What’s Next for Plastics?
The Complete Guide to False Codling Moth Control
You'd think that growers could breathe a sigh of relief every season once they've harvested their fruit — instead this heralds the start of a whole new set of challenges.

South African producers compete in a global market with ever more stringent rules. Consumers want unblemished fruit but eco-friendly production systems. Regulators have phytosanitary requirements but limits on pesticide use. And on top of all this is the intensifying resistance to plastic packaging. Plastic packaging has been key to the successful export of fruit — it protects against all manner of damage and deterioration. Plastic is also infinitely adaptable and relatively inexpensive. But it’s polluting our environment. Consumers are increasingly rejecting plastic packaging and forcing retailers to do the same. Governments have taken notice and are passing legislation to limit plastic use. So where does this leave the fruit industry?

This issue of Fresh Quarterly aims to answer many of your questions around plastic packaging. We’ve pulled together a range of voices from both the plastics and the fruit industry to bring you up to date on the latest developments.

Our other focus — false codling moth — is another headache for exporters. False codling moth is a phytosanitary pest in addition to damaging fruit. How can growers control false codling moth when regulators and consumers are clamouring for reduction in chemical pesticide use? Fortunately there are several options and we’ve put together a handy guide summarising them all.

We’ve also included pieces on some of the exciting new projects funded by Hortgro Science. One of these is the establishment of a temperature-phenophase database that will help growers to better manage rest break — invaluable information for adapting to a changing climate.

Enjoy!

Anna Mouton

PS The magazine is interactive. Click on article titles in the contents to take you directly to the article. Click on links in the text to access supplementary material. Links look like this.
False codling moth damages fruit and its phytosanitary status causes headaches for exporters. Fortunately it can be controlled — read our comprehensive guide to learn how.

Does Oriental fruit moth mating disruption work for false codling moth?

Researchers will use the genome to study pesticide resistance and develop next-generation control methods.

Guide to the biology of false codling moth

Why you need an augmentorium

Know your tortricid moths

Researchers will use the genome to study pesticide resistance and develop next-generation control methods.

Looking to the future

A need to better understand seasonal temperatures and bud break in pome and stone fruit has inspired a new project that aims to establish a phenophase-temperature database for South African conditions.

Letter from the Editor

New tissue culture facility to serve fruit industry

Development of a climate and terrain tool for the EGVV

The international symposium on precision management of orchards and vineyards
NEW TISSUE CULTURE FACILITY TO SERVE FRUIT INDUSTRY

Hortgro Pome and Hortgro Stone have joined forces with the Canning Fruit Producers Association, the South African Table Grape Industry, Raisins SA and the SAPO Trust to develop a tissue culture facility near Paarl. The development of clonal apple and stone fruit rootstocks will be a focus area.

“The goal is to make affordable clonal rootstocks available to nurseries in sufficient quantities,” said André Smit, director of Hortgro Stone, at a recent industry event. “The nurseries will then be able to supply high quality new trees to producers.” The tissue culture facility is set to become operational within the next twelve months.

Development of a Climate and Terrain Tool for EGGV

Access to reliable climate data has always been critical to growers — climate data informs everything from cultivar selection to orchard management. A project led by Prof. Adriaan van Niekerk and Dr Tara Southey of the Centre for Geographical Analysis at Stellenbosch University has been generating maps of climate data that growers can use to inform on-farm decisions.

The researchers are applying the latest geospatial technology to generate detailed profiles of the Elgin-Grabouw-Vyeboom-Villiersdorp area. Growers will be able to access orchard-level information on variables such as chill units and growing degree hours online through the TerraClim tool — click here for more. The climate and terrain tool will initially only be developed for the EGGV area but could be expanded in future projects.

October 2019 | Palermo | Italy

The International Symposium on Precision Management of Orchards and Vineyards

A recent week-long symposium focussing on precision agriculture featured speakers from around the world. Precision agriculture aims to fine-tune crop management based on data and allows growers to optimise production — even within the constraints imposed by climate change. We asked three South Africans attendees for their take on the highlights.

“The new frontier is variation in fruit maturity because it leads to endless problems post-harvest,” says Prof. Wiehann Steyn, research manager at Hortgro Science. Steyn was surprised to find that scientists from several countries have made fruit uniformity a major research theme — even countries with fewer climatic challenges than South Africa. We already know that more uniform trees help to reduce variation in fruit. Steyn was intrigued by one approach to improving tree uniformity. “You have different soil types in your orchard and they vary in all sorts of ways. If you plot the soil characteristics, you can potentially use different rootstocks on the different soil types. You’ll end up with an orchard where all the trees look identical even though the soil isn’t.”

Prof. Karen Theron, chair in applied preharvest deciduous fruit research at Stellenbosch University, was impressed by a presentation on variable drip rate irrigation. “There was a Dr Nadav from Israel who showed how they can install systems that irrigate thirty by thirty metre plots individually. They scan the soil and install the system so that it irrigates according to the requirements of each specific soil type.”

Agricultural adviser Chris Jurisch of Arbortech describes the symposium as a mind-blast. He was struck by several talks on tree training systems that increase yields while opening the door to mechanisation. Speakers introduced concepts such as variable rate mechanical pruning which is based on satellite and drone sensing of the vigour of an individual plant. Researchers are also working on bringing robotics into the orchard for precision crop estimation and to quantify fruit size.

“It was a major eye-opener,” says Jurisch. Steyn agrees, stating that the symposium was more exciting and cutting-edge than many others that he’s attended in recent years.

“Often when you think about precision agriculture, you think it’s only about technology — how to use drones and so on — but it’s much wider than that,” remarks Theron. “In the future this would be one of the best conferences to attend, also for the technical people in our industry.”

The next International Symposium on Precision Management of Orchards and Vineyards is likely to be held in Australia in 2023.

www.hortgroscience.co.za

Development of a Climate and Terrain Tool for EGGV

Below An example of a temperature-data overlay generated by the climate and terrain tool.
Is it time to move on?
By Grethe Bestbier

Fruit packaging has evolved dramatically since the early 1970s. How did we get to where we are today, and why is plastic so popular in the fruit industry? Fresh Quarterly spoke to three people at the heart of the packaging business to get a better understanding of fifty years of plastics.

Plastic packaging wasn’t always the norm. According to Johan Strydom, specialist in fresh fruit supply chains at PS Logistics, before the 1970s fruit were packed and transported without using a single bit of plastic. In those years, all stone fruit was packed in wooden crates, pome fruit wrapped in paper and grapes protected by softwood shavings.

In the 1970s, things started to change. Apples and pears were packed in cartons, followed by grapes and stone fruit by the end of the decade. Fruit were cooled inland. Road transport replaced railway transport. Composite cartons, made from corrugated cardboard, hardboard and plastic, entered — and later exited — the market. Grapes were packed in plastic bags instead of wrapped in paper sheets. This was followed by polycoat paper bags, carrier bags and modern-day punnets. Apples were packed in plastic bags. Foam sheets were included when packing pallets of apricots to prevent movement of fruits causing abrasions. A new age of plastics had arrived.

In 1978, the first container ships began transshipping fruit. Boxes of fruit were now stacked on disposable wooden pallets and plastic straps used to keep cartons in place. Throughout the 1980s, plastic became ever more popular. Fruit were cooled in cooling tunnels. From the cooling tunnels, the pallets were loaded into the ship with jetty cranes, where the boxes or cartons were stacked by hand, one by one.

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The reason for switching over to plastic is a combination of costs, quality and market requirements,” says Strydom. Compared to, for example, a paper bag, plastic is much cheaper.

Cost is isn’t the only consideration. The most important benefit of using plastic is the preservation of fruit quality. “You have to manage the moisture content,” says Malcolm Dodd, founder of Coldcubed, a company specialising in temperature-controlled supply chains. “The bag prevents water from leaving the fruit. In the 1970s, fruit that lost moisture in long-term storage and shipping started to lose quality.” Because the atmosphere has a low relative humidity compared to the fruit, moisture tends to move out of the fruit. Plastic packaging increases the humidity around the fruit, limiting water and mass loss.

Fruits packed in plastic bags also retain optimum maturity for longer, since the bag restricts gas exchange. The atmosphere inside the bag is modified due to release of carbon dioxide and uptake of oxygen by the fruit. This prevents overripening.

“It plays an incredibly important role in the quality of the produce, particularly when you have very long supply chains,” says Dodd. Plastic packaging such as trays also prevent fruit surface damage due to skins rubbing during shipping.

The last factor driving the use of plastic is the market’s high expectations. “The challenge is to try and change the human mind. People always look for the most attractive, shiniest, brightest, neatest thing,” comments Dodd.

This includes foods. Sometimes, he says, packaging of food serves little purpose except satisfying the consumer’s expectations. Plastic keeps the product looking good, and without it, food wastage would increase.

The WONDER OF PLASTIC

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THE WAY FORWARD

So is the answer to go back to paper wrappers? Not necessarily, according to Dodd, who explains that it takes a huge amount of energy to create paper — heating, chemical processes, and cutting down trees. Even though paper comes from renewable sources, it takes many years for a tree to grow, while plastics are mainly by-products of the oil industry.

The solution is for the industry to switch over to recyclable and ‘friendly’ plastics. “We don’t want to completely move away from plastic, because if used correctly, it is very beneficial,” says Henk Griessel, quality assurance manager at Tru-Cape. The focus should be to eliminate plastics that can’t be recycled commercially, such as polystyrene, BDPP — biaxial-oriented polypropylene — and PVC — polyvinyl chloride.

“We as the Packhouse Action Group’s plastic workgroup made the decision to still use plastic, but to focus on specific types. We are trying to replace problematic plastic with materials like LDPE — low-density polyethylene — since South Africa’s LDPE recycling is outstanding.” While some countries are moving towards using biodegradable and compostable plastics as well as synthetic waxes, neither is currently mainstream in South Africa — the first due to recycling issues and the second for economic reasons.

Griessel describes plastic awareness in recent years as a movement. The fruit industry is a significant user of recycled plastic and has an important role to play in working towards local and international targets. “The entire world is very plastic-negative,” he says. Luckily, in the fruit industry, there is optimism rather than despair. “I think there is a positive attitude,” says Dodd. “They are very aware of the need to satisfy the consumer demand.”
The South African fruit industry used the benefits of polyethylene bags from 2008 to 2010. Dawie Moelich, then of Experico, tested various liners in combination with plastic crates and cardboard boxes. Forced-air cooling rates were faster in the plastic crates than in the cardboard boxes. Fruit also cooled four to eight times faster without liners. Faster cooling was beneficial for Bon Chrétien but had no benefit for the other cultivars.

Fruit lost the most moisture in the plastic crates and when packed without liners. The researchers concluded that packaging liners are necessary as moisture barriers in most cases. With Bon Chrétien, 20µm bags resulted in yellower fruit. A significant and sensitive ability seems to be a significant waste of a potential quality maintenance benefit of polyethylene liners, especially for cultivars which are not sensitive to elevated carbon dioxide levels. For cultivars with specific requirements, where it is still potentially possible to read a summary of his presentation from the July 2019 issue of Fresh Quarterly.

Although oxygen and carbon dioxide levels were not specifically studied in this programme, the atmospheric gas levels were occasionally monitored towards the end of the cold storage period. In the 600 x 400 mm pome fruit packaging, the carbon dioxide levels were frequently below 6%. This indicated that the LDPE liners, as tested in MK9 format on the pome fruit, were likely to have minimal impact on maintenance of green skin colour by means of atmosphere modification, even if the moisture barrier properties of the film are beneficial. It was also evident that the carbon dioxide levels in packaging with more free headspace were lower than in the fuller packed formats, indicating that the “folding” of the bags is important, as has been previously reported.

Since the requirement for some form of moisture barrier was clearly evident for most of the fruit populations studied, sacrificing the modified atmosphere ability seems to be a significant waste of a potential quality maintenance benefit of polyethylene liners, especially for cultivars which are not sensitive to elevated carbon dioxide levels. For cultivars with specific requirements, where it is still potentially possible to utilise the modified atmosphere potential of LDPE for quality maintenance, the consistency of quality and dimensions of polyethylene liners and means of application require continual attention.

The rise of edible coatings

The current standard is a plastic liner in each box of fruit. Covering the entire pallet may reduce the total amount of plastic as well as facilitating recycling. Initial trials will be conducted with Royal Gala apples. The packaging trials will also revisit the use of different liners for Forelle pears. Previous research showed that 20µm polyethylene bags have the potential to replace the standard 37µm bags. The new project will focus on FEMA — Forelle early market access — pears. A reduction in liner thickness holds the promise of decreasing total plastic use. Results from the first year of trials will inform the experimental design for the second year of the project.

New projects get under way

Hortgro Science has contracted Experico to conduct a knowledge review of plastic use in the pome and stone fruit industries. The review will include lessons to be learnt from other local industries. It will cover the entire value chain from packhouses to retailers with special consideration of the requirements of our export markets. Close attention will be paid to trends in other exporting countries such as Chile. The knowledge review is a one-year project and is seen as a starting point for further research.

The second project is a collaboration between the Agricultural Research Council and Experico and will involve packaging trials. Researchers will test the efficacy of a plastic cover that encloses an entire pallet. The current standard is a plastic liner in each box of fruit. Covering the entire pallet may reduce the total amount of plastic as well as facilitating recycling. Initial trials will be conducted with Royal Gala apples. The packaging trials will also revisit the use of different liners for Forelle pears. Previous research showed that 20µm polyethylene bags have the potential to replace the standard 37µm bags. The new project will focus on FEMA — Forelle early market access — pears. A reduction in liner thickness holds the promise of decreasing total plastic use. Results from the first year of trials will inform the experimental design for the second year of the project.

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The rise of edible coatings

One way to gain the advantages of plastic without the drawbacks is to coat fruit in waxy materials called edible coatings. The fruit’s natural wax is removed and a synthetic coating applied, limiting moisture loss and protecting the fruit from spoilage organisms. Edible coatings are already common in both Chile and the United States. New Zealand is also increasingly turning to waxes, although they use less plastic than South Africa — New Zealand fruit is exported in bulk and bagged in the country of import.

Hortgro Science has been funding trials of edible coatings on stone fruit. Trials done on plums showed that certain edible coatings could reduce shrivel significantly. Dr Ola Fawole presented the latest on this research at the recent Hortgro Science Symposium. You can click here to read a summary of his presentation from the July 2019 issue of Fresh Quarterly.

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Polyethylene — the main plastic in many fruit bags — is made from the by-products of petroleum manufacture. When crude oil is refined through fractional distillation, gasses such as ethene, propene, butene and hexene are produced. A combination of these gases is used to make different polymers. Morkel says that, as long as people are powering engines with petrol, the ingredients for polyethylene are there.

Plastics such as polyethylene are supplied as pellets to converters who manufacture bags and other packaging products. Converters have a responsibility to work in a sustainable and environmentally friendly manner, says Morkel. Good manufacturing practices are crucial. “No spillage of raw material pellets is allowed. It is immediately swept up. This is done to prevent the possibility of environmental pollution, should any of this material end up in our stormwater systems. We rework all our factory scrap, nothing is discarded.”

Other green manufacturing practices include replacing old machines with more efficient ones to reduce electricity costs and carbon emissions.

Morkel says that it’s important for plastic converters to communicate with their clients to find possible design improvements. Buyers of single-use plastics need to constantly re-evaluate their packaging systems in order to find out the minimum amount of plastic needed to preserve fruit quality. Can they reduce film thickness? Is there a way to limit unnecessary secondary packaging?

FOOD FOR THOUGHT
Packaging for food tends to be more complicated than for other items. According to Morkel, food safety is a critical consideration that limits his company’s ability to use post-consumer recycled plastic in their products. When you eat an apple, you want to know that its packaging is safe. If the origin of the recycled plastic is not known, it can be potentially dangerous to the consumer.

“That is why Patagon Flex currently uses 100% virgin plastic to produce fruit packing bags destined for the export market. Otherwise, we would never be able to issue a food safety declaration for our products,” says Morkel. “At this stage the four main products made out of post-consumer recycled polyethylene are irrigation pipes, refuse bags, plastic carrier bags and plastic furniture.”

Another challenge is printed plastics. As Morkel explains, printed plastic can’t be recycled to make clear or colour-specific products. Recycled printed plastics have black pigment added to standardise the colour and therefore only black products can be made. There are also cost implications. The price difference between virgin and recycled plastic was quite significant a few years ago with clear recycled polyethylene much cheaper than virgin polyethylene. That is no longer true. “If there were a large price difference, there would be a price incentive to add clear recycled material to our product, but then again, food safety would be an issue,” says Morkel.

Morkel states that they do use recycled plastics — up to 75% — for products that are not food-related. He believes that economic factors shouldn’t be the only driving force. “You should produce and use recycled material because it’s the right thing to do. It contributes to creating a cleaner environment by reducing plastic pollution. You should do it because it will reduce the impact that single-use plastic currently has on the environment, including our oceans.”

GOING BEYOND RECYCLING
Alternatives to recycling are becoming more viable. One is oxy-biodegradable plastics, which are meant to lighten the environmental load by self-degrading in the presence of oxygen, heat and sunlight. Unfortunately oxy-biodegradable plastics are not suitable for recycling, as they begin to degrade when heated during the recycling process.

Natural polymers also have drawbacks. Polylactides and corn-starch plastics are both made from natural products and degrade easily, but can cost up to ten times more than a polyethylene alternative. These so-called bioplastics cause problems when misidentified at waste separation facilities. “If not identified correctly at the recyclers, they will contaminate the recycled polyethylene,” cautions Morkel.

An interesting alternative to speed the breakdown of plastics has been developed in joint research between Ben-Gurion University in Israel and counterparts in Canada. The scientists identified microorganisms that can digest plastics from landfill sites and domestic compost heaps. “They then developed a substance that can be added to polyethylene that attracts these microbes,” Morkel says. “But for now the simplest and most effective solution is still recycling. Not only will this clean up the environment, but it will also lead to the creation of many jobs.”

According to Morkel, awareness is crucial to unleash the full potential of recycling. “Advertising and marketing motivate people to buy something. In similar fashion products made from recycled polymers must be marketed as the new trend.”

Morkel is confident that plastics will continue to play a part in our futures. “Plastic is a wonderful thing,” he says. “We just need to use it responsibly and stop wasting it.”
## Plastic Packaging
### in the fruit industry

**Current status and alternatives**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Packaging type</th>
<th>Plastic component</th>
<th>Problems and solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pome and stone fruit</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pallet straps</td>
<td>PP</td>
<td>Polypropylene</td>
<td>Use white rather than blue to increase recyclability.</td>
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<tr>
<td>Pallet corner pieces</td>
<td>PVC</td>
<td>Polystyrene</td>
<td>Problematic in EU and UK. Paper alone is not strong enough but an alternative is required.</td>
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<tr>
<td>Pallet wrap</td>
<td>LDPE</td>
<td>Low-density polyethylene</td>
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<tr>
<td>Slip sheet</td>
<td>HDPE</td>
<td>High-density polyethylene</td>
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</tr>
<tr>
<td>Plastic crates</td>
<td>HDPE</td>
<td>High-density polyethylene</td>
<td></td>
</tr>
<tr>
<td>Liner</td>
<td>LDPE</td>
<td>Low-density polyethylene</td>
<td>Revisit the industry standards. Alternatives are clear and possibly thinner bags. Waxing as a fruit treatment currently in limited use.</td>
</tr>
<tr>
<td>Printed bags</td>
<td>PVC</td>
<td>Polystyrene</td>
<td>PVC is problematic in EU and UK. Replace with LDPE.</td>
</tr>
<tr>
<td>Trays</td>
<td>Expanded polystyrene</td>
<td>Polypropylene</td>
<td>Not permitted in some parts of the EU and UK. Replace with pulp or paper.</td>
</tr>
<tr>
<td>Flow wrap</td>
<td>BOPP laminates</td>
<td>Biaxially-oriented polypropylene</td>
<td></td>
</tr>
<tr>
<td>Bubble wrap</td>
<td>Expanded polystyrene</td>
<td>Polyethylene</td>
<td>Not recycled in South Africa. An alternative is required.</td>
</tr>
<tr>
<td>Punnets</td>
<td>PET thermoform grades</td>
<td>Polyethylene terephthalate</td>
<td></td>
</tr>
<tr>
<td>Fruit PLU label</td>
<td>PP</td>
<td>Polyethylene</td>
<td>Alternatives may be paper labels or laser printing on fruit.</td>
</tr>
<tr>
<td>Bread clips</td>
<td>PP</td>
<td>Polypropylene</td>
<td></td>
</tr>
<tr>
<td><strong>Stone fruit only</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shrivelling sheet</td>
<td>HDPE</td>
<td>High-density polyethylene</td>
<td></td>
</tr>
<tr>
<td>Sponge</td>
<td>PU</td>
<td>Polyurethane</td>
<td></td>
</tr>
<tr>
<td>Cling wrap</td>
<td>PE</td>
<td>Superthene or Pexie</td>
<td>Polyethylene</td>
</tr>
<tr>
<td><strong>Cherries</strong></td>
<td>Life cycle bag</td>
<td>Modified atmosphere packaging Complex of plastic mixtures</td>
<td></td>
</tr>
<tr>
<td>Carton strapping</td>
<td>PP</td>
<td>Polypropylene</td>
<td></td>
</tr>
<tr>
<td>Pallet wrap</td>
<td>PET</td>
<td>Polyethylene terephthalate</td>
<td></td>
</tr>
<tr>
<td>Product outer bags</td>
<td>LDPE</td>
<td>Low-density polyethylene</td>
<td></td>
</tr>
<tr>
<td>Polypropylene glue bags</td>
<td>LDPE</td>
<td>Low-density polyethylene</td>
<td></td>
</tr>
<tr>
<td>Chemical containers</td>
<td>HDPE</td>
<td>High-density polyethylene</td>
<td></td>
</tr>
</tbody>
</table>

**Key to Tesco categories**

- **Exit**
  - Plastics that are poor for recycling and potentially harmful
- **Hold**
  - Replace when infrastructure or technical developments permit
- **Everything else is in the green or preferred category**
  - Easily recycled and can have high recycled content

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Content provided by the Plastics Work Group
Join the Circular Economy

How South African businesses can up their recycling game
By Grethe Bestbier

A circular economy is one where everything is reused and nothing is wasted. Modern economies tend to be linear — we take resources to make things that we use and then discard. This has created problems with resource depletion on the one hand and environmental degradation on the other. A circular economy addresses both these issues by turning refuse into raw materials.

Recycling is key to the circular economy. South Africa is already a world leader in recycling but that’s no reason for local businesses to be complacent. The fruit industry’s Packhouse Action Group has been proactive by establishing a plastics work group to mitigate the risks associated with plastic packaging. They have also been looking at other global initiatives to see how South Africa can take sustainability to the next level.

THE STORY SO FAR
According to Johann Conradie, chair of the South African Plastics Recycling Organisation (SAPRO), South Africa sets a global example when it comes to recycling. “Relative to the size of its economy, no other country recycles as much as South Africa,” says Conradie. Almost half of all post-consumer plastic is recycled annually in South Africa. South Africa is also the foremost recycler of low-density polyethylene.

Although developed countries often appear to be doing well at recycling, their figures include plastic shipped to China. Since China stopped accepting plastic waste in 2018, there has been a backlog at recycling plants in the European Union. South Africa, however, recycles locally. Despite our economic challenges and the lack of government support for recyclers, the sector is thriving.

That’s all good news with respect to our situation internally, but it’s not where the story ends. South African fruit production in 2018 was a staggering 320 million cartons. The deciduous sector — stone and pome fruit — was responsible for a quarter of these. Each and every one of these cartons contained some form of plastic packaging.

What can the South African fruit industry do to stem the tide? Here it can be useful to look at what’s happening elsewhere.
PUTTING A WRAP ON PLASTIC
WRAP — Waste and Resources Action Programme — is a global initiative to promote sustainable waste management. WRAP has been establishing Plastics Pacts worldwide, aimed at promoting sustainable plastic use. In the United Kingdom, WRAP has implemented the UK Plastics Pact with support from the Ellen MacArthur Foundation, a charity that advances the growth of the circular economy.

Although WRAP addresses multiple issues, their UK Plastics Pact has focussed on plastics since its establishment in April 2018. The goal is a system where plastic is valued and doesn’t pollute the environment.

“It’s about fixing the system and making sure plastic is seen as the great material that it can be,” said strategic partnership manager Peter Skelton in a recent presentation to the Plastics Work Group.

To achieve this goal, the UK Plastics Pact has four targets designed around driving circularity of plastics. Members undertake to reach these targets by 2025.

Plastics Pact has focussed on plastics since its establishment in April 2018. The goal is a system where plastic is valued and doesn’t pollute the environment.

“The pact is a sector commitment,” says Skelton. “We are working with the retailers and they are working with the suppliers to try and achieve these targets.” WRAP’s technical specialist Laura Lewis, adds that these targets call for real action, which is monitored and measured. “It’s not a philanthropic kind of sustainability effort,” says Lewis. “It is action and innovation.”

The Packhouse Action Group endorses WRAP implementation as a way of improving sustainability in the fruit industry.

THE SOUTH AFRICAN PLASTICS PACT
Plastics Pacts have also been launched in France and Chile. “Globally we have common challenges. So, let’s share and not reinvent the wheel,” says Skelton. “We don’t need every country to have one, but we need Plastics Pacts that can actually influence the system.”

In South Africa, a Plastics Pact is being implemented by SAPRO and the World Wide Fund for Nature (WWF). Although a global approach with similar targets is beneficial, it’s crucial to adapt the policies to local conditions.

“Every country has its own challenges and circumstances,” says Conradie. South Africa’s recycling industry hasn’t existed for very long, which is one challenge. “Another factor is that our recycling is mainly based on economic viability, while in many other nations, such as the UK, the main incentive for recycling is sustainability – despite the high costs.”

Countries also have different recycling technologies. While the UK uses infrared technology to identify and separate different types of plastics, South Africa relies on manual labour. On the other hand, while most countries don’t recycle polystyrene, South Africa is one of the few that do. All these differences need to be taken into account by specific Plastics Pacts.

The Packhouse Action Group, along with WRAP, encourages South African retailers to sign up to the SA Plastics Pact: Embracing the circular economy is part of future-proofing the deciduous fruit industry — and the wider world in which they operate. FQ

Research Inventory
A list of projects relevant to plastic packaging and funded by Hortgro Pome and Hortgro Stone.

COMPLETED PROJECTS
2003. Moelich D. Post-harvest factors influencing the development of lenticel spot, bitterpit and browning disorder in Braeburn apples.
2010. Viljoen H. Identify a bag liner which enables effective application of SmartFresh on packed apples and simultaneously controls moisture loss.
2010. Moelich D. Determination of effective packaging formats for deciduous and citrus fruit with special reference to uniformity, fruit quality maintenance and strategic global warming requirements.
2012. Moelich D. Evaluation of modified atmosphere packaging (MAP) and other technologies to improve storage quality of Forelle pears and decrease the 12 weeks mandatory storage period.
2013. De Kock A. Determination of the optimum packaging, with the view to reduce moisture loss on Charlisma apricots.
2019. Lötze E. Postharvest moisture loss studies in Japanese plums (Prunus salicina Lind.)
2019. Viljoen H. Identify and test improved packaging as well as humidity control in cold stores to reduce moisture loss and shrivel in nectarines.
2019. Viljoen H. Identify and test improved packaging systems as well as humidity control in cold stores to reduce moisture loss and shrivel in plums.

CURRENT PROJECTS
Fawole O. Application of post-harvest edible coatings to alleviate shrivel in plums and nectarines.
Fawole O. Application of post-harvest bioactive edible coatings and natural antimicrobial peptides as a green solution to alleviate shrivel and extend storage life of plums.
Botes A. Moisture loss studies in pears.
False Codling Moth

What growers need to know about control

By Anna Mouton

False codling moth is — you guessed it — a moth and it belongs to the family Tortricidae. Its relatives include other important agricultural pests such as codling moth, Oriental fruit moth, and pear leafroller. False codling moth is indigenous to South Africa and is considered a phytosanitary pest by most of our major overseas markets.

The phytosanitary status of false codling moth ups the ante for control. Detection of false codling moth damage in fruit destined for export will result in rejection of the entire consignment. Too many interceptions and the importing country may refuse South African fruit altogether — with serious cost implications for our industry.

False codling moth also leads to direct economic losses due to damage. Its larvae feed on a wide variety of crops, including some stone fruit, citrus, pomegranates, cotton, macadamia and pecan nuts, peppers, olives and maize. They have a wide host range and are found on wild hosts such as wild figs, wild olives, yellowwood, kei apple and red milkwood.

False codling moth larvae do not attack apples. Their indiscriminate feeding habits and year-round activity make false codling moths formidable adversaries. But happily for growers, they can be controlled — read on to learn how.

MONITORING

“If you don’t monitor your moth populations, you’re not going to make an impression,” says Matthew Addison, programme manager for crop protection at Hortgro Science. “You’ve got to monitor to apply the correct management.” Monitoring is also compulsory for growers wishing to export to specific markets. Pheromone traps and damage assessments are the two methods for monitoring and growers should use both. “Pheromone-baited traps are fantastic,” affirms Addison, “but they’re indirect. Fruit damage assessments work a dream. It’s accurate and you cover a whole lot of other insects as well — and diseases for that matter.”

The key to successful monitoring is to start when the trees are in blossom and to continue after harvest. Traps should be checked weekly and scouting for damage done every two weeks. A preharvest damage assessment should be performed within ten days prior to harvest.

Larvae of false codling moth may be confused with those of other pests. Growers can make use of the insect identification service offered by Stellenbosch University to obtain an accurate diagnosis. Click here for more about this service.

PESTICIDES

Monitoring will tell you how serious your problem is. What then? Pesticides might seem the obvious choice in this case. But remember, phytosanitary regulations will dictate which pesticides can be used for the specific market you are trying to meet.
solution and there are dozens of products registered for use against false codling moth in stone fruit in South Africa. These represent more than ten active ingredients and several different chemical groups. Most are inexpensive and should decimate false codling moth larvae. Sound too good to be true? It is.

Most chemical pesticides are only effective against the newly hatched larvae. False codling moth females lay their eggs on the surface of fruit and the larvae penetrate the fruit soon after hatching. Once inside they are protected from pesticides. The application window is therefore only a small part of the entire life cycle. There are no chemical pesticides registered for use against eggs or adult moths.

On top of this, there is the ever-present danger of resistance. “We need to promote non-chemical control, because a thing that’s polyphagous, like false codling moth, is many times more likely to develop insecticide resistance than something that only eats one fruit,” Addison says. Polyphagous creatures feed on a range of host plants — Addison calls false coding moth the ultimate polyphage.

Resistance reduces the number of chemical options available to growers. So do increasing demands for residue-free products. Addison explains that markets are changing and requirements are set to become more stringent.

A further problem with pesticide use is that it affects beneficial insects such as pollinators and predators. Growers that make the transition from heavy spraying to a more integrated pest management system find that they have fewer secondary pests. “There are lots of track records that illustrate this,” Addison says. “A whole load of secondary pests like mealy bug and mites go away. Suddenly your fruit quality improves.”

Addison acknowledges that chemical pesticides will continue to be part of programmes for false coding moth control. “It’s getting that first generation. So spray — even if it’s four sprays — early.” He thinks that by implementing more holistic pest control, that could drop to two applications in the second year.

**MATING DISRUPTION**

False codling moth females release substances known as pheromones to attract males. Male moths spend much of their short lives searching for and following pheromone trails. Mating disruption works by dispensing artificial pheromones in the orchard, confusing the males and preventing them from finding females.

Dr Vernon Steyn, researcher with pest management company Insect Science, examined the response of false codling moth to mating disruption as part of his doctoral research. He found that dispensers that release relatively low quantities of pheromones compete with females for the attention of males — so-called competitive mating disruption.

The sterile insect technique involves the release of — you probably guessed this one too — sterile insects. The sterile insects compete with fertile insects for mates. This reduces the overall number of successful matings and therefore the overall number of viable eggs laid by females. Sterile insect technique for false codling moth is available in South Africa through XSIT, an initiative of the citrus industry. [Click here](#) to visit the XSIT website.

Both male and female moths are released under sterile insect technique for false coding moth. The adult moths don’t cause any direct damage to the fruit and it’s therefore not necessary to exclude females. Releases must be done over large areas — all growers in a region have to buy in for the method to be effective.

Steyn believes that sterile insect technique should combine well with mating disruption. “Each one of those sterile females is her own pheromone dispenser. So it’s extra pheromone you’re adding to the system.”

Research has shown that sterile insect technique

“Do your mating disruption properly and the problem goes away”
Orchard sanitation is key to controlling pests like false codling moths and fruit flies. But destroying damaged fruit can mean simultaneously destroying beneficial predators such as parasitic wasps. What to do? One solution that saves the good guys is to use an augmentorium.

An augmentorium is a tent-like structure for covering decaying fruit. The idea is to place damaged and fallen fruit under a mesh that prevents the escape of pests that may have developed in the fruit. At the same time, the mesh allows beneficial predators such as parasitic wasps free access. It has been found to be very effective for fruit flies. Prof. Pia Addison of the Department of Conservation Ecology and Entomology at Stellenbosch University believes it should work equally well for false codling moth.

“The one we have is a tent,” she explains, “but any structure or container covered in a mesh that retains the adult fruit flies and releases the parasitic wasps will work. An added benefit could be the production of compost from the rotting fruit.”

A mesh size of 1.96 mm² will contain adult fruit flies and should work equally well for false codling moth.

The one we have is a tent, she explains, “but any structure or container covered in a mesh that retains the adult fruit flies and releases the parasitic wasps will work. An added benefit could be the production of compost from the rotting fruit.”

Get an augmentorium!

BIological control relies on diseases and predators to exterminate pests. Growers can give nature a leg up by boosting populations of pathogens — organisms that cause disease — and predators through applying a range of commercially available products. These do not harm beneficial insects and have a zero-day withholding period.

Egg parasitoids are wasps that parasitise the eggs of other insects. Trichogrammatidae cryptophlebiae is one such a wasp and can destroy the majority of false coding moth eggs by late summer. Trichogrammatidae is sensitive to pesticides and tends to disappear when orchards are oversprayed. They can be purchased as pupae in sheets of paratreated stone fruit production could be reaping similar rewards.

Biological control is sensitive to ultraviolet radiation and not suitable for certain areas during peak summer months.

Beauvaria bassiana is a fungus that attacks not only false coding moth larvae but also other pests such as red spider mite. It too is available as a spray with similar characteristics to granulovirus sprays.

Steyn’s research uncovered other organisms that hold promise in the fight against false coding moth. He tested pathogenic nematodes against the soil stages and found that some nematodes kill 100% of false coding moth larvae within 48 hours. The nematodes penetrate the larvae and release bacteria that liquify its organs. After consuming the resulting larval smoothie, the initial one or two nematodes will have multiplied to as many as 15,000, which re-enter the soil, ready to find their next victim.

“I found in field trials that the nematodes persist for as long as four weeks after application,” recalls Steyn. Work continues on finding ways to grow the millions of nematodes that would be required for widespread use — growers can expect to see new products in the near future.

Sanitation

“Sanitation makes up a large part of false coding moth control,” says Steyn. “You remove everything that gets out of the fruit into the soil.” Results from citrus have shown that it’s possible to remove as many as three-quarters of the false coding moth larvae from an orchard by practicing good sanitation. Addison stresses that false coding moth larvae will continue to develop in fallen fruit. “The fruit falls off and gets full of fungi and yeasts which convert it into to a really good food supply.” The same is true for fruit flies — the larvae readily mature in decayed fruit and then pupate in the soil.

Orchard sanitation consists of weekly removal of injured and fallen fruit during the season as well as removal of all fruit remaining after harvest. Fruit can be buried 30 centimetres below the surface or deeper, or alternatively it can be finely pulped. Augmentoria are another option for destroying larvae while simultaneously amplifying populations of parasitoids.

“The best strategy is to target every life stage so that you remove some individuals at every step. You want a small population — if you have a huge population, you can throw everything at it, but it’ll be hard to have an impact,” advises Steyn. “But if you went in with sanitation, mating disruption, implemented all of those things systematically, you won’t end up with that big population.”

Addison agrees. “Your best bet is an integrated pest management system that includes mating disruption. There are no silver bullets.”

“Your best bet is an integrated pest management system that includes mating disruption.”

End of article.

Get an augmentorium!

A mesh size of 1.96 mm² will contain adult fruit flies and should work equally well for false codling moth.
If you’re catching moths, something is wrong!

South Africans have heard a lot about criminal families in recent years thanks to revelations of state capture and other nefarious doings. Growers will be familiar with one family whose activities are especially damaging to the fruit industry — the Tortricidae. The Tortricidae are a family of moths whose members include some of the world’s worst agricultural villains including codling moth, false codling moth, pear leaf roller, and Oriental fruit moth. These pests damage fruit and complicate market access for exporters. How can producers fight back and gain the upper hand?

Dr Daleen Stenekamp is a researcher in applied crop protection. She explains that one of the challenges of dealing with closely related moth males is that they are often hard to tell apart. “We worked on stone fruit and the problem is that you get both false codling moth and Oriental fruit moth in stone fruit. The moths look different but the larvae and fruit damage look the same. Oriental fruit moth occurs worldwide so it’s not a quarantine pest like false codling moth.”

Both Oriental fruit moth and false coding moth can be effectively controlled by mating disruption. Growers can hang pheromone dispensers in their orchards early in the season to prevent moths from mating and laying eggs on fruit. But mating disruption can become expensive if you need to use different dispensers for different moths.

“Oriental fruit moth and false coding moth mating disruption use the same pheromones,” Stenekamp says, “but in different ratios. So the question was, can mating disruption for Oriental fruit moth have an effect on false coding moth?”

GOOD NEWS AND BAD NEWS
Stenekamp and her team compared mating disruption for Oriental fruit moth and false coding moth by placing pheromone dispensers in several stone fruit orchards and releasing a large number of sterile false coding moths in these orchards as well as in control orchards with no dispensers. They hung out traps to monitor the effect. The trials were conducted over two seasons.

On the bright side, growers can be assured that mating disruption works wonders on false coding moth. “On one farm where we worked, there was an orchard with terrible damage, to the extent that the farmer lost nearly his entire harvest in that orchard,” Stenekamp recalls. “Then he used mating disruption and he had minimal damage at the end of the first season and none at the end of the second.

“He had another orchard, which was one of our controls, and always suffered severe damage. He decided to use false coding moth mating disruption there as well — which wasn’t so good for our research, but I completely support his decision.”

The bad news is that growers won’t be able to rely on one type of mating disruption to control both moths. “We discovered that the Oriental fruit moth mating disruption did affect the false coding moths, but with zero tolerance to false coding moth it wasn’t sufficient,” Stenekamp states, “whereas the false coding moth mating disruption pretty much shut down the traps so that we caught nothing.”

Stenekamp recommends that growers use pheromone traps and fruit damage assessments to determine which moths are the culprits on their farms. “It’s very important to have larvae in fruit identified and not to assume that it’s false coding moth. There are others it could be.” Correct identification is important when deciding on the best control strategy, especially with methods that target species selectively, like mating disruption.

Monitoring will also show whether control is working. “If you’re using mating disruption you would expect to catch no moths in your traps. If you’re catching moths, something is wrong,” Stenekamp cautions. “You could, for example, have a very long, hot season and your mating disruption starts fading towards the end. You may need to supplement it, especially if you have a late cultivar.”

Stenekamp believes that mating disruption is a crucial weapon in the war on moths. “Mating disruption works. And I think sterile insect technology combined with mating disruption is a very good option if you have problems with false coding moth — rather than relying on chemicals when we are becoming more limited with regards to chemical use.”

Stenekamp’s research was funded by Hortgro Pome and Hortgro Stone as part of a larger project on surveillance and control of false coding moth.
The False Codling Moth Genome Sequence

Paving the way for next-generation pest control

By Anna Mouton

“Here’s been rapid growth in pest control methods that are based on genome information,” says Dr Minette Karsten, postdoctoral researcher with the Applied Physiological Ecology Laboratory within the Department of Conservation Ecology and Entomology at Stellenbosch University. She is part of a team — lead by Prof. John Terblanche — that is sequencing the genome of false codling moth. The project is funded by Hortgro Pome and Hortgro Stone.

“Having a genome sequence facilitates an incredible number of downstream applications that we simply can’t access at present,” Karsten explains. “So our idea is to create a genomic toolkit that we — and others — can bring to bear on questions for which we currently don’t have answers.”

The project kicked off last year. Samples of DNA have already been extracted from false codling moths and are being processed by Macrogen, a biotechnology company that specialises in genome sequencing. Karsten and her colleagues will use the raw data provided by Macrogen to assemble the complete sequence.

A genome sequence is basically a series of characters where each character represents one of the four bases that make up DNA — think of it as an alphabet with only four letters. Genes are strings of bases that spell out instructions for making proteins. Organisms need thousands of different genes to make the thousands of different proteins that are the building blocks of their bodies.

Karsten won’t know how big the false codling moth genome is until she receives the sequencing data, but it’s likely to be similar in size to that of other closely-related moth species. The genome of codling moth was recently sequenced and that ran to about 773 million base pairs. To put this in perspective, if bases were letters of the alphabet, the codling moth genome would be roughly the same length as 120 sets of the entire Harry Potter series.

“A genome sequence facilitates an incredible number of downstream applications”

Go with the gene flow

One of the first uses of the genome will be the development of microsatellite markers to study gene flow in false codling moth. Genomes don’t only consist of instructions for making proteins — they also contain large sections of non-coding DNA. Non-coding DNA is often made up of short sequences that repeat several times. These are called simple sequence repeats or microsatellites. Microsatellites can be used as markers to measure how closely individuals are related. Different species
have different sets of microsatellites throughout their genome. Individuals within a species have the same microsatellites but the number of sequence repeats of a given microsatellite will vary. Patterns of variation allow researchers to determine ancestry and differentiate subpopulations.

“The question is whether there are subpopulations of false codling moth in South Africa,” Karsten says, “and if so, are they geographical? Or do they relate to areas as discrete management units — basically islands — for example when applying sterile insect technique.”

Karsten describes how microsatellite markers will indicate whether gene flow is occurring between different areas and hosts. “If, for the sake of illustration, we find that the Eastern Cape has its own population and now moths arrive from the Western Cape, but Eastern Cape moths don’t go the other way, you can ask how this happens. Are we exporting something to the Eastern Cape?”

The team also hopes to obtain samples of moth-in-fested fruit so that they can use microsatellite markers to examine questions around host preference. “If a false coding moth emerges from say, an orange, will it always return to oranges regardless of what other fruit are available?” Karsten wonders. “There is some evidence for this but not enough — we don’t know the answer.”

Putting false coding moth to flight

Erika Huisamen is the doctoral student working on the gene flow project, for which she has been gathering a wide range of infected fruit and trap catches from different areas. In addition, she is studying the biology of false coding moth. Her laboratory is filled with cages of adult moths drinking sugar water while awaiting their turn to contribute to science.

“I’m doing flight ability experiments in the insectarium. I’m seeing whether the moths have stronger or weaker flight when they’ve had a certain temperature stress,” Huisamen says. She has been exposing fifth-instar larvae to different temperatures and allowing them to pupate. Huisamen then tests the adults for dispersal ability.

Laboratory studies on pesticide exposure at different temperatures are also planned. This will use technology called transcriptomics. Transcriptomics identifies all the messenger RNA in a cell. “DNA is the plan — how things are put together,” Karsten explains. “To get from DNA to proteins — the physical components of biological systems — you need messenger RNA. The messenger RNA carries the message of which proteins need to be made.”

Researchers can tell which genes are being expressed by looking at what messenger RNA has been produced. “So we can change various things and see how that changes gene expression. For example we can see which genes are upregulated in response to sublethal pesticide concentrations,” Karsten says. “One major focus of this project is to identify the genes responsible for pesticide resistance.”

Understanding the genetic basis of pesticide resistance is just one way in which this work could help growers in the future. “There are many next-generation novel control methods that are up-and-coming,” Karsten says. She points toward the example of research to develop mosquitos that spread genes which cause the population to collapse.

“At this point we won’t be developing those sorts of techniques,” Karsten cautions. “But we are sequencing the genome which will enable us to do many other things that we can’t do without it.”
A list of projects relevant to false codling moth and funded by Hortgro Pome and Hortgro Stone.

**COMPLETED PROJECTS**

- 2013. Addison P. False codling moth ecology in fruit orchards.
- 2013. Terblanche J. Biochemical responses of false codling moth to low temperature and modified atmospheres.
- 2016. Johnson S. CATTS as a post-harvest treatment for chill-sensitive plum cultivars and associated phytosanitary insect pests.
- 2016. Terblanche J. High temperature disinfestation of false coding moth larvae.
- 2016. De Villiers M. Phytosanitary status of false coding moth, *Thaumatotibia leucotreta* (Meyrick) (Lepidoptera: Tortricidae) on pears.
- 2018. De Villiers M. Phytosanitary status of false coding moth, *Thaumatotibia leucotreta* (Meyrick) (Lepidoptera: Tortricidae) on plum cultivars.
- 2018. De Villiers M. The susceptibility of fruit to infestation by false coding moth, *Thaumatotibia leucotreta* (Meyrick) (Lepidoptera: Tortricidae), at different stages of development.
- 2018. Johnson S. CATTS and ethyl formate fumigation as post-harvest phytosanitary treatments for stone and pome fruit and associated phytosanitary insect pests.
- 2018. Stenekamp D and Asia T. Control of false codling moth on stone fruit with mating disruption.
- 2018. Ware AB and Du Toit CLN. Comparison of cold disinfestation treatments of *Thaumatotibia leucotreta* (Lepidoptera: Tortricidae) in peaches, plums (*Prunus* spp.) and media.

**CURRENT PROJECTS**

- Terblanche J, Karsten M and Huisamen E. False codling moth population genetics: gene flow in agricultural environments.
- Terblanche J and Karsten M. Sequencing the genome and transcriptome of false codling moth, *Thaumatotibia leucotreta*, for pest management.

**PUBLICATIONS**


You can contribute to doctoral student Erika Huisamen’s research. She is after any fruit — cultivated or wild — with false coding moth damage. Huisamen hopes to recover live larvae to study host preference in false coding moth.

Please contact her on 063 052 6348 or eopperman@sun.ac.za.

She will arrange for collection of the fruit.

Read more about the project on p28.
LOOKING TO THE FUTURE

Developing a South African phenophase-temperature database

A need to better understand seasonal temperatures and bud break in pome and stone fruit has inspired a new project that aims to establish a phenophase-temperature database. The project is jointly led by Dr Esmé Louw from the Department of Horticultural Science at Stellenbosch University and Dr Iwan Labuschagne from specialist evaluation company Provar. The project is funded by Hortgro Pome and Hortgro Stone.
Crop production

Spring flowering is a pivotal event in fruit production. Now is the moment when fruit begin to set — or not. Trees that linger in dormancy and blossom unevenly are troublesome to manage compared to trees that wake up smartly and get on with the job of flowering. Uneven flowering complicates operations such as fruit thinning and result in variable fruit maturity with implications for postharvest management.

Trees — like us — rouse more readily after a good rest. Growers have long known that many deciduous fruit trees need winter chill for dormancy and that a lack of adequate chill is a red flag for protracted flowering. Protracted and uneven flowering leads to large variations in the size of fruitlets. Reduced vegetative bud break results in fewer fruit-bearing positions. Growers are compelled to leave more than one fruit per fruit-bearing position — ending up with smaller and less deeply coloured fruit.

The long-term growth habit of the tree is also affected by bud-break behaviour. Trees develop more basal dominance in areas with warmer winters. Growers struggle to train these more basal-dominant trees to fill their allocated vertical space. This can have a dramatic impact on the long-term yield and profitability of orchards.

WHAT WILL THE NEW PROJECT DO FOR GROWERS?

The researchers will gather data on temperature and the phenology of bud break and flowering in both newly-established and mature apple and plum orchards in three areas. Their phenological data will include total bud break and the dates of onset of growth, first flower, full bloom and end of bloom. This will allow them to calculate parameters such as the duration of the early, late and total bloom periods.

Data will be collected for five years. It will be used to investigate which autumn, winter and spring temperature scenarios are associated with different bud-break and flowering patterns. Growers already recognise that winter chill is not the whole story — this past winter was mild but a warm spring gave trees the push they needed to blossom better than expected. The outcome would have been much less favourable had spring been cold. A large data set will provide more insight into the role of spring and autumn temperatures in bud-break and flowering phenology.

The data set will also allow researchers to assess different chill models and see which works best under local conditions.

The final objective of the project is to apply the chill models to climate data for the main apple and plum production areas in South Africa. This will facilitate predictions about the most likely temperature patterns in different areas — vital information for growers trying to adapt to a warming world.

A better understanding of temperature effects on bud break and flowering can help growers manage dormancy more effectively. Knowing what to expect and the most appropriate treatment to break dormancy will go a long way to ensuring even flowering and fruit set as well as optimal development of fruiting wood and tree architecture.

At present most growers consider only the total amount of winter chill when planning for rest break — an unreliable strategy. Growers need models that are specific to South African conditions and that take the temperature fluctuations outside of winter into account. More accurate models will give growers the tools they need to get trees off to a flying start — the first step toward a great harvest.

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