thus support effective use of chlorine for flume sanitation.

Project leader: Prof UL Opara (SU)

Packaging of the future: Integrated model-based design and performance evaluation of packaging for the SA fruit industry

Research Organisation Project Number: V-11-USH-PHO6

Objective

New research equipment were installed for testing package resistance to airflow, impact and compression loads, respectively. A relative humidity controller was also installed inside one cold store to permit future studies looking at the effects of humidity on fruit quality.

Methodology

A methodology was developed and tested for assessing the contributions of package components to the total resistance to airflow. This was successfully applied to apple and table grape packaging.

A survey was carried out to document the geometric characteristics of 'telescopic' and 'display' ventilated package designs used for handling apples and pears in South Africa. This new information provides a valuable input to ongoing and future research on improving the packaging used in the South African pome fruit industry.

CFD modelling systems for investigating the cooling performance of ventilated horticultural packaging were developed and validated for table grape packaging, and used to study the effects of vent design.

Results

The results showed that the benefits of increasing vent area to enhance fruit cooling rate begins to diminish beyond 7% total vent area.

Conclusion / Recommendations

Finite element modelling was applied to investigate the resistance of packaging to compression load. Further experimental research is ongoing to validate the model results. We have established collaboration with NAMPAK to assist us with access to specialised equipment needed to characterise the mechanical properties of the parts of the composite package. Preliminary results have shown good agreement between model results and experimental data under standard testing conditions, which highlights the potential of the model as a research tool.

Project leader: Prof M C Dodd (SU).

Optimisation of the cold chain with particular focus on cooling within containers

Research Organisation Project Number: 1/09-10

Objective

Optimisation of the cold chain with particular focus on cooling within containers
This project was run with the assistance of funds provided by CRI for the same project.

Methodology

Two identical reefer shipping containers were leased for a three year period commencing January 2010. One of the containers was modified to "Reversed Air Flow" technology. Simply described this comprised creating an air delivery duct across inside front face of the container. A return air duct was created by suspending sheeting to the roof of the container from the front for nine meters along the inside of the roof. The chilled air is thus delivered into the cargo in the same way as a land based "Pre-cooling" system, thus increasing the efficiency of use. A set of trials have been run side by side across a range of fruit kinds and build a data base on air and pulp temperature, relative humidity, energy consumption and out turn quality of the fruit. The main challenge of running this project was to get 40 identical pallets of fruit on "loan" from an exporter for a period of up to fourteen days. Some exporters, however, have been most helpful in "loaning" export fruit for the trial before exporting it. The objective of the project was to generate as much data as possible to build a dossier of data that will enable the fruit industry to engage with shipping lines with a view to getting better quality fruit out of the containers after the shipping period . In total a set of 19 trials have been conducted over three years across apples, pears, plums, table grapes and citrus.

Results

In all cases, except for when the fruit was packed in punnets, the horizontal airflow technology improved the pulp temperatures of the fruit compared to the controls and the relative humidity was raised. There were no negative effects to the quality of the fruit due to the technology and in several cases the fruit when evaluated after subsequent storage and shelf life had a higher quality rating when stored under the horizontal airflow.

Conclusion / Recommendations

A PCT patent has been taken out by Stellenbosch University Innovation office on the technology. The Peer Review Work group has requested that this technology be introduced to the shipping industry.

Project leader: Prof M C Dodd (SU).

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 very end over two seasons

Research Organisation Project Number: CC2/2011

Objective

One of the challenges of managing a chilled fruit export supply chain is getting the fruit to the market in the best possible condition with accompanying sufficient shelf life. Accurate temperature and humidity control is vital to achieve this and not knowing what temperature and humidity abuse occurs from the beginning to the end of the chain limits the ability to manage the chain. To understand what was happening regarding temperature and relative humidity along a typical chilled fruit export supply chain a project was initiated utilising radio enabled technology.

Methodology

This equipment records the temperature and humidity continuously and uploads the information to a radio receiver which in turn transfers the data via the internet. It is possible to thus get a real time view of the conditions within the storage environment. The project was run over two seasons and the products studied were plums, apples and pears wherein radio enabled pulp temperature and relative humidity recorders were placed into a carton placed on the top of a pallet. There were two such pallets placed into a container, one at the front and the other at the rear. Radio receivers were placed at strategic points along the supply chain including the pack house, the receiving distribution centre (DC), the supermarket DC and a supermarket. These receivers enabled the segmentation of the data into the various links within the supply chain. Quality samples were drawn from the cartons at the final DC.

Results

The results of the two seasons study showed that there were sometimes problems with the temperature of the fruit at the time of loading the container. The temperature and relative humidity management within the shipping containers was always poor. On occasion the receiving depot did not place the fruit at the correct temperature and the relative humidity was always lower than the desired level of 90%. Despite these issues there were no problems with the quality of the fruit, however, no shelf life tests were conducted on the fruit.

Conclusion / Recommendations

This trial shows that the radio enabled temperature and relative humidity technology works effectively and can be used as a cost effective means of obtaining a view of the temperature and humidity across the supply chain from beginning to end. This information would aid in the resolution of claims as the service provider that had not performed their function correctly could be held responsible for any damage or loss

Progress Reports for March 2014

Project title	Researcher
Effect of irradiation as a mitigation treatment on storage quality of plums.	D Moelich
Effect of pre-conditioning of apples at high temperatures and low 02 as an alternative for DPA treatment for the prevention of superficial and bitter pit development on Granny Smith and Braeburn apples during cold storage.	K van der Merwe
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.	K van der Merwe
Determine optimum controlled atmosphere storage conditions for Abate Fetel pears.	K van der Merwe
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.	K van der Merwe
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.	K van der Merwe
Extended cold storage of Abate Fetel pears for EU market.	P van der Merwe
Assessment of DPA residue levels on untreated fruit and possible related sources of cross-contamination.	P van der Merwe
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.	H Bergman

POST HARVEST PROJECTS - FINAL REPORTS

Project leader: Mr A de Kock (Experico)

Determination of the optimum packaging, with the view to reduce moisture loss on Charisma apricots

Research Organisation Project Number: AP 01-12

2012 Season

- Charisma apricots harvested at different maturities were packed in perforated HDPE plum wrappers and PE bags with 54 x 2, 54 x 6, 108 x 6 and 162 x 6 mm perforations in 2011/12.
- Fruit were examined for moisture loss, external and internal quality, as well as taste after 32 days in cold storage at -0.5°C as well as after a subsequent shelf life of 5 days at 10°C.
- Flesh firmness was affected negatively by perforated wrappers and outer bags.
- Decay tended to be higher in wrappers and bags.
- Taste was inferior in wrappers and bags, 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.

2013 Season

- Due to the negative effects of plastic bags and wrappers on flesh firmness, decay and taste, non-perforated paper wrappers were tested in the 2013 season in an effort to reduce moisture loss without the negative effects on quality which occur with perforated PE bags.
- The paper wrappers did not affect flesh firmness significantly, while after shelf life, advanced maturity 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 less mature harvest 1 fruit but in the more mature harvest 2 fruit, mass loss was reduced significantly by all the wrapper treatments compared to the controls. Mass loss across different wrapper treatments was similar.
- Loss in fruit diameter was reduced in harvest 1 fruit by the HDPE plum wrapper, but was similar in the paper wrappers and the control fruit.
- Albeit non-significant, taste was negatively affected using the HDPE plum wrapper compared to the controls and the paper wrappers. Taste of Charisma apricots packed in the paper wrappers was similar or better than the controls.

Project leader: Dr Mariana Jooste (SU / Hortgro Science)

Membrane studies in Japanese plums (*Prunus salicina Lindl.*)

Research Organisation Project Number: MJ01/05

The export of Japanese plums from South Africa is challenging, since most cultivars are prone to develop chilling injury (CI) when stored at low temperatures. This injury manifests as gel breakdown or internal browning in the mesocarp tissue of the fruit on removal from low storage temperature conditions, i.e. in the consumer's fruit basket, who subsequently does not buy plums again.

Loss of cell membrane integrity and oxidative stress are, respectively, the primary and secondary physiological responses to CI. The main aim of this study was to investigate changes in cell membrane composition and levels of antioxidants in plums throughout fruit development and maturation, during forced air cooling (FAC) and storage under different temperature regimes.

'Sapphire' (a chilling susceptible cultivar) accumulated high levels of glutathione and polyunsaturated fatty acids (PUFAs) during fruit development. Therefore, the cultivar is protected against lipid peroxidation while developing on the tree, but the high levels of PUFAs, which are easily oxidised, may cause this cultivar to be chilling susceptible when stored at low temperatures. It is suggested that the high levels of monounsaturated fatty acids (MUFAs), which are not easily oxidised, and ascorbic acid that accumulated in 'Angeleno' (a chilling resistant cultivar) during fruit development, render this cultivar CI resistant during long-term cold-storage.

When stored at -0.5 °C, CI development increased at a higher rate, ethylene evolution rates were higher and water soluble antioxidant activity (HAA), ascorbic acid and glutathione levels, and the MUFA:PUFA ratio was lower in H2 (more mature) 'Sapphire' plums than H1 fruit (less mature). Therefore, concurrent with H2 fruit having lower levels of antioxidants to quench free radicals caused by chilling stress, their cell membranes were more vulnerable to oxidation due to their phospholipid fatty acid composition. H2 fruit also had higher levels of saturated fatty acids, and hence less fluid cell membranes than H1 fruit when stored at -0.5 °C.

An intermittent warming (IW) regime delayed symptom appearance and reduced CI severity in plums significantly compared to storage at -0.5 °C. Fruit stored under the IW regime had a more optimal phospholipid fatty acid composition and lower membrane sterol levels under shelf-life conditions to keep the membranes fluid. It also had higher levels of HAA and lipid soluble antioxidant activity, ascorbic acid and glutathione, which rendered fruit better protected against oxidation.

Elevated storage temperatures (2.5 °C to 7.5 °C) caused higher levels of lipid peroxidation or low ascorbic acid levels and poor fruit quality compared to the IW regime in 'Sapphire' plums. ‘Laetitia' plums stored at 5 °C and 7.5 °C had significantly less CI than under the IW regime, but softened quicker due to higher ethylene evolution rates.

'Sapphire' tolerated both long and short FAC durations, but a slower initial FAC rate prevented CI manifestation and caused a higher HAA after cold-storage in this fruit. 'Laetitia' cooled with a slower initial FAC rate and for a longer duration resulted in the best fruit quality and had higher HAA, total phenolic, phospholipid and saturated phospholipid fatty acid concentrations during storage.

Project leader: Amirhossein Bahramisharif (SU)

Pilot study on the potential of implementing biological control strategies and soft products for postharvest control of plant pathogens of pome fruit in South Africa

Research Organisation Project Number: USPPCL4

Chemical fungicides provide good control of postharvest fungal decay of pome fruits. However, a continuous use of fungicides has led to major public concerns regarding fungicide toxicity and development of resistance by pathogens.

The overall aim of this research was to evaluate various alternative control strategies that can be used to reduce dependency on synthetic fungicides. Recently, the use of non-chemical products to control decay caused by postharvest pathogens has been widely investigated and have the potential to replace synthetic fungicides.

This review describes the effectiveness of using biological control agents, soft products, sanitizers, essential oils and plant extracts for the management of postharvest diseases of pome fruits.

A short-list of biological control strategies and soft products with potential for postharvest control of plant pathogens of pome and stone fruit in South Africa included Peracetic acid, Chlorine dioxide, *Cryptococcus albidus* and related *Cryptococcus* species, Avogreen and related *Bacillus* species, *Trichoderma* species, and Sodium hypochlorite and hydrogen peroxide.

Project leader: Amirhossein Bahramisharif (SU)

Evaluation of industry needs with respect to post harvest diseases of stone fruit in South Africa

Research Organisation Project Number: USPPCL5

Chemical fungicides provide good control of postharvest fungal decay of stone fruits. However, a continuous use of fungicides has led to major public concerns regarding fungicide toxicity and development of resistance by pathogens.

The overall aim of this research was to evaluate various alternative control strategies that can be used to reduce dependency on synthetic fungicides. Recently, the use of non-chemical products to control decay caused by postharvest pathogens has been widely investigated and have the potential to replace synthetic fungicides.

This review describes the effectiveness of using biological control agents, soft products, sanitizers, essential oils and chitosan for the management of postharvest diseases of stone fruits.

Project leader: Mr JP Louw (UP)

Host specificity, pathogenicity and virulence of various *Penicillium* species on deciduous fruit crops (pome fruit)

Research Organisation Project Number: UP-PEN110

The South African deciduous fruit industry is a major player in the international export markets and is constantly under pressure to ensure blemish free top quality fruit.

More complex and extended supply chains are exposing fruit to postharvest pathogens for longer periods of time while the product is in transit and being distributed. Complex fruit trade networks result in a bigger variety of fruit from various countries being retained together potentially exposing the surfaces to an increasing range of pathogens. Numerous *Penicillium spp*. have been associated with spoilage on different fruit types and if not regularly removed, contribute to heavy inoculum loads in distribution centres.

This study investigates pathogenicity and virulence of selected *Penicillium spp*. isolated from South African and European Union fruit export chains (pear and citrus). *Penicillium* expansum was the most- and *P. crustosum* the second most virulent on all the apple (cvs. Royal Gala, Granny Smith, Golden Delicious, Top Red and Cripps' Pink) and two of the pear cultivars (Packham's Triumph, Forelle) tested. *Penicillium digitatum* was the most virulent on Beurre Bosc, Beurre Hardy and Sempre (Rosemarie) pears and third most virulent on Granny Smith and Cripps' Pink.

To our knowledge this is the first report where *P. digitatum* has been described as highly virulent on certain pome fruit cultivars. These cultivars are also the most commonly associated with decay on the export markets resulting in considerable end-market losses.

This study provides new information on host specificity and the importance of pathogenic *Penicillium spp*. isolated from the fruit supply chain environment.

Project leader: Mr JP Louw (UP)

Host specificity, pathogenicity and virulence of various *Penicillium* species on deciduous fruit crops (stone fruit)

Research Organisation Project Number: UP PEN110

Stone fruit are highly perishable fruit susceptible to numerous postharvest pathogens.

Penicillium expansum is one of the postharvest stone fruit pathogens contributing to losses. A single report recorded *P. crustosum* pathogenicity on peaches, but none have reported *P. solitum* pathogenicity on any stone fruit.

Complex extended supply chains expose fruit to more postharvest pathogens for longer periods of time as it move through the chain. This study investigates pathogenicity and virulence of selected *Penicillium spp*. isolated from pear -and citrus chain environments.

Penicillium expansum was the most- and *P. crustosum* the second most aggressive on all nectarine (NE 3-48-49, ARC NE-5, Sunburst, Sunlite, NE 6-4-31, Bright Pearl, May Glo, Alpine and Flavortop) and plum (Pioneer, African Rose (farm), Honey Star, Red unknown, African Rose (market), Fortune and Sunkiss) cultivars. *Penicillium solitum* was the least virulent and only caused symptoms on some cultivars (not found on NE 6-4-31).

To our knowledge this is the first report where *P. crustosum* and *P. solitum* have been described as pathogens on nectarine and plum cultivars. Virulence results produced on nectarines and plums were very similar, depending on the cultivars.

This study provides new information on host specificity and the importance of pathogenic *Penicillium spp*. isolated from the fruit supply chain environment.

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