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**Visual material production:**
Media World

**Additional information sources:**
Citrus Production Guidelines: Volume IV – Harvesting and Packing of Citrus, *Citrus Research International*
Key Industry Statistics (various editions), *Citrus Growers Association*

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Module 1
The South African Citrus Industry

Presenter: Justin Chadwick

References

The information and figures used in this module are derived from the 2008 Key Industry Statistics, published by the Citrus Growers’ Association. Please consult the latest edition of this publication or the members’ section of the CGA website for current information.

Introduction

For more than 100 years, citrus has been exported from South Africa to all over the world. The industry has a long and successful history of growth, innovation and forward thinking.

Since 2006, South Africa has been the second largest exporter of fresh citrus in the world, although we are only the twelfth largest producer. We export oranges, grapefruit, lemons and soft citrus to more than sixty foreign countries.

Of the about 2 million tons of citrus produced in Southern Africa every year, around 69% is exported, 7% is processed, and the remaining 24% is sold on the local market.

There are eighteen citrus growing regions in South Africa, allowing us to produce a wide variety of export citrus for a large portion of the year.

Citrus Sectors

The citrus industry has four sectors, as per the main citrus types, namely:

- Oranges
- Soft citrus
- Grapefruit
- Lemons
Oranges

About two thirds of our citrus is orange production. Of the 60,000 hectares under citrus, around 24,000 ha are under Valencia oranges and about 14,000 ha under Navel oranges.

Most of the Valencias are produced in the Limpopo and Mpumalanga provinces, whereas Navels prefer the colder areas in the Western and Eastern Cape and are also produced in areas around Marble Hall and Groblersdal.

We do process oranges, mostly into oranges juices, about 300,000 tons per annum. We also sell on the local market, about 120,000 tons, with about 750,000 tons exported annually.

In terms of our major export markets, continental Europe takes 42% and the United Kingdom 8%. About 18% of our production goes to the Middle East, Northern America takes about 6% and then the Far East takes 9% of our orange exports. In total, the orange industry earns about 3 billion Rand in foreign exchange annually.
**Soft Citrus**

In total, 5,000ha of soft citrus are grown in South Africa. This is mostly grown in the Western Cape, with 58% coming out of that area. The second biggest area is the Eastern Cape, with 25%, and then there are small pockets of soft citrus up in the Limpopo and Mpumalanga provinces.

In terms of how the soft citrus is utilised, 20,000 tons are processed annually, about 25,000 tons are sold on the local market, and the balance of about 100,000 tons is exported every year.

The United Kingdom is by far our biggest market for soft citrus. They absorb in excess of 50% of soft citrus exported annually and continental Europe takes 20%, and then we just about distribute to most other markets around the world. In terms of gross earnings, soft citrus earns about 500 million Rand per annum.

Soft citrus is the most competitive product in all our citrus ranges in the southern hemisphere, with large quantities also coming out of Peru, Uruguay, Argentina and Chile.

In terms of the global soft citrus markets, Spain is by far the largest soft citrus exporter, with China second, Morocco third and South Africa the fifth largest exporter in the world.

<table>
<thead>
<tr>
<th>Destination</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>42%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>8%</td>
</tr>
<tr>
<td>Middle East</td>
<td>18%</td>
</tr>
<tr>
<td>North America</td>
<td>6%</td>
</tr>
<tr>
<td>Far East</td>
<td>9%</td>
</tr>
<tr>
<td>Other</td>
<td>17%</td>
</tr>
<tr>
<td>Destination</td>
<td>Percentage</td>
</tr>
<tr>
<td>-------------</td>
<td>------------</td>
</tr>
<tr>
<td>Europe</td>
<td>24%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>51%</td>
</tr>
<tr>
<td>Middle East</td>
<td>6%</td>
</tr>
<tr>
<td>North America</td>
<td>12%</td>
</tr>
<tr>
<td>Far East</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>1%</td>
</tr>
</tbody>
</table>

**Grapefruit**

The next sector that we will look at is grapefruit. This is largely grown in the Limpopo province with about 32% to 34% from there. In Mpumalanga have about 30%, and in KwaZulu-Natal about 20%.

In terms of the usage of grapefruit, approximately 175,000 tons are processed annually. There is a very small local market of just over 3,000 tons annually. The bulk of the fruit is exported, about 200,000 tons.

Japan is a very important market for us, absorbing about 40% of our exports every year and the balance goes into Europe, with about 43% going into continental Europe. The United Kingdom takes about 8% and Eastern Europe, which is a growing market for all types of citrus, takes about 6%.

In terms of global exports, South Africa is the second biggest exporter of grapefruit in the world, behind the USA. In total, grapefruit earns about 600 million Rand in foreign exchange every year.
### Lemons

The final sector we look at is lemons, grown on about 4,500 hectares. The majority of lemons are grown in the Eastern Cape, particularly in the Sunday's River area, where about 45% of lemon production is. Then we have in the Western Cape about 21%. Lemons prefer the cooler areas of South Africa.

In terms of usage, about 70,000 tons are processed every year that goes into both lemon juices and lemon oils. About 10,000 tons is marketed on the local market and then the balance of about 110,000 tons is exported every year.

The lemon crop in the Southern Hemisphere is dominated by Argentina, exporting about 360,000 tons and juicing about 1,000,000 tons a year. In terms of the southern hemisphere lemon industry, Argentina dwarfs the South African lemon industry. The other big players are Spain, Mexico and Turkey.

In terms of our lemon exports, 45% goes to the Middle East, about 16% to continental Europe, 12% to the United Kingdom, and about 15% into South-East Asia. In total, the lemon industry earns about 400 million Rand in foreign exchange.
Sector Comparisons

Production by Sector

<table>
<thead>
<tr>
<th>Type</th>
<th>Annual production (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oranges</td>
<td>1,170,000</td>
</tr>
<tr>
<td>Soft citrus</td>
<td>145,000</td>
</tr>
<tr>
<td>Grapefruit</td>
<td>378,000</td>
</tr>
<tr>
<td>Lemons</td>
<td>190,000</td>
</tr>
<tr>
<td>Total</td>
<td>1,883,000</td>
</tr>
</tbody>
</table>

Export by Sector

<table>
<thead>
<tr>
<th>Type</th>
<th>Annual exports (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oranges</td>
<td>750,000</td>
</tr>
<tr>
<td>Soft citrus</td>
<td>100,000</td>
</tr>
<tr>
<td>Grapefruit</td>
<td>200,000</td>
</tr>
<tr>
<td>Lemons</td>
<td>110,000</td>
</tr>
<tr>
<td>Total</td>
<td>1,160,000</td>
</tr>
</tbody>
</table>

Foreign Exchange Earnings by Sector

<table>
<thead>
<tr>
<th>Type</th>
<th>Annual forex earnings (R million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oranges</td>
<td>3,000</td>
</tr>
<tr>
<td>Soft citrus</td>
<td>500</td>
</tr>
<tr>
<td>Grapefruit</td>
<td>600</td>
</tr>
<tr>
<td>Lemons</td>
<td>400</td>
</tr>
<tr>
<td>Total</td>
<td>R4,500</td>
</tr>
</tbody>
</table>
Total Usage

<table>
<thead>
<tr>
<th>Usage</th>
<th>All Varieties (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing</td>
<td>560,000</td>
</tr>
<tr>
<td>Local Market</td>
<td>158,000</td>
</tr>
<tr>
<td>Export</td>
<td>1,160,000</td>
</tr>
<tr>
<td>Total</td>
<td><strong>R4,500</strong></td>
</tr>
</tbody>
</table>

The Citrus Industry

Until 1997, the citrus industry was regulated, in other words everything was done through the Citrus Board. Since deregulation the industry has broken up into a number of different bodies.

The growers formed the Citrus Growers Association in 1998, largely responsible for research in the industry, but also playing a role in transformation, information and market access.

Export agents formed the Fresh Produce Exporters Forum and particular in terms of citrus, the Citrus Exporters Forum. They look at the export side and what is going on in the market.

The Citrus Growers Association also formed the Citrus Academy in 2005, which looks after training and skills development in the citrus sector. Then they also have Citrus Research International, which does research work and looks at the technical side of market access.

Websites of Industry Bodies

<table>
<thead>
<tr>
<th>Citrus Growers’ Association (CGA)</th>
<th><a href="http://www.cga.co.za">www.cga.co.za</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Citrus Research International (CRI)</td>
<td><a href="http://www.cri.co.za">www.cri.co.za</a></td>
</tr>
<tr>
<td>Citrus Academy</td>
<td><a href="http://www.citrusacademy.org.za">www.citrusacademy.org.za</a> / <a href="http://www.sitrusakademie.co.za">www.sitrusakademie.co.za</a></td>
</tr>
<tr>
<td>Fresh Produce Exporters’ Forum</td>
<td><a href="http://www.fpef.co.za">www.fpef.co.za</a></td>
</tr>
</tbody>
</table>
Postharvest Innovation

Over the past couple of years the industry has also looked at more research and more innovation in the packaging and the cold chain arena. The industry has formed the Citrus Cold Chain Forum, with players from all different aspects of the citrus industry, looking at these issues and trying to ensure that South Africa stays ahead in terms of technology and requirements in packaging and in the cold chain.

The Post Harvest Innovation Fund is funded by the Department of Science and Technology and has been put together by the Fresh Produce Exporters Forum. The Post Harvest Innovation Fund funds various projects in the cold chain arena, specifically looking at packaging and cold chain infrastructure.

In terms of the packhouses in the industry, in the past most packhouses were cooperative type packhouses, but since deregulation many farmers have their own packhouses. We now have packhouses packing 50,000 or less cartons right up to huge communal or company owned packhouses that pack up to 5 million cartons.

In terms of packing material, most citrus is exported in cardboard cartons. There hasn't been a lot of development in terms of changing the technology of these cartons over time, but ‘super-vent cartons’ are now being developed, which allow for more cooling.

There is also work being done on containers, in terms of the airflow in containers, so that the air comes into the container and is distributed evenly throughout the container. This is particularly important in our cold sterilisation markets where the fruit has to be at a certain core temperature in order for the pests that are of issue to be destroyed.

In terms of pallets, obviously they are a vital part of the whole transport infrastructure. It is a requirement that all pallets are treated, either hot water treated or chemically treated to ensure that there are no borers in the pallets. It is also important that pallets are constructed correctly and the industry has over the years developed protocols and standards for proper packaging and pallet manufacturing.
Industry Challenges

In terms of challenges and opportunities that face our industry: because most of our fruit goes into continental Europe and the United Kingdom, we have consumers that are very concerned about issues such as food safety, issues around the environment and issues around ethical trading.

In terms of the food safety aspects what they are most concerned about is chemical residues and bacterial contamination. In terms of ethical trading we are engaged with the UK retailers to ensure that our working conditions are acceptable to them. In terms of the environment we got work that is underway in terms of the carbon emissions and carbon calculator, so that growers can actually determine their own carbon footprint.

Transformation of the citrus sector and land reform in general in South Africa is obviously a very important issue. Within the citrus industry we have a number of black growers that are now involved in the industry. The Citrus Growers Association has a mentorship programme which is funded by the Department of Agriculture, where successful commercial farmers are put in touch with these new growers in order to help transfer skills.

We also joined operations with the Department of Agriculture in terms of extension, we have our own extension offices in the north and in the south and we engage with the extension offices of the Department of Agriculture in order to get certain of their personnel to become citrus experts and able to transfer skills and technology to new black growers in the industry.

Extension Officers

Extension officers provide technical advice on farming practices. The Department of Agriculture, Forestry and Fisheries employee extension officers that assist all types of farmers. In some provinces there are government extension officers that specialise in citrus production, while citrus farmers in other provinces receive extension services from generalists.

Citrus Research International (the CRI) also employee extension officers. They focus on technical advice and technology transfer – they make sure that the latest information and findings from the researchers are communicated to growers so that it can be implemented in the industry.
Labour utilisation in the sector, there is roughly 60,000 labourers that are employed in the production part of the industry, and probably another 40,000 employed in packhouses and downstream activities. This labour is employed in some of the poorest rural areas of South Africa, such as the Eastern Cape and the Limpopo regions.

The other challenges obviously revolve around the cost of production with escalating prices of fertiliser and fuel prices. Obviously we are down here in the bottom end of Africa and we have to transport our fruit a long way to the markets. Any increase in oil prices has an adverse effect on transport costs.

**active learning**

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 1.1 – Mind Map**

Do research on the internet about the industry organisations that play a role in the Southern African citrus industry. Hold a group discussion around the history, roles and responsibilities of these bodies. Record the details of your discussions on a mind map in your workbook.

*(Additional resource reference: Citrus Academy learning material – Industry Overview)*

**Activity 1.2 – Research Report**

Consult industry media sources and have a discussion with your supervisor / mentor on the latest developments on the challenges that face the citrus industry. Write a 2-page report based on the information that you gather.

*(Additional resource reference: Weekly CGA newsletters – From the Desk of the CEO; SA Fruit Journal; general media)*
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Module 2
Value Chain

Contributor: Malcolm Dodd

Introduction

Just like every other businessman, a citrus grower runs his business in order to make a profit. How do you make a profit from farming with citrus? With very few exceptions, citrus farming is profitable only when the majority of the fruit produced on the farm is sold on the overseas market, where you can sell citrus for more money than on the local market.

We are lucky in South Africa to have land, water, and the right climate to produce a wide range of citrus fruit for a big part of the year. The fact that we are in the southern hemisphere also means that our citrus is ready for the market at a different time of the year from northern hemisphere countries.

Because of these favourable conditions, we are able to produce good quality citrus fruit and supply it to people living in countries where they either don’t produce citrus – because they don’t have the land, water and right climate – or during a time of year when their fruit is not ready for the market.

Citrus Usage and Income

Of the commercially grown citrus in South Africa, about 61% is exported as fresh fruit. Of the balance, about 30% is sold on the local market and 9% is sent for processing. Yet over 90% of total revenue is generated from exports.
Export Agents

Many growers use an agent to help them with their fruit exports. An export agent’s job is first and foremost to know the market, and to advise the grower on where to send how much of his fruit.

The export agent also plans and manages the shipping and sale of the fruit, and tells the grower and packhouse what the specific market requirements are for the fruit. The export agent then receives the money for the fruit from the buyer, pays costs, fees and levies to service providers, keeps an amount as commission, and pays the rest to the grower.

The Value Chain

When we look at the value chain for South African citrus, we look at the chain of events that must take place to bring our citrus to the market overseas.

We call it a value chain because getting the fruit to the market is not enough – we must make sure that the fruit that arrives in the market is what the consumer wants in terms of how it looks, what it tastes like, and how it was produced. This means we must comply with the quality standards and requirements of the consumer. This is what gives the fruit value, and what makes the consumer willing to pay money for the fruit.

Before we look at the links of the value chain, we need to understand the meaning of the term ‘value’. A useful definition for this term is the ‘benefit that you can expect for something, normally measured in money’. People perceive the value of a thing differently, mostly depending on how much they need the product, how unique the product is, and how much the product meets their own expectations and requirements.

The value of a thing is not set by the cost of producing it – it is set in the mind of the person who holds the money, and if that person does not think it is worth spending money on, the product has very little value.

**Value**

The benefit what you can expect for something, normally measured in money.
The Cold Chain

Another important thing that one must remember when exporting citrus, is that it is also a cold chain.

Citrus is cooled to maintain the quality of the fruit, to slow down the ripening process and respiration, and to stop or slow down the development of postharvest diseases. Once citrus is cooled, whether that is in pre-cooling facilities at the packhouse or when it reaches the harbour, the cold chain must not be broken. Breaking will cold chain is the quickest way of breaking the value chain.

Links in the Value Chain

Please note that in this module, we use a simple example of a value chain to explain to you how it works, and we have included industry averages for the percentage cost that every link in the chain adds to the final cost of export fruit.

Remember that cost structures of different operations and value chains are different, depending on cultivar, production practices, packaging, market and shipment of the fruit.

Your value chain may also include steps that we have not included here, such as fruit being repacked overseas before being sold. But it is important that you understand these principles, that you are able to analyse your own costs, and above all, that you understand how easily the value of your fruit can be lost.

Link 1 - Production

The first step in the value chain is the production of citrus fruit. Production includes every step up to the point where fruit is hanging on the tree, including:

- Choosing the right variety and cultivar
- Planting the orchard
- Taking care of plant nutrition and irrigation
- Pruning the trees when necessary
- Protecting them from pests, diseases and competition from weeds

All of these activities are aimed at producing the best possible quality fruit, and fruit that the consumer wants and will spend money on.
All of these activities also cost money. The grower pays the capital costs of establishing the orchard, including the land and land preparation, the irrigation system, the trees and so on, and he must buy the machinery and equipment that he will need.

After that, he must pay all the input costs for producing good quality fruit, including salaries, water, fertiliser, plant protection products and fuel.

Production is driven by two factors: **quality** and **volume**. The grower must produce fruit in volumes that justify the money he spent on capital and input costs. Volume is normally expressed in tonnage per hectare. The quality of the product is essential in creating value, meaning something that the consumer will pay money for. If the grower fails in either of these two respects, his farm will not be profitable.

If the grower and his workers do all their production tasks well, they will come to the harvesting season with a good volume of superior quality fruit hanging on the tree. We have already said that there has been considerable cost involved in getting the fruit to this point, but let us consider what the value of the fruit is.

It is obvious that it must have some value, and that good quality fruit of a superior cultivar will have more value, but what exactly is the value? In terms of realising the value that we aim for – the money that an overseas consumer pays for the fruit – it is not much at all. In order to realise this value, the fruit has only taken the first step on a long journey. We need to add more value, which means that we have to spend more money. Up to this point, we have only spent about 11.5% of what it will eventually cost us to get the fruit to the consumer.

**Link 2 - Picking**

The next step is to harvest the fruit and send it to the packhouse. This adds more costs, because pickers and supervisors have to be paid for their work, and equipment is required for harvesting. This cost is included in the 11.5% above.
Link 3 – Packing

Once the fruit reaches the packhouse, it is, in some cases de-greened, washed, treated, waxed, sorted, graded, sometimes wrapped and labelled, and then packed into cartons, which are then stacked on pallets and inspected to make sure it is fit for export. In some cases, fruit will be pre-cooled at the packhouse before being transported.

The cost that is added in this process can be quite a lot, and depends on the type of citrus you have and the market for which it is meant. But on average, packing adds another 13% of your total cost.

Link 4 – Transport

The next link in our chain is moving the fruit from the packhouse to the port from where it is shipped to an overseas market.

Pallets can be loaded onto flatbed, tautliner or refrigerated trucks, depending on the cultivar and the market. Refrigerated trucks are used to transport fruit that has been pre-cooled at the packhouse.

The fruit can also be packed into containers at the packhouse, with the packed container then shipped on a truck. Another option that is gaining popularity in South Africa is transporting containers or loose pallets by rail.
The distance that the fruit has to travel to the port depends on where you are in the country and where the port is from where your fruit will be shipped.

The distance and method of transport determines how much it will cost you, but on average, transport makes up about 1.5% of your eventual cost.

<table>
<thead>
<tr>
<th>Link 1&amp;2 – Production and Picking</th>
<th>11.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 – Packing</td>
<td>13%</td>
</tr>
<tr>
<td>4 – Transport</td>
<td>1.5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>26%</strong></td>
</tr>
</tbody>
</table>

**Link 5 – Harbour Handling**

Before the fruit is loaded onto a ship, it may have to be stored at the harbour terminal for a period of time, where it is either cooled in pre-cooled facilities, or kept in holding rooms that maintain the temperature of the fruit if it has already been pre-cooled.

This also costs money, and together with the handling fee that the fruit terminal charges, it adds another 3.5% to your costs.

<table>
<thead>
<tr>
<th>Link 1&amp;2 – Production and Picking</th>
<th>11.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 – Packing</td>
<td>13%</td>
</tr>
<tr>
<td>4 – Transport</td>
<td>1.5%</td>
</tr>
<tr>
<td>5 – Harbour Handling</td>
<td>3.5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29.5%</strong></td>
</tr>
</tbody>
</table>

**Link 6 – Shipping**

The fruit is now loaded onto ships, either in containers, or as loose pallets. On the ship, fruit must be kept at the temperature to which it has been pre-cooled, and is sometimes also exposed to cold a sterilisation treatment, depending on the market it is going to.

Shipping of fruit, including insurance, makes up about 18.5% of your total cost.
<table>
<thead>
<tr>
<th>Link 7 – Receiving and Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>When the fruit arrives in the overseas market, it is again handled in the harbour, sometimes stored, and transported to the point where it is sold to the consumer.</td>
</tr>
<tr>
<td>The grower also carries these logistics costs, which is about 13% of the total cost.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Link 8 – Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>The fruit is now eventually sold to the consumer. The retailer adds on his profit margin, which is normally around 30% of the final costs, and the consumer buys the product.</td>
</tr>
</tbody>
</table>
Other Cost

The last cost item that we must add is the commission of the export agent and the importer, and the various levies and inspection fees that is paid on export fruit.

This adds the final 9% to the cost.

1-2 – Production and Picking 11.5%
3 – Packing 13%
4 – Transport 1.5%
5 – Harbour Handling 3.5%
6 – Shipping 18.5%
7 – Receiving and Transport 13%
8 – Sales 30%
Other Costs 9%
Total 100%

Value and Profit

The big question is now: how much does the consumer pay for the fruit?

If the consumer looks at the product and thinks that it is good value for money, she will pay enough to cover all the costs that we have listed above, and there will be a little left for the grower to make a profit.

The value is therefore more than the costs for producing, packing and shipping the fruit. This is of course mostly the case – there are enough growers in South Africa that is able to make a decent living from producing citrus to prove that it can be a profitable business.

Breaking the Value Chain

But a chain is something that can be broken, and breaking the value chain is to lose all the value of our product.

Let us look at this chain of events again, and consider everything that can go wrong and that can mean that the consumer will not see enough value in the fruit to be willing to pay enough money for it, to cover our costs and put some money in the pocket of the grower.
Link 1 – Production

Let’s say that when the fruit was on the trees, somebody didn’t pay attention to the irrigation of the trees while the fruit was growing, and the fruit turned out to be very small.

If this fruit is even exported – which in many cases it won’t be because it will simply not meet the requirements – the consumer will not be willing to pay good money for the fruit, because it does not meet her expectations. The fruit will have to be discounted, or sold on the local market for a lot less money.

The value chain was weakened, value was lost.

Link 2 – Picking

As a next example, let’s say that while fruit was being picked, a fruit fell on the ground and the worker picked it up and put it with the other export fruit, because he was never told not to do this. Nobody could see that this fruit was infected and it went through the packhouse and was packed with other fruit into a carton.

But when the fruit arrives in the overseas market, the entire carton is infected with sour rot. This fruit cannot be sold to the consumer, and will be destroyed. The grower will still have to pay for all the costs of producing, packing, transporting and shipping the fruit, but he will get no money for it.

The value chain was broken by one picker that wasn’t trained properly, and value was lost.

Link 3 – Packing

Let us now look at the packhouse. Let’s say that the concentration of fungicides in the hot water fungicide bath was not monitored regularly, and the fruit was not treated well enough to kill all the fungal spores that it brought in from the orchard.

Nobody can see that there is a problem at the packhouse, and the fruit is packed and shipped.
It arrives in the market overseas, and some of the fruit is covered in mould. The importer takes the time to sort the fruit again, to find those that can still be sold, adding even more cost for the grower. The grower will now only get some of the money for the shipment, and may or may not be able to cover his costs.

**The value chain was compromised, value was lost.**

Another example from the packhouse is the person stacking the pallets not paying attention, and thinking that it is not really important to use the right stacking pattern – as long as the cartons stands in stacks on the pallets, he cannot see why he should do the extra work to put them in a pattern. This pallet is now loaded on a truck and transported to the harbour.

Because the stacks on the pallet are unstable, the cartons start shifting, and by the time the pallet is picked up to be loaded onto the ship, it is so unstable that the stacks simply topple over.

The fruit and the cartons end up smashed to pieces on the quayside. The harbour is not willing to take responsibility for this, and the packhouse carries the cost for that pallet.

**The value chain was broken by a pallet stacker that didn’t understand the importance of his job, value was lost.**

**Link 5 – Harbour Handling**

We have already said that maintaining the cold chain goes hand in hand with maintaining the value chain. Let us look at an example here.

At the pre-cooling facilities at the harbour, the inspectors are on their way, and the forklift driver takes your fruit out of the cold room and put it outside, ready for inspection. But the inspector is delayed, and arrives three hours late.

By now, your fruit has been standing outside on a sunny winter’s day in Durban for five hours. The fruit has warmed up and started to respire faster.

The inspector eventually arrives, approves the consignment, and the fruit is returned to the cold room. But now, because the cold chain has been broken, the fruit starts to decay very quickly, because that is what
happens when the temperature is not kept stable. By the time the fruit arrives in the market overseas, decay has set in good and proper, and the whole lot has to be destroyed.

**Breaking the cold chain is the surest way to break the value chain.**

**What Link Are You?**

There are a great many examples of how things can go wrong in this chain of events. How many more can you think of?

What can happen in the particular job that you do, that can compromise the fruit and destroy its value? What does it mean for you and your job, if the grower and the packhouse have to carry these losses, which could easily have been prevented?

**Conclusion**

Exporting a fresh product like citrus fruit is not for the faint hearted. It is possible to make good money from this business, but it means that one must be willing to face many risks.

Some risks cannot be controlled by the grower, like the weather, the exchange rate, and production from other countries that compete with our fruit.

But there are also many of these risks that can be controlled, and many things that each person in this chain can do to make sure that the value of the fruit is not placed at risk unnecessarily.

**active learning**

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 2.1 – Flowchart**

Draw a flowchart to explain your understanding of the process that is followed in the fruit industry, from when the fruit is picked to when it is delivered to the consumer.
Activity 2.2 – Group Project

Work as a group to complete the following tasks:

✓ Hold a discussion around the flowcharts that each member of your group developed in activity 2.1. Draw a poster showing the links in the value chain that your group agrees on.
✓ Add to each link in the chain the critical control points that will impact on the quality of the product.
✓ Brainstorm as a group and identify the possible pitfalls for each link and critical control point in the chain. Write your conclusions on post-it notes and add these to your poster.
✓ Summarise your findings by making keynotes in your workbook.

Activity 2.3 – Workplace Research

Conduct workplace research and write a 2-page report on the cost chain of your business. Include the following information:

✓ Details of the citrus type(s) that is handled / produced by your organisation
✓ Details of the markets that are targeted for your fruit
✓ The links in the value chain for the fruit, including detailed information on the actions taken at each link and the persons / service providers responsible for those actions
✓ The percentage cost associated with each link in the value chain
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Draw a flowchart to explain your understanding of the process that is followed in the fruit industry, from when the fruit is picked to when it is delivered to the consumer.
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✓ The percentage cost associated with each link in the value chain
Module 3
Citrus Varieties

Presenter: Andy Lee

Introduction

Citrus fruit comes in a wide variety of shapes and sizes. For marketing and production in South Africa, citrus is separated into four main groups, being oranges, grapefruit, lemons and soft citrus. In each of these groups are a number of varieties and cultivars.

Information

Cultivar versus Variety – Terminology in the Citrus Industry
(Adapted from publication of Dr. Graham Barry – SA Fruit Journal, April/May 2006)

A misunderstanding and lack of consistency often occurs when naming the different types of citrus fruit. Resolving this problem can be a complex issue and the terminology used by technical and marketing personnel often differs.

Therefore, the following guideline is proposed to reduce, and ultimately avoid, confusion pertaining to the naming of citrus fruit types in a) the production and b) the marketing of citrus fruit.

The commercially important types of citrus are divided into six groups: sweet oranges, mandarins, grapefruit, shaddocks (pummelos), lemons, and limes. These groups are easily identifiable in the marketplace. However, within each of these six types of citrus are numerous cultivated varieties, sometimes referred to as cultivars and other times as varieties.

Hopefully this simple guideline will help to avoid unnecessary confusion in the naming of citrus fruit types in both the orchards and in the trade.

Production-Related Terminology

- A cultivar is a group of cultivated plants with distinct characteristics. The word ‘cultivar’ is a contraction of the phrase ‘cultivated variety’.
- For example, Bahianinha Navel orange has a better fruit set ability than Palmer Navel orange.
- Strangely enough, the correct term in Afrikaans is ‘cultivar’, although ‘kultivar’ is often used and seems to be gaining recognition.

Market-Related Terminology

- Variety is used as a trade designation for fruit with similar characteristics, and is often made up of more than one cultivar.
For example, Navels are considered to be excellent eating oranges, whereas Valencias are considered to be dual-purpose oranges, consumed both as fresh fruit or used for juicing.

In Afrikaans the term is ‘variëteit’.

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**Example of Use of Cultivar and Variety Terminology**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Navels</th>
<th>Valencias</th>
<th>Satsumas</th>
<th>Clementines</th>
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<tbody>
<tr>
<td>Cultivar</td>
<td>Palmer</td>
<td>Olinda</td>
<td>MihoWase</td>
<td>Nules</td>
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<td>Navelina</td>
<td>DuRoi</td>
<td>Kuno</td>
<td>Oroval</td>
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<tr>
<td>Bahianinha</td>
<td>Midknight</td>
<td>Owari</td>
<td>Marisol</td>
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</tbody>
</table>

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**Citrus Types**

There are many types of citrus cultivars of which the most important commercially are:

- Navels
- Valencias
- Grapefruit
- Mandarins and mandarin hybrids
- Lemons and limes

**Limes**

The small green fruit are limes that are seedless. These are known as Tahiti or Persian limes and production in South Africa is not high. Limes are produced more in really hot and humid tropical areas of the world, such as the Caribbean Islands and similar climates.

**Lemons**

The larger fruit, the lemons, the yellow fruit are produced in South Africa on a very large scale and are sought after in our markets because of the high juice percentage that we attain with the selections we use.
Mandarins

The dark orange red fruit are Mandarin hybrids and it is very well sought after in the Middle and Far Eastern markets. Its colour also makes it popular in the European Union. It is seedless and is an excellent quality fruit to eat.

Grapefruit

Then we have white or Marsh grapefruit and Star Ruby or red pigmented Grapefruit. Grapefruit is popular still in the European Union and we also do have markets in other parts of the world such as Japan.

Oranges

We then have a valencia. They are a little bit pale at the moment because it is a later maturing fruit. Then we have Navel selections, in the front there are two selections: a Palmer navel which is the pale colour and a Cara-Cara navel which is the red pigmented navel.

Cultivar Selection

In each cultivar category there are numerous selections which are similar in many ways yet differ in important aspects such as time of maturity, fruit size, fruit shape, internal quality and flavour, tree vigour and internal and external fruit colour.

These selections have made it possible for growers to produce a flow of superior quality fruit throughout the season, which now extends from mid-March to mid-October in Southern Africa.

These maturity charts depict the times of maturity of the different selections per cultivar category throughout the season and in the different production areas.
## Maturity Charts

### Mandarin & Mandarin Hybrid Maturity Periods in Cold Regions - 2008 Season

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**Note:** Maturity per selection was based on a 3 week period peaking at a ratio of 11:1

### Navel Maturity Periods in Cape Regions – 2008 Season

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**Note:** Maturity was based on a 3 week period peaking at a ratio of 10:1
Valencia Maturity Periods in Northern Regions – 2008 Season

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Note: Maturity was based on a 3 week period peaking at a ratio of 10:1

Grapefruit Maturity Periods in Northern Regions – 2008 Season

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Note: Maturity was based on the minimum export ratio

Lemon Maturity Periods in Cape Regions – Past 3 Seasons

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<td>Lisbon</td>
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<td>Limoneira</td>
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<td>Verna</td>
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</tbody>
</table>
Conclusion

There are specific export requirements for each type of citrus. Each type also has characteristics that determine how it should be handled in the packhouse to best preserve its quality.

It is therefore very important to know the different varieties and cultivars that are packed in your packhouse, and to know how the fruit should best be handled and what is required of that fruit in the export market.

<table>
<thead>
<tr>
<th>Citrus Cultivar Characteristics</th>
<th>Cultivar</th>
<th>Description</th>
<th>Origins</th>
<th>Harvest Period</th>
<th>Marketing (Week No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Navels</strong></td>
<td></td>
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<tr>
<td><strong>Production Areas</strong></td>
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<tr>
<td><strong>Oranges</strong></td>
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<tr>
<td><strong>Valencias</strong></td>
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<tr>
<td><strong>Midseasons</strong></td>
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<tr>
<td><strong>Late Navels</strong></td>
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</tr>
<tr>
<td><strong>Tomango</strong></td>
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</tbody>
</table>

**Navels**
- Medium to large seedless fruit with small embedded navel at the stylar end of the fruit. Easily peeled with soft fibred segments. The world’s premier dessert fruit.
- Originally from China. The Washington navel was the first commercially recognised navel. Many selections now exist.
- March to June
- 15-30

**Late Navels**
- Late ripening selections of navels.
- Selections derived from the Navel
- End May to end July
- 22-35

**Tomango**
- Small but good quality fruit. Largely seedless with tender juicy flesh.
- Unknown
- May and June
- 22-32
<table>
<thead>
<tr>
<th>Variety</th>
<th>Characteristics</th>
<th>Origin</th>
<th>Fruiting Period</th>
<th>Size Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shamouti</td>
<td>Medium to large size. Oval in shape. Distinctive fragrance and flavour.</td>
<td>Israel</td>
<td>June and July</td>
<td>25-35</td>
</tr>
<tr>
<td>Midknight</td>
<td>Large fruit and virtually seedless. Good internal quality. Bears more fruit inside the tree canopy.</td>
<td>Sundays River Valley in the Eastern Cape, South Africa</td>
<td>Mid July to mid August in hot areas, and from August to mid September in colder areas</td>
<td>33-43</td>
</tr>
<tr>
<td>Delta Seedless</td>
<td>Medium-sized, seedless fruit of good quality with a smooth rind.</td>
<td>South Africa</td>
<td>Mid July to end August in hot areas and end July to early September in colder areas</td>
<td>30-42</td>
</tr>
<tr>
<td>Valencia</td>
<td>Medium to large fruit, roundish in shape with a well-coloured, moderately thin rind of smooth, sometimes finely pebbled texture. The relatively high acid content and high sugar content to produce a delicious taste. This variety is ideal for juicing.</td>
<td>Portuguese Azores</td>
<td>July to end September in hot areas and mid July to mid October in colder areas</td>
<td>30-49</td>
</tr>
</tbody>
</table>

### Soft Citrus (Mandarins)

<table>
<thead>
<tr>
<th>Production Areas</th>
<th>Eastern Cape: 43%</th>
<th>Western Cape: 50%</th>
<th>Other: 7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satsumas</td>
<td>Earliest ripening of all soft citrus varieties. They are seedless and very easily peeled. Flavour can only be described as average to poor.</td>
<td>Japan</td>
<td>March to end April</td>
</tr>
<tr>
<td>Novas</td>
<td>Medium to large fruit, with a rind that does not peel easily and has a distinctive aroma. The flesh is deep orange. The segments are juicy, tender and sweet.</td>
<td>Florida</td>
<td>April to mid May in hot areas and May to Mid June in colder areas</td>
</tr>
<tr>
<td>Citrus Variety</td>
<td>Description</td>
<td>Origin</td>
<td>Harvest Period</td>
</tr>
<tr>
<td>----------------</td>
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<td>--------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>Clementine</strong></td>
<td>The world’s premier mandarin. They are easy to peel and, if grown in single blocks away from other cross-pollinating varieties, the fruit are seedless. When mature, the peel turns bright orange. The fruit has a distinctive sweet taste and flavour.</td>
<td>Thought to be China. Numerous selections have been discovered or developed in Spain, Corsica, Italy and Morocco.</td>
<td>Mid April to end June</td>
</tr>
<tr>
<td><strong>Minneola</strong></td>
<td>A hybrid of grapefruit and tangerine, they tend to have big fruit with a distinctive nipple at the stem end of the fruit. The mature fruit turns a deep orange colour. It is juicy, aromatic and has a good tangy flavour.</td>
<td>Florida</td>
<td>Mid May to end June in hot areas Mid June to end July in colder areas</td>
</tr>
<tr>
<td><strong>Tambor</strong></td>
<td>Generally difficult to peel, the pulp is tender and extremely juicy. The fruit is of medium size and slightly flattened at the stylar-end, where a small navel often forms.</td>
<td>Jamaica</td>
<td>End June to early August</td>
</tr>
<tr>
<td><strong>Nadorcott</strong></td>
<td>Easily peeled, the rind turns deep orange at maturity. Seedless when grown in separate blocks away from other cross-pollinating varieties. Late maturing. Internal quality is excellent with high sugar levels.</td>
<td>Morocco</td>
<td>June-August</td>
</tr>
</tbody>
</table>

**Grapefruit**

**Production Areas**
- Eastern Cape: 3%
- KwaZulu-Natal: 12%
- Limpopo Province: 15%
- Mpumalanga: 35%
- Swaziland: 35%

**Marsh**
The fruit is large, white and virtually seedless. Marsh is suitable for fresh consumption in segments and for juicing. | Lakeland, Florida | End March to mid June | 17-35 |
**Rosé**
This fruit has a pale-pink flesh, and the skin is yellow with a red blush.
- Texas
- Mid April to end June
- 19-35

**Star Ruby**
Rind is this and a deep golden yellow to red. The flesh is deep red and the fruit rarely has more than one or two seeds. Very high juice content and sweet flavour. Well suited to those who find other grapefruit too sharp in taste.
- Weslaco, Texas
- Mid April to end June in hot areas
- 19-35

**Lemons**

**Production Areas**
- Eastern Cape: 35%
- Western Cape: 15%
- KwaZulu-Natal: 3%
- Limpopo Province: 15%
- Mpumalanga: 30%
- Swaziland: 2%

**Eureka**
The rind is smooth and has a thin to medium thickness. This lemon has a high acid level and high juice content. It rarely has more than 5 seeds per fruit and is often seedless.
- California in 1858
- Mid February to mid July in hot areas and mid March to mid August in colder areas
- 12-44

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**active learning**

*Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignment below.*

**Activity 3.1 – Flowchart**

Draw a flowchart, linked to a year calendar, showing the growth cycle and harvesting of citrus fruit.

*(Additional resource reference: Citrus Academy learning material: Introduction to Citrus Production)*
### Activity 3.2 – Research Worksheet

Fill in the blanks in the table:

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Description</th>
<th>Origins</th>
<th>Harvest Period</th>
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</thead>
<tbody>
<tr>
<td><strong>Production Areas</strong></td>
<td>Which province produces the highest percentage navels?</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Which province produces the highest percentage Valencias?</td>
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</tr>
<tr>
<td></td>
<td>Which province produces the highest percentage Midseasons?</td>
<td></td>
<td></td>
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</tr>
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<td><strong>Navels</strong></td>
<td>Medium to large seedless fruit with small embedded navel at the stylar end of the fruit. Easily peeled with soft fibred segments. The worlds’ premier dessert fruit.</td>
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<td></td>
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</tr>
<tr>
<td><strong>Late Navels</strong></td>
<td>Late ripening selections of navels.</td>
<td>Selections derived from the Navel</td>
<td>End May to end July</td>
<td></td>
</tr>
<tr>
<td><strong>Tomango</strong></td>
<td>Unknown</td>
<td>May and June</td>
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<td>Medium to large size. Oval in shape. Distinctive fragrance and flavour.</td>
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</tbody>
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Activity 3.1 – Flowchart

Draw a flowchart, linked to a year calendar, showing the growth cycle and harvesting of citrus fruit.

(Additional resource reference: Citrus Academy learning material: Introduction to Citrus Production)
## Activity 3.2 – Research Worksheet

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<td>Late Navels</td>
<td>Which province produces the highest percentage Midseasons?</td>
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<td>Tomango</td>
<td>Medium to large seedless fruit with small embedded navel at the stylar end of the fruit. Easily peeled with soft fibred segments. The world’s premier dessert fruit.</td>
<td>Selections derived from the Navel</td>
<td>End May to end July</td>
<td></td>
</tr>
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<td>Shamouti</td>
<td>Navels</td>
<td></td>
<td></td>
<td></td>
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<tr>
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<tr>
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<td>Tomango</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valencia</td>
<td>Tomango</td>
<td></td>
<td></td>
<td></td>
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- **Navels**: Medium to large seedless fruit with small embedded navel at the stylar end of the fruit. Easily peeled with soft fibred segments. The world’s premier dessert fruit.
- **Late Navels**: Late ripening selections of navels.
- **Tomango**: Unknown
- **Shamouti**: Medium to large size. Oval in shape. Distinctive fragrance and flavour.
- **Midknight**: Sundays River Valley in the Eastern Cape, South Africa
- **Delta Seedless**: Medium-sized, seedless fruit of good quality with a smooth rind.
- **Valencia**: Medium to large fruit, roundish in shape with a well-coloured, moderately thin rind of smooth, sometimes finely pebbled texture. The relatively high acid content and high sugar content to produce a delicious taste. This variety is ideal for juicing.
Module 4
Citrus Markets

Presenter: Paul Hardman

Introduction

South African citrus is exported to more than sixty countries across the world. Even though only 67% of the total citrus we produce is exported every year, exports generate more than 90% of the income generated by the industry.

It is therefore extremely important for us to understand where the different citrus types are exported to, and what volumes each export market absorbs. We also need to understand that there are standards set by these markets, which all growers and packhouses must comply with.

Citrus Usage

Firstly we will look at the overall splits in terms of how the 2 million odd tons of citrus that is produced in South Africa annually is divided between export, processed and local consumption.

On average 67% of citrus is exported, 25% is processed into fruit juices and citrus oils and 8% is consumed on the local market.

If you look at the different varieties there is a big difference between what the breakdown is between those different of markets. For example, 73% of oranges are exported whereas only about 10% is sent to the local market and the balance of 17% is processed.

Grapefruit on the other hand is mostly exported, just under 60% the remaining 40% is processed with very few sales on the local market, less than 1%.
Citrus Markets

Valencia Markets

Of the valencia crop, which is by far the biggest citrus type in terms of production, approximately 42 million 15kg equivalent cartons are exported a year.

Most of that fruit lands up in Northern Europe, about 35%, followed by Southern Europe, with about 16%. Another key market for the valencia growers is the Middle East. Russia has grown as an important market over the last couple of years and takes about 10% of valencias now.

Grapefruit Markets

On average, about 12 to 15 million 15kg carton equivalents of grapefruit are exported each year. The pattern that we see of where that fruit goes to is quite different from the other fruit kinds.

Japan remains a key market for grapefruit growers. It is reported under the Far East figure, which receives 34% of grapefruit.

Soft Citrus Markets

In 2008 we exported about 7.3 million 15kg equivalent cartons of soft citrus.

Soft citrus has historically depended quite heavily on the UK market, particularly for the Satsuma varieties, and that remains a key market, taking a full 44% of the crop in 2008.

Market Information

More information on key industry statistics can be obtained in the members’ section on the website of the Citrus Grower Association (www.cga.co.za).
Market Requirements

Due to the requirements that are now placed on growers in terms of both food safety and phytosanitary factors, it is necessary to know very early in the production cycle where you are going to be sending your fruit to.

DAFF publishes minimum quality standards, which include food safety, and all growers need to recognise these and apply them on their own farms.

There are general aspects looking at quality and safety of the product, also ensuring that there is no biological, physical or chemical contamination in the citrus that is exported.

They also specify minimum standards for packing, and how the product needs to be displayed for inspection. There is a traceability requirement – each and every carton of citrus exported from South Africa needs to be traceable.

In addition to that there are specific marking requirements that need to be applied to the cartons, on one hand to facilitate traceability, but also to facilitate inspection.

Phytosanitary

The term phytosanitary literally means ‘plant hygienic’ (phyto=plant, sanitary=hygienic) or ‘hygienic plant’, and is used to refer to plant health. Commonly, phytosanitary requirements concern the presence of pests and diseases and the chemicals that can be used for pre-harvest pest control.
Market Requirements

Information on market requirements can be obtained from the website of the Department of Agriculture, Forestry and Fisheries, at www.daff.gov.za.

Maximum Residue Levels

One of the key food safety requirements is to comply with the maximum residue levels of the importing country.

The CGA and CRI, Citrus Research International, publish a document that specifies the MRLs (Maximum Residue Levels), and in addition also indicate what the usage would be for plant protection products in order to achieve those MRLs.

Growers are advised and strongly encouraged to use this document as it gives them the assurance that when their product arrives in the overseas market it will be legally compliant with the residue requirements in that market. There are also specific phytosanitary requirements for each market.

Accreditation Schemes

In addition to the official requirements, growers are again encouraged to consider what the buyers are looking for in terms of additional certification and special private accreditation schemes that may be over and above the minimum standards.

This is an aspect that is commercially driven. Examples might be a GLOBALGAP audit or GLOBALGAP or BRC certification.

GLOBALGAP

GLOBALGAP is a private sector body that sets voluntary standards for the certification of agricultural products around the globe.

BRC Global Standard

The BRC Global Standard was developed by the British Retail Consortium (BRC), and is a benchmark for packing quality and safety.
Accreditation Schemes

More information on accreditation schemes such as GLOBALGAP and BRC can be found in module 49 – Commercial Accreditation Schemes.

Market Information

The Citrus Growers’ Association makes available market information throughout the citrus season to all citrus growers in South Africa.

In addition, a statistics booklet is produced every year with all the information of citrus produced and exported during the previous season. To find out more about these publications, please visit the website of the Citrus Growers Association at www.cga.co.za.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignment(s) below.

Activity 4.1 – Presentation

As a group, draw a pie chart for each of the citrus types to show what percentage goes to which market segment. Present your graphs to the rest of the class, explaining each segment of the graph in more detail.

Activity 4.2 – Media Research

Get hold of the Key Industry Statistics booklet (for any year), published by the CGA and look up the following information:

✓ In the table in your workbook, list the five major export markets for Valencias, grapefruit and soft citrus in order of export volume.
✓ In the second table in your workbook, indicate which countries are the largest producers and exporters of the different citrus types.
Activity 4.1 – Presentation

As a group, draw a pie chart for each of the citrus types to show what percentage goes to which market segment. Present your graphs to the rest of the class, explaining each segment of the graph in more detail.
Activity 4.2 – Media Research

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✔ In the first table below, list the five major export markets for Valencias, grapefruit and soft citrus in order of export volume.

✔ In the second table below, indicate which countries are the largest producers and exporters of the different citrus types.

<table>
<thead>
<tr>
<th>Valencias</th>
<th>Grapefruit</th>
<th>Soft citrus</th>
</tr>
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<tbody>
<tr>
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</table>

<table>
<thead>
<tr>
<th>Citrus Type</th>
<th>Largest Producer</th>
<th>Largest Exporter</th>
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<tbody>
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</tbody>
</table>
Module 5
Citrus Export Standards

Presenter: Paul Hardman

Introduction

In 1963, the World Health Organisation and the Food and Agriculture Organisation established the Codex Alimentarius Commission. **Codex Alimentarius** is a Latin term, meaning Food Code, and the commission is often simply referred to simply as ‘Codex’.

Codex is an inter-governmental body with 171 members, as of March 2005. The mandate of Codex is to establish international food standards to ensure food safety and fair practices in the market place. Member countries use these standards to develop their own food safety regulations and legislation.

In South Africa the Department of Agriculture, Forestry and Fisheries is mainly responsible for developing food safety and quality standards, which they base on the Codex standards.

The Codex standards are only a guideline, and there may be small differences in the legislation and regulations used by its member countries. As citrus exporters, we need to be aware of the South African standards and requirements, and those of the countries we export to.

The CGA often gets calls and requests from growers about what information and what requirements there are for exporting citrus, and what they basically need to comply with.

In this module we are going to look at just some of those aspects of information they need to be aware about and basically what they need to be putting into practice on farms in order to prepare export citrus.
The Department of Agriculture, Forestry and Fisheries

The main source of information is the Department of Agriculture, Forestry and Fisheries website (www.daff.gov.za), where they publish the minimum standards for exports. In order to export any agricultural product one needs to comply with the Agricultural Product Standards Act, 119 of 1990. That is the overarching Act that creates the framework for exporting agricultural products.

Within the Act you then get specific standards and requirements and those relate to specific products. We are dealing with citrus, the citrus standards and requirements, and we are going to even drill down a bit further and look at the soft citrus as just one example of those standards and requirements.

FBO Code

One of the first things that a grower will need before he exports any agricultural product is a food business operator (FBO) code. The Department of Agriculture, DAFF, allocates these codes. To apply for one, you can go to the DAFF website and follow the links to where they allocate codes. But essentially any carton of fruit exported from South Africa needs to have that code on it, without it you cannot export.

Phytosanitary Requirements

In terms of the phytosanitary requirements that growers will need to adhere to when exporting: to find these requirements, follow the IPPC link on the website and there you will see exactly what the requirements are for each market.

Market Requirements – Soft Citrus

Looking at what a soft citrus grower might need to comply with when he looks at the quality standards and the food safety requirements for exporting citrus, essentially there are two parts under the standards and requirements that he needs to be aware of.
The first part relates to general requirements, and these in fact will apply to all citrus fruits. Within those standards they also then start referring to internal and external quality standards. These are then set out in part 2.

It is important that growers understand and apply these requirements because this is what will be used by the Perishable Products Export Control Board (PPECB) inspectors when they come onto the farm and into the packhouse to do inspections. They will follow these requirements very closely and, where you don’t comply, that fruit will be rejected.

**Food Safety**

We will now just briefly look at the food safety aspects that fall into the standards and requirements. When using plant protection products, growers need to adhere to Act 36 regulations, meaning using products that are registered for use within South Africa. Secondly they need to make sure that the usage is in compliance with that Act in order to achieve residue level that comply too the South African maximum residue level legislation.

There is a third aspect that growers need to be aware of if they’re exporting citrus. You need to comply too the importing countries maximum residue level legislation as well. In that sense one needs to know how to change your practices on the farm to adhere to or reach those international targets.

For this purpose the CGA and CRI put together a Recommended Usage Restrictions document, which basically informs how the products needs to be used in order to reach the international requirements.

**Example of Market Requirements**

Just as a last example of the type of requirements that growers need to be aware of in terms of the phytosanitary aspects: each pallet used to palletise cartons needs to have an official stamp on it that clearly indicates that it has been treated under ISPM15 rules.

That is an indication that the pallet is suitable for export. On the DAFF website you can find out what those rules are including what stamp to look for on the pallet.
Export Market Requirements

Overseas buyers have their own specifications concerning the fruit that they want. These specifications are mostly in line with the minimum standards and requirements issued by DAFF, but there might be small differences, such as different internal quality parameters or blemish standards.

The client normally passes his specifications on to the export agent and the export agent in his turn passes it to the packhouse.

Packhouse managers and growers must always be aware of these instructions and specifications in order to ensure that their product is packed and handled correctly. Specific requirements for export countries are also available from the DAFF website.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignment(s) below.

Activity 5.1 – Research

Explain in your own words what the functions of the Perishable Products Export Control Board (PPECB) are. Find at least three examples of things that (PPECB) inspectors might look for or at during an inspection at the packhouse. Now record the examples in your workbook, and explain why you think these inspection points exist.

(Additional resource reference: Module 33 – PPECB Inspections; www.ppecb.com)

Activity 5.2 – Worksheet

Answer the questions below:

✓ Explain in your own words what you understand by maximum residue levels.
✓ Why are MRLs important?
✓ Where can growers and packhouses find more information about MRLs?
✓ What can a grower do to ensure that MRLs comply with prescribed levels?

Activity 5.3 – Research Project

Locate the export market requirement documents for lemons and navels. In a table, make a summary comparing the internal quality standards for the two citrus types.
Activity 5.1 – Research

Explain in your own words what the functions of the Perishable Products Export Control Board (PPECB) are. Find at least three examples of things that (PPECB) inspectors might look for or at during an inspection at the packhouse. Now record the examples in your workbook, and explain why you think these inspection points exist.

(Additional resource reference: Module 33 – PPECB Inspections; www.ppecb.com)
## Activity 5.2 – Worksheet

**Answer the questions below:**

- ✓ Explain in your own words what you understand by maximum residue levels.

  

- ✓ Why are MRLs important?

  

- ✓ Where can growers and packhouses find more information about MRLs?

  

- ✓ What can a grower do to ensure that MRLs comply with prescribed levels?

  

---
Activity 5.3 – Research Project

Locate the export market requirement documents for lemons and navels. In a table, make a summary comparing the internal quality standards for the two citrus types.

<table>
<thead>
<tr>
<th>Internal factor</th>
<th>Lemons</th>
<th>Navels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>
Module 6
Yield and Fruit Size

Presenter: Stephan Verreynne

**Yield**

Yield refers to the amount of fruit produced, and can be expressed in terms of:

<table>
<thead>
<tr>
<th>Type</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree yield</td>
<td>kg per tree kg/tree</td>
</tr>
<tr>
<td>Orchard yield</td>
<td>tons per hectare t/ha</td>
</tr>
<tr>
<td>Export yield</td>
<td>15kg carton equivalents per hectare cartons/ha</td>
</tr>
<tr>
<td></td>
<td>(10kg carton equivalents for soft citrus)</td>
</tr>
</tbody>
</table>

**Introduction**

The success of a citrus grower depends on the quality, size and volume of fruit that he can produce for the market. All three of these factors can be manipulated through production practices, but before he can decide which practices to employ, the grower needs to know what the current situation is.

As we approach harvest time, the grower also needs to be able to estimate how much fruit is hanging on his trees, and what the size range of the fruit is. This information is used in his harvesting planning, and is sent through to the packhouse so that they can do their planning.

**Citrus Fruit Development**

Citrus fruit growth follows a sigmoidal curve, with three phases. Phase 1 is mainly cell division, phase 2 is mainly cell enlargement, and phase 3 is when ripening takes place and the fruit colour changes from green to orange, and sugars increase and acids decrease. There is little fruit growth during phase 3.

Climatic conditions during phases 1 and 2 of fruit growth are very important. A single factor, or a combination of controllable and uncontrollable factors, can have an impact on fruit growth and fruit size.
**Sigmoidal Curve**

The term sigmoidal is used to describe an S-shaped object. In this case, it describes the growth curve of citrus, meaning that, in terms of fruit size, growth is slow in the beginning, speeds up in the middle and slows down again at the end.

**Uncontrollable Growth Factors**

Uncontrollable factors include climate, and mainly temperature. Fruit growth takes place mostly between 20°C and 28°C. Seasonal differences also affect fruit growth and size. Rainfall and humidity also play an important role.

**Controllable Growth Factors**

The controllable factors that impact on fruit growth and size, that are selected before harvesting, are the soil type (depth and structure), and the cultivar and rootstock that we select.

Vigorous rootstocks produce larger fruit. Tree age also plays a role. Older trees produce more but smaller fruit, while younger trees bear fewer fruit but they are larger.

**summary**

**Fruit Growth Factors**

**Uncontrollable Factors**
- Temperature – 20-28°C for fruit growth
- Humidity
- Rainfall (related to irrigation)

**Controllable Factors**
- Soil type (depth and structure)
- Cultivar – fruit size characteristic of cultivar
- Rootstock – more vigorous, larger fruit
Production Practices

Irrigation

Irrigation plays a very important role in fruit growth, particularly during phase 2. During this phase, the trees must under no circumstances experience water stress, as this will cause a decrease in the growth rate of the fruit.

Plant Nutrition

Plant nutrition also plays a major role. The potassium level in the leaves should not be lower than 0.9%, as lower potassium levels cause smaller fruit. The nitrogen-potassium ratio must be between 1:6 and 2:2.

Tree and Root Health

Tree and root health is very important, specifically nematodes and Phytophthora (root rot). If these are present in the orchard, you will have smaller fruit.

Other Practices

There are a few other factors that we can control to produce bigger fruit.

We can delay the harvest, but during phase 3 there is little fruit growth, so not much will be gained in fruit size. We can also harvest selectively and pick the bigger fruit first.

Summer girdling is labour intensive and isn’t common practice. Pruning can be used to improve light distribution in the tree, resulting in bigger fruit.
Fruit Thinning

Tree fruit load affects fruit size, specifically the number of fruit on a tree. The more fruit there is on a tree, the smaller the fruit will be. Fruit thinning reduces the number of fruit per tree, and therefore competition between fruit, resulting in bigger fruit.

Thinning can be done by hand, but it is more common in citrus production to use synthetic auxins.

definition

Auxins

Auxins are natural plant hormones or synthetic substances that affect the growth and development of all plant parts.

summary

Production Practices

Production practices that impact on fruit size and yield are:
- Irrigation
- Plant nutrition
- Maintaining tree and root health
- Delaying harvesting
- Harvesting selectively
- Summer girdling
- Pruning
- Fruit thinning

information

Production Guidelines

Please consult the CRI Production Guidelines for more information, as follows:
- **Irrigation** – Volume II, section 2
- **Plant nutrition** – Volume II, section 1
- **Plant manipulation (summer girdling, pruning, etc.)** – Volume II, section 5
Harvest Planning

To do harvest planning, it is important to know if the fruit is generally large or small. It is also important to identify markets for specific fruit. Smaller fruit is sent to different markets than large fruit.

One also needs to determine the fruit size range per tree, to know what size category the orchard will peak at.

It is also important to predict the yield, in kilogram per tree, and to determine whether the fruit size comply with export standards. Should it not comply with export standards for size, the management programme must be adjusted.

Fruit Size Estimates

To predict fruit size, we measure fruit, using one of two methods.

We can measure the diameter of a representative sample of 50 to 150 fruit from two to five representative trees with a typical fruit load. Representative trees are trees of a typical size and with a typical fruit load. It is important to measure at least 500 fruit per unit, meaning per block or per cultivar. Use a calliper, preferably a digital one, with a logger to download the data directly onto the computer.

The second method is to pick all the fruit from one or two representative trees, and to measure them one by one.

We use the measured fruit sizes to determine the size range at picking, based on long term growth curves and gradients and the predicted harvest time.

From historical data, we can forecasts more or less when picking in a block should begin. To compile historical data and determine growth curves, certain fruit are marked and they are measured weekly, bi-weekly or monthly, depending at how much time you have, from physiological fruit drop to harvest time.
Index Trees

To build accurate historical data, it is important to measure and test the fruit of the same index trees at the same time every year.

Yield Estimates

The number of fruit per tree is also determined after fruit drop.

The one method is to put a sticker on every fruit in a tree, and then counting the number of stickers you used, to determine the number of fruit in the tree.

The other method is to remove and count all the fruit from the tree, in which case the fruit can also be measured to predict the fruit size distributions.

The number of fruit is used to calculate the percentage in every size category. The number of fruit per size category, multiplied by the average fruit weight, gives the kilograms in every fruit size category.

The weights for all size categories are added up to give the weight per tree. The number of trees per ha is then used to calculate the yield per hectare in tons.

Please see the skills sheets on **Fruit Size Estimates** and **Yield Estimates**.

Yield and Fruit Size Estimate

We have a citrus farm in Citrusdal in the Western Cape. In the middle of January we decide to do a yield and fruit size spread estimate for our Washington navels. Before we start to measure the fruit, we need to prepare a data table so that we know in which size categories the fruit will be at this time.

We start our spreadsheet by putting down the count categories for navel oranges and the minimum fruit diameter at picking for each category (this information is industry standards).
From past experience we know that we will start harvesting our Washington navels at the end of June. We now need to work out how much we can still expect the fruit to grow before it is harvested. To do this, we use information that is available from people that do citrus research – the monthly fruit growth increments table.

<table>
<thead>
<tr>
<th>Citrus Type</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mihowase Satsuma</td>
<td>9.5</td>
<td>10.1</td>
<td>7.4</td>
<td>8.2</td>
<td>2.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nules Clementine</td>
<td>5.0</td>
<td>7.5</td>
<td>7.6</td>
<td>5.5</td>
<td>3.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eureka Lemon</td>
<td>4.4</td>
<td>5.2</td>
<td>7.2</td>
<td>5.5</td>
<td>3.4</td>
<td>2.4</td>
<td>1.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Navel (mean)</td>
<td>4.8</td>
<td>7.3</td>
<td>7.8</td>
<td>4.5</td>
<td>3.9</td>
<td>1.5</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bahianinha</td>
<td>6.1</td>
<td>7.0</td>
<td>8.0</td>
<td>4.0</td>
<td>3.7</td>
<td>1.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palmer</td>
<td>3.1</td>
<td>7.8</td>
<td>8.3</td>
<td>5.4</td>
<td>2.9</td>
<td>1.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robyn</td>
<td>5.3</td>
<td>6.6</td>
<td>7.5</td>
<td>3.9</td>
<td>5.3</td>
<td>1.7</td>
<td>0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washington</td>
<td>3.9</td>
<td>7.8</td>
<td>7.4</td>
<td>4.7</td>
<td>3.8</td>
<td>0.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valencia (mean)</td>
<td>4.5</td>
<td>6.0</td>
<td>7.6</td>
<td>5.4</td>
<td>4.3</td>
<td>2.8</td>
<td>1.7</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Delta</td>
<td>4.4</td>
<td>5.7</td>
<td>7.6</td>
<td>5.1</td>
<td>4.4</td>
<td>3.0</td>
<td>1.4</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Midknight</td>
<td>5.3</td>
<td>6.3</td>
<td>7.8</td>
<td>6.2</td>
<td>4.4</td>
<td>2.4</td>
<td>1.7</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Valencia</td>
<td>3.8</td>
<td>6.2</td>
<td>7.6</td>
<td>4.8</td>
<td>4.3</td>
<td>2.9</td>
<td>1.9</td>
<td>1.2</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Monthly fruit growth increments in Citrusdal, based on historical data from 3 consecutive years. (Navel and Valencia in bold represent the means of all Navel or Valencia cultivars, respectively.)

From the row for Washington navels, we calculate that we can expect our fruit to still grow by 26.35mm from middle January to end of June (1.95+7.8+7.4+4.7+3.8+.07). We now add another column to our spreadsheet, in which we subtract 26.35 from the minimum diameter at harvest. This gives us the minimum diameter that the fruit will be in January for each size category.
We now go to our index tree and measure 100 fruit on the tree, and sort them into the categories that we have on our spreadsheet. We also count all the fruit on our index trees, and find that we have on average 500 fruit per tree. We can now add the following information.

<table>
<thead>
<tr>
<th>Count (Fruit / 15kg carton)</th>
<th>Min diameter at picking (mm)</th>
<th>Min diameter on 15 Jan (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>99</td>
<td>72.65</td>
</tr>
<tr>
<td>36</td>
<td>95</td>
<td>68.65</td>
</tr>
<tr>
<td>40</td>
<td>90</td>
<td>63.65</td>
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<tr>
<td>48</td>
<td>86</td>
<td>59.65</td>
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<tr>
<td>56</td>
<td>82</td>
<td>55.65</td>
</tr>
<tr>
<td>64</td>
<td>78</td>
<td>51.65</td>
</tr>
<tr>
<td>72</td>
<td>73</td>
<td>46.65</td>
</tr>
<tr>
<td>88</td>
<td>69</td>
<td>42.65</td>
</tr>
<tr>
<td>105</td>
<td>65</td>
<td>38.65</td>
</tr>
<tr>
<td>125</td>
<td>62</td>
<td>35.65</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Count (fruit / 15kg carton)</th>
<th>Min diameter at picking (mm)</th>
<th>Min diameter on 15 Jan (mm)</th>
<th>Fruit measured per size category</th>
<th>Fruit in size category per tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>99</td>
<td>72.65</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>36</td>
<td>95</td>
<td>68.65</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>40</td>
<td>90</td>
<td>63.65</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>48</td>
<td>86</td>
<td>59.65</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>56</td>
<td>82</td>
<td>55.65</td>
<td>15</td>
<td>75</td>
</tr>
<tr>
<td>64</td>
<td>78</td>
<td>51.65</td>
<td>30</td>
<td>150</td>
</tr>
<tr>
<td>72</td>
<td>73</td>
<td>46.65</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>88</td>
<td>69</td>
<td>42.65</td>
<td>15</td>
<td>75</td>
</tr>
<tr>
<td>105</td>
<td>65</td>
<td>38.65</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>125</td>
<td>62</td>
<td>35.65</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>500</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Now we know how many fruit we have in each category per tree in our orchard at the moment. But now there is another factor that we must take into account – summer-fall fruit drop, during which the trees will all lose some fruit. From historical data on the farm, we know that we can expect to lose about 30% of the fruit on the trees before the end of June. We can therefore estimate that the number of fruit per size category per tree at the end of June, will be as follows:
Now we would like to calculate what our yield per tree will be in kilogram. To do this, we need to know what the mean fruit weight will be per size category. This is easy enough to calculate – remember that we know how many fruit goes into a 15kg carton, so we can simply divide that number of fruit into 15 to get the mean fruit weight in kilogram. If we now multiply the mean weight per fruit with the number of fruit that we have estimated there will be on the trees at the end of June, we get the yield per fruit size category in kilogram. If we add together this column, we get the estimated yield per tree.

<table>
<thead>
<tr>
<th>Count (fruit / 15kg carton)</th>
<th>Min diameter at picking (mm)</th>
<th>Min diameter on 15 Jan (mm)</th>
<th>Fruit measured per size category</th>
<th>Fruit / size category / tree</th>
<th>Fruit / size category / tree at end June</th>
<th>Mean fruit weight (kg)</th>
<th>Yield per tree (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>99</td>
<td>72.65</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.468</td>
<td>0</td>
</tr>
<tr>
<td>36</td>
<td>95</td>
<td>68.65</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.417</td>
<td>0</td>
</tr>
<tr>
<td>40</td>
<td>90</td>
<td>63.65</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.375</td>
<td>0</td>
</tr>
<tr>
<td>48</td>
<td>86</td>
<td>59.65</td>
<td>5</td>
<td>25</td>
<td>17.5</td>
<td>0.313</td>
<td>5.5</td>
</tr>
<tr>
<td>56</td>
<td>82</td>
<td>55.65</td>
<td>15</td>
<td>75</td>
<td>52.5</td>
<td>0.267</td>
<td>14</td>
</tr>
<tr>
<td>64</td>
<td>78</td>
<td>51.65</td>
<td>30</td>
<td>150</td>
<td>105</td>
<td>0.234</td>
<td>24.6</td>
</tr>
<tr>
<td>72</td>
<td>73</td>
<td>46.65</td>
<td>20</td>
<td>100</td>
<td>70</td>
<td>0.208</td>
<td>14.6</td>
</tr>
<tr>
<td>88</td>
<td>69</td>
<td>42.65</td>
<td>15</td>
<td>75</td>
<td>52.5</td>
<td>0.171</td>
<td>9</td>
</tr>
<tr>
<td>105</td>
<td>65</td>
<td>38.65</td>
<td>10</td>
<td>50</td>
<td>35</td>
<td>0.143</td>
<td>5</td>
</tr>
<tr>
<td>125</td>
<td>62</td>
<td>35.65</td>
<td>5</td>
<td>25</td>
<td>17.5</td>
<td>0.120</td>
<td>2.1</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>500</td>
<td>350</td>
<td></td>
<td></td>
<td>74.8kg</td>
<td></td>
</tr>
</tbody>
</table>
Our Washington navels are planted at the trees spacing of 5x3m, which means that we have 667 trees per hectare. We can therefore calculate our yield per hectare as follows:

Yield per hectare = yield per tree x trees per hectare
= 74.8kg x 667
= 49,891.6kg
= **49.9 ton/ha**

**active learning**

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignment(s) below.

**Activity 6.1 – Workplace Interview**

Interview a subject matter expert such as a citrus grower or farm manager, and find answers to the following questions:

✓ What was the yield per hectare for one orchard of a particular type of citrus during the last season?
✓ What was the average fruit size for this orchard?
✓ How did this compare to the estimated yield and fruit size for that orchard?
✓ When were the estimates done?
✓ Can you explain to me, step-by-step, how the estimates were done?

**Activity 6.2 – Practical**

Ask your coach / supervisor to monitor you while you prepare and use equipment to measure fruit size. Make sure that you follow the correct procedures according to your organisation’s SOP manual.
**Activity 6.1 – Workplace Interview**

Interview a subject matter expert such as a citrus grower or farm manager, and find answers to the following questions:

<table>
<thead>
<tr>
<th>Details of interviewee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name and surname:</td>
</tr>
<tr>
<td>Date of interview:</td>
</tr>
<tr>
<td>Signature of interviewee:</td>
</tr>
</tbody>
</table>

- What was the yield per hectare for one orchard of a particular type of citrus during the last season?

- What was the average fruit size for this orchard?

- How did this compare to the estimated yield and fruit size for that orchard?

- When were the estimates done?

- Can you explain to me, step-by-step, how the estimates were done?
Activity 6.2 – Practical

Ask your coach / supervisor to monitor you while you prepare and use equipment to measure fruit size. Make sure that you follow the correct procedures according to your organisation’s SOP manual.

<table>
<thead>
<tr>
<th>Tools and equipment</th>
<th>Handling before, during and after task completion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

**SOPs:**

<table>
<thead>
<tr>
<th>Day</th>
<th>Details of tasks completed</th>
<th>Time spent on tasks</th>
<th>Signature of supervisor</th>
</tr>
</thead>
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</table>
Fruit Size Estimates

Requirements

☐ Calliper (preferably digital with logger)

Method 1

1. Select 2 to 5 representative trees (trees of typical size and fruit load) per unit (block or cultivar)
2. Measure 50 to 150 fruit on representative trees
3. Measure at least 500 fruit per unit (block or cultivar)
4. Transfer information to computer system or note by hand
5. Calculate average fruit size per unit (block or cultivar)
6. Repeat measurements on regular basis, noting results to develop growth curves
7. Use predicted growth to estimate fruit size range at picking

Method 2

1. Pick all the fruit from one or two representative trees
2. Measure fruit one by one
3. Follow steps 4 to 7 of method 1
Yield Estimates

Requirements

☐ Self-adhesive labels

Method

1. Select 2 to 5 representative trees per unit (use same trees as for fruit size estimates)
2. Put on label on each fruit in tree
3. Count the number of labels used from box by looking at the backing paper that remains

Alternatively, if method 2 is used for fruit size estimates, all fruit that is removed are counted.

4. Use number of fruit to calculate percentage per size category
5. Weight per size category = fruit per size category × average fruit weight
6. Weight per tree = total of weights per size categories
7. Yield per hectare = weight per tree × trees per hectare
Module 7
Packhouse Planning

Presenter: Gert Kotze

Introduction

Packhouses need to do careful planning during the off-season to maximise productivity and output during the packing season. Planning must be done for:

- Equipment maintenance
- Packing material
- Chemical usage
- Labour requirements

The ability to predict volumes and target markets is therefore of cardinal importance to the packhouse manager. For a packhouse to function well, it is crucial that there are close cooperation and good communication between the producer, export agent, packhouse, input suppliers, and logistics service providers.

Equipment Maintenance

Packhouse planning starts with equipment maintenance. Throughout the year, records are kept of where breakages and wear and tear occur most often. When the season stops, work starts with the maintenance of these parts.

In addition to maintenance, planning starts based on volumes to be received in the next season, for packing material, chemicals and labour.

Packing Materials

The formula we use is based on estimates from producers, based on history and the fruit load of trees during the year. From this we estimate fruit volumes in terms of cartons equivalents.

A decision is also made on the target markets for the coming year, and carton requirements are calculated on this basis.
An order can now be sent to the carton manufacturer specifying the number of cartons needed per week per market.

A plan is then developed with the manufacturer, of which the details are sent through by the coordinator on a daily basis once packing starts.

**Chemicals**

The same principle is used for calculating the chemical requirements, for the drench and the fungicide bath.

The calculation is based on tonnage put through the packhouse. It is monitored on a daily basis, comparing actual chemical usage during packing with the predicted usage, and adapting the projections if necessary.

**Labour**

As for labour, skeleton staff starts when we start packing the smaller cultivars. The total workforce is employed when the main packing starts.

The number of workers is based on the previous year’s figures. If the packhouse has been expanded, requiring more staff, workers are trained to perform and supervise those new tasks.

**Conclusion**

Fruit volumes for the packing season are estimated based on yield and fruit size estimates done by growers. Once the target markets for the fruit has been chosen, estimates can be made of how much packing material (including cartons, carton labels, fruit labels, wrappers, pallets, strapping, and so on), chemicals and other consumables will be needed.

This information is communicated to input suppliers. Using the estimated volumes, the packhouse manager can also predict the number of workers that he will require for each job in the packhouse, and the training needs for the workers.

Training should take place before the season, in order to have a fully trained and motivated workforce in place when packing starts.
active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignment(s) below.

Activity 7.1 – Workplace Research

Conduct research in your workplace or the packhouse where you are doing your practical training to determine the following:

✓ What volume of citrus was packed in the packhouse during the previous season in ton?
✓ What is the maximum volume of fruit that your packhouse handles in a day?
✓ How much fungicides were used in the packhouse during the previous season?
✓ How many cartons were used during the previous season of the carton type that is used most in your packhouse?
✓ How many temporary and how many permanent workers were employed by the packhouse during the previous season?

Activity 7.2 – Workplace Interview

Interview your packhouse manager or supervisor and find out whether the fungicide usage, carton requirements and worker numbers are expected to change in the next season. If so, find out the reasons for these changes.
# Activity 7.1 – Workplace Research

Conduct research in your workplace or the packhouse where you are doing your practical training to determine the following:

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ What volume of citrus was packed in the packhouse during the previous season in tonnes?</td>
<td></td>
</tr>
<tr>
<td>✓ What is the maximum volume of fruit that your packhouse handles in a day?</td>
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Interview your packhouse manager or supervisor and find out whether the fungicide usage, carton requirements and worker numbers are expected to change in the next season. If so, find out the reasons for these changes.

Details of interviewee

Name and surname:
Date of interview:
Signature of interviewee:
Module 8
Rind Disorders

Presenter: Paul Cronje

Introduction

Rind disorders are physiological defects that occur on the citrus rind, or peel. They are not caused by pathogens, such as fungi.

There are a number of citrus rind defects, with different causes and preventative measures. It is important for the grower to be able to identify rind disorders correctly and to know what preventative steps can be taken to control them.

These defects are different from pathological problems that have to do with fungal infections. These disorders are physiological, caused by something in the rind that causes cells to degenerate, resulting in unsightly scars.

Rind Structures and Functions

The citrus rind is a modified leaf, with an interesting and complicated physiology. The rind can photosynthesise, respire and transpire just like an ordinary leaf.

It is important during fruit growth that this leave must develop optimally. It must contain high levels of minerals, especially magnesium and calcium, to strengthen cell walls and membranes.

Photosynthesis

Photosynthesis literally means production through light (photo=light, synthesis=production) and is the process by which green plants turn carbon dioxide and water into food using sunlight energy.
Respiration

Respiration is an energy-producing oxidation process in cells, the complete chemical and physical process in which oxygen is delivered to plant cells and carbon dioxide and water are given off. The plant takes up oxygen (O$_2$) and releases carbon dioxide (CO$_2$).

Transpiration

Transpiration means to lose water through the surface of a plant, particularly through the stomata in the leaf surface.

There must be sufficient carbohydrates in the rind, which it mostly generates through its own photosynthesis. These carbohydrates provide energy for cellular processes, and must also provide sufficient energy for postharvest respiration.

The moisture balance of the rind is very important. Water provision during rind development must be maintained through good irrigation.

Production Guidelines

Please consult volume II, section 1 of the CRI Production Guidelines for more information on plant nutrition.

Postharvest Practices

Drenching

When the fruit is harvested, the heat in the fruit, caused by sunshine, must be removed as soon as possible. This means the field heat must be taken out of the fruit.

The best way is to drench the fruit at the packhouse, in a drench system that also contains fungicides. Water moving over the fruit and evaporating from the rind removes the heat. This prevents excessive moisture loss from the fruit.
The Packline

After being harvested and before being packed, the fruit moves over the packline, which has many moving parts, such as rollers and brushes.

These must be kept in good condition to prevent injuries to fruit. Any small injury will lead to a lot of moisture being lost from the rind.

Wax Application

Wax application is an important aspect of the packing process. All citrus fruit needs a wax application to limit moisture loss.

The right wax must be selected according to the cultivar and the market. The wax must be permeable enough to release CO$_2$ from the fruit, and to allow oxygen to enter the fruit.

Logistics

Chilling injury is a rind defect that is becoming more important to citrus growers as imports increase to countries requiring a cold sterilisation protocol. Such protocols are applied in exports to countries such as the USA, Japan, South Korea and China.

It is important to know that the longer the fruit is exposed to these low temperatures, the more chilling injury will occur. All the participants in the logistics chain must be careful not to expose fruit to these low temperatures for longer than required.

Rind Disorders

We have now looked at the main causes of rind defects. Next we look at the groups into which specific disorders are classified.
**Rind Pitting**

The first important one is the rind pitting or rind breakdown group.

This is normally caused by a perforated oil gland in the rind from which oil leaks, causing brown marks as the oil destroys cells and their contents oxidise. This usually happens about two to five weeks after harvesting, which means that the fruit looks in a good condition when it is packed and shipped, but develop blemishes before arriving at the market, where it then has to be destroyed.

To prevent this disorder, production practices such as fertilisation, irrigation and handling must be monitored closely.

**Peteca Spot**

Peteca spot on lemons is an interesting defect. It is also associated with the degeneration of oil glands in lemon rind, but it happens very quickly, as little as two or three days after harvesting.

We have found that fruit is more sensitive when harvested after a cold front, especially if it was accompanied by rain.

An important aspect that must be addressed in the packhouse is the choice of wax. A wax with a good exchange capacity must be selected. CO$_2$ must be able to leave the fruit and oxygen must be allowed in. A high build-up of CO$_2$ around the fruit usually causes more peteca.

**Oleocellosis**

Oleocellosis is a well-known defect. Here the oil gland is damaged physically during picking and handling. The oil leaks onto the rind surface, destroying the outer cell layers.

These cell layers contain the carotenoid pigments that give the fruit its orange colour. As the fruit colour develops, you get dark brown spots on the orange rind.
Chilling Injury

A defect that is of increasing significance in South African citrus is chilling injury.

Citrus is naturally a subtropical fruit, and is therefore very sensitive to low temperatures. But markets such as the USA, South Korea, Japan and China, require a cold sterilisation protocol for export fruit.

Chilling injury can be limited by making exposure time as short as possible. The logistic chain must be well-designed, and every role player must realise that the longer fruit is exposed to those low temperatures, the greater the danger of chilling injury.

Module Reference

For best practices in terms of handling fruit during picking, please refer to module 13 – Picking Practices and module 14 – Picking Supervision, and for more information on the importance of the cold chain, please consult module 47 – Cold Chain Review.

summary

Rind Disorders

<table>
<thead>
<tr>
<th>Name</th>
<th>Cause</th>
<th>Prevention</th>
</tr>
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<tbody>
<tr>
<td>Rind pitting</td>
<td>Insufficient irrigation and plant nutrition</td>
<td>✓ Good production practices</td>
</tr>
<tr>
<td></td>
<td>Injuries during harvesting and packing</td>
<td>✓ Cautious fruit handling</td>
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<tr>
<td>Peteca spot</td>
<td>Harvesting during or after a cold front</td>
<td>✓ Good harvesting practices</td>
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<tr>
<td></td>
<td>Wax with insufficient exchange capacity</td>
<td>✓ Choosing wax with good exchange capacity</td>
</tr>
<tr>
<td>Oleocellosis</td>
<td>Oil gland damage during handling</td>
<td>✓ Cautious fruit handling</td>
</tr>
<tr>
<td>Chilling injury</td>
<td>Exposure to low temperatures for too long periods</td>
<td>✓ Proper management of logistics chain</td>
</tr>
</tbody>
</table>
Conclusion

To limit and control rind disorders it is important to look at production practices, specifically plant nutrition and irrigation, to ensure that the fruit is handled carefully during picking and packing, and to make sure that good packhouse practices are applied, especially when it comes to wax applications.

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignment(s) below.

Activity 8.1 – Worksheet

Complete the table in your workbook stating for each disorder in the pictures below:

- ✔ What is the name of the disorder?
- ✔ What causes this disorder?
- ✔ When do the symptoms of the disorder first appear?
- ✔ How can the disorder be prevented?

Activity 8.2 – Staff Training

Make a list of five specific things that can be done on the farm and / or in the packhouse to prevent most rind disorders. Now develop a learning session for the employees on a citrus farm and in a citrus packhouse during which you explain to them these five things.
# Activity 8.1 – Worksheet

Complete the table stating for each disorder in the pictures below:

✓ What is the name of the disorder?
✓ What causes this disorder?
✓ When do the symptoms of the disorder first appear?
✓ How can the disorder be prevented?

<table>
<thead>
<tr>
<th>Name</th>
<th>Causes</th>
<th>Timing of symptoms</th>
<th>Prevention</th>
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Keynotes:
Introduction

Apart from rind disorders, citrus is vulnerable to a number of postharvest diseases, which are caused by fungi.

Fungal organisms produce spores through which they propagate. Spores are adapted for dispersal, meaning that they are able to become airborne and, like some seeds, they can be spread by wind, water, or anything else that moves.

There are spores of different fungi all around us in the air. When spores settle down somewhere, they wait for the right conditions to start growing. Once the spores start growing and multiplying, feeding on the surface they are attached to, it becomes very difficult to stop the disease from developing.

There are many different fungi that can infect citrus fruit. Some of their spores can remain latent for up to 12 months, ready to propagate when the conditions are right. To control these fungal diseases, we need to create conditions in which the spores will not be able to propagate or infect fruit, and to minimise the spore load in the orchard and in the packhouse.

Propagation

Propagation means the multiplication of organisms. In terms of fungal disease development, it refers to the process where fungal spores starts multiplying and thereby infecting and destroying the fruit.

Latent

Latent means present or existing, but in an underdeveloped, unexpressed or dormant form. In fungal disease development, it is used to refer to fungal spores that are there but not active, waiting for the right conditions.
Postharvest Disease Groups

Although there are about fourteen fungal postharvest diseases that we have to contend with, 80 to 90 percent of postharvest losses are caused by only about one quarter of these pathogens. These major postharvest diseases can be divided into two groups, being wound pathogens and latent pathogens.

The most economically important wound pathogens are:

- Green mould
- Blue mould
- Sour rot
- Trichoderma brown rot

Latent pathogens include:

- Diplodia stem-end rot
- Anthracnose rot
- Phomopsis stem-end rot
- Alternaria rot
- Brown rot, caused by Phytophthora

Wound Pathogens

Green Mould

Green mould infection takes place through wounds caused by insects and injuries to the fruit that occur during picking, transport and packing.

To prevent green mould, we therefore need to make sure that insects that cause wounds, such as fruit fly and false codling moth, are properly controlled, and that fruit is handled carefully during picking, transport and packing. Sanitation of the orchard and packhouse furthermore helps to keep the spore load down.

TBZ, SOPP and Imazalil, or combinations of these fungicides, can be used as treatments in the packhouse to control green mould.
Fungicides

TBZ – Thiabendazole
SOPP – Sodium ortho-phenylphenate

Blue Mould

Blue mould also infects fruit through wounds and injuries, just like green mould, but blue mould can spread from infected fruit to other fruit in a packed carton.

Blue mould is prevented and controlled in the same way as green mould.

Sour Rot

Sour rot is caused by a fungus that is present in the soil of all the citrus producing areas. The spores are spread to the fruit by dust and by water splashing up onto the low-hanging fruit when it rains. Fruit is infected through injuries that go through to the albedo, or the white part of the peel. The injuries can be caused by insects, such as false codling moth, fruit fly and fruit-sucking moths, and by snap picking fruit.

All citrus varieties, and especially soft citrus, are vulnerable to it, while over-mature fruit is also more susceptible.

The sour odour that develops in the advanced stages of the disease attracts vinegar flies, which can spread the fungus and cause other injured fruit to become infected.

Sour rot develops most quickly at temperatures above 27°C. It spreads in packed cartons from infected fruit to healthy fruit, and its development is stimulated by the presence of green mould spores.

To prevent infection pest control is very important. Good picking practices must be employed, so that injuries to fruit, such as those caused by snap picking, are avoided and fruit is not packed when it has been in contact with the soil.
Fruit must be picked before it becomes over-mature and it must be packed and refrigerated as soon as possible after picking. Packhouse sanitation is essential to prevent vinegar flies, which are attracted to sour rot, from spreading the disease.

Guazatine is the only fungicide that is registered for the control of sour rot, but SOPP also provides some protection.

**Trichoderma Brown Rot**

The trichoderma brown rot fungus is found in soil, and attacks the fruit of all citrus varieties. Initial infection requires an injury to the fruit, but in packed cartons the fungus spreads from infected fruit to healthy fruit.

Trichoderma causes cellulose to decompose and can grow on paper, cardboard and wood. It can therefore establish in wrappers, cartons, pallets and wooden bins, from where it can grow again and infect healthy fruit.

To prevent the fungus, injuries to fruit must be avoided and fruit that has been in contact with the soil must not be packed. Over-mature fruit must also be avoided. Wooden bins and lugs can be cleaned with steam.

Cooling fruit to below 10°C after packing effectively limits the development and spread of this rot. The fruit can also be treated with TBZ.

**Latent Pathogens**

**Diplodia Stem-End Rot**

The fungus that causes Diplodia stem-end rot (SER) sporulates on deadwood, including bark and twigs, and can survive from one season to the next.

Diplodia spores, as is the case with Phomopsis and Anthracnose spores, are washed down during rainfall onto the dead calyx tissue or onto the rind or under the calyx. The calyx is the button, or stem-end, of the fruit.
Here the spores remain latent until conditions are favourable for infections to develop, such as during degreening, when the fruit ages, or when the calyx dies and abscises. This area then becomes an entry point to the fruit where the infection develops internally as well as externally.

To prevent this disease, trees must be kept free of deadwood, fruit should be picked before they become over-mature, and 2,4-D can be applied in the packhouse to maintain a living green calyx on the fruit. TBZ is effective for controlling Diplodia SER. Refrigerating the fruit as soon as it is packed also helps to control the disease.

**Anthracnose Rot**

Anthracnose rot is common in citrus orchards and all citrus types, especially soft citrus. Spores are produced on dry twigs and dead tissue in the tree, from where they spread to young fruitlets by wind, rain and insects.

The fungus penetrates the rind through injuries or insect punctures, and remains latent until conditions are favourable for it to grow. These favourable conditions occur when fruit is over-mature or injured. Young fruit can sometimes be attacked while still on the tree, by fungus growing into the fruit from deadwood.

To prevent the development of Anthracnose rot, it is important that production practices promote tree vigour and fruit quality, and that deadwood is removed from trees. Fruit must be harvested at optimum maturity and should not be kept in storage for lengthy periods.

The fungus is controlled by packhouse treatments with TBZ, Imazalil and Prochloraz.

**Phomopsis Stem-End Rot**

The first sign of the Phomopsis stem-end rot is softness around the stem-end of the fruit, with no initial discoloration. Thereafter, a very slight off-colour and eventually a tan to brown and almost black colour develop.

The infected tissue shrivels a little, causing a shoulder or ridge to form between decayed and healthy tissue. The pulp becomes mushy, but there is no discoloration. An unpleasant, rancid odour develops.
Phomopsis has a lifecycle and mode of infection similar to Diplodia, in that it remains latent in the button tissue, and infects the fruit when the calyx abscises. Further infection develops after the harvest when loosening of the calyx results in natural openings, through which the fungus then penetrates.

Phomopsis stem-end rot may be prevented by cultural practices that promote vigorous trees and fruit with high vitality, by avoiding an accumulation of dry twigs in the tree, and avoiding conditions that will lead to abscission of the button such as injuries, over-maturity, degreening of fruit with ethylene, high temperatures during transit of packed fruit, and long storage.

**Alternaria Rot**

Alternaria rot in citrus appears in different forms. This fungus causes navel-end rot in navel, stylar-end rot in lemons, mandarin hybrids and some other orange varieties, stem-end rot in all citrus varieties, and internal black rot in most citrus varieties.

The spores of the fungus infect the flower tissue and by the time the fruit is mature, the fungus is established in the button tissue and on the stylar scar, out of reach of fungicides. It may also develop from injuries in the rind, caused by insects or mechanical practices.

Mature fruit and fruit with low vitality as a result of unfavourable weather conditions, such as low temperatures over a long period or frost, dry, hot winds, low humidity or extreme heat, are more vulnerable to Alternaria rot, as is fruit with signs of sunburn.

Control measures include production practices that promote tree vigour and the removal of fruit that shows signs of sunburn and splitting at the stylar-end. The use of 2,4-D in the packhouse is essential to delay the abscission of the calyx.
Phytophthora Brown Rot

Phytophthora brown rot can be devastating, especially during seasons of high and frequent rainfall during harvesting, when fruit is more likely to get into contact with wet soil.

This disease cannot be controlled by any registered postharvest fungicide, and prevention is therefore the only cure.

When fruit comes into contact with wet soil, or if rainwater splashes up onto low-hanging fruit, Phytophthora spores, which are present in the soil, get onto the fruit and penetrate the rind within three hours at temperatures between 12°C and 20°C.

Fruit must be prevented from coming into contact with soil, and pickers must be warned never to pick up fruit that has been in contact with the soil and place it with the fruit destined for the packhouse. Trees must be skirted so that the branches will not bear fruit that hang low enough for rainwater to splash onto it.

Conclusion

Infection by most postharvest diseases can be prevented by:

- Production practices that promote tree vigour and fruit quality
- Not packing over-mature fruit
- Deadwood removal and skirting
- Regular removal of fallen fruit
- Handling fruit with care during picking and transport
- Washing fruit in sanitised water when it enters the packhouse
- Treating fruit with the prescribed dosages of fungicides, ensuring sufficient residues, as soon as possible but no longer than 48 hours after picking
- Not packing fruit with low vitality
- Storing fruit at 4.5°C as soon as possible after packing
- Not storing fruit for long periods
- Regular packhouse sanitation
Production Practices

An effective pre-harvest pest control programme is essential in controlling postharvest diseases. For more information on pre-harvest pest control, please refer to module 11 of this series, and consult volume III of the CRI Production Guidelines.

Postharvest Diseases

<table>
<thead>
<tr>
<th>Name</th>
<th>Mode of infection</th>
<th>Prevention and control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green mould</td>
<td>- Infection through wounds caused by pest insects</td>
<td>- Prevent injuries during picking, transport and packing</td>
</tr>
<tr>
<td></td>
<td>- Infection through injuries caused by handling (picking, packing, transport)</td>
<td>- Control insects that cause wounds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Orchard sanitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Packhouse treatments with TBZ, SOPP and Imazalil</td>
</tr>
<tr>
<td>Blue mould</td>
<td>- Same as green mould</td>
<td>- Prevent injuries during picking, transport and packing</td>
</tr>
<tr>
<td></td>
<td>- Can spread from infected to healthy fruit</td>
<td>- Control insects that cause wounds</td>
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<tr>
<td></td>
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<td>- Orchard sanitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Packhouse treatments with TBZ, SOPP and Imazalil</td>
</tr>
<tr>
<td>Sour rot</td>
<td>- Soil-borne pathogen</td>
<td>- Control insects that cause wounds</td>
</tr>
<tr>
<td></td>
<td>- Infection through deep injuries (albedo) caused by insects, snap picking</td>
<td>- Prevent injuries to fruit</td>
</tr>
<tr>
<td></td>
<td>- Spread by vinegar flies</td>
<td>- Prevent contact between fruit and soil</td>
</tr>
<tr>
<td></td>
<td>- Over-mature fruit more susceptible</td>
<td>o Do not pick up fallen fruit and put with other fruit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Skirt trees</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Do not pack over-mature fruit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Pack and refrigerate fruit soon after picking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Packhouse sanitation to control vinegar fly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Packhouse treatment with Guazatine and SOPP</td>
</tr>
</tbody>
</table>
### Latent pathogens

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Symptoms</th>
<th>Preventive Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diplodia stem-end rot</td>
<td>Sporulates on deadwood, washed onto calyx, infects when calyx abscises</td>
<td>- Remove deadwood&lt;br&gt;- Pick fruit at optimum maturity&lt;br&gt;- Apply 2,4D to maintain calyx&lt;br&gt;- Refrigerate fruit after packing&lt;br&gt;- Packhouse treatment with TBZ</td>
</tr>
<tr>
<td>Anthracnose rot</td>
<td>Sporulates on deadwood, spreads to fruitlets, infects when fruit is over-mature or injured</td>
<td>- Cultural practices for vigorous trees and fruit&lt;br&gt;- Remove deadwood&lt;br&gt;- Pick fruit at optimum maturity&lt;br&gt;- Do not keep fruit in storage for long periods&lt;br&gt;- Packhouse treatment with TBZ, Imazalil and Prochloraz</td>
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<tr>
<td>Phomopsis stem-end rot</td>
<td>Sporulates on deadwood, washed onto calyx, infects when calyx abscises / loosens</td>
<td>- Cultural practices for vigorous trees and fruit&lt;br&gt;- Remove deadwood&lt;br&gt;- Avoid fruit injuries, over-mature fruit, degreening, transport at high temperatures and long storage</td>
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<tr>
<td>Alternaria rot</td>
<td>Infects flower tissue, establishes out of reach of fungicides, may develop from rind injuries (insects or mechanical)</td>
<td>- Cultural practices for vigorous trees&lt;br&gt;- Remove fruit with sunburn and split stylar-ends&lt;br&gt;- Apply 2,4D to maintain calyx</td>
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<tr>
<td>Phytophthora brown rot</td>
<td>Soil-borne pathogen, infects through soil contact</td>
<td>- Prevent contact between fruit and soil&lt;br&gt;- Control fungus in soil during pre-harvest pest control&lt;br&gt;- No postharvest control</td>
</tr>
</tbody>
</table>

### active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignment(s) below.

### Activity 9.1 – Worksheet

Answer the questions below in your workbook, in your own words and according to your understanding:

- What are pathogens?
- Name four wound pathogens.
- What are the symptoms of the following latent pathogens?
  - Diplodia stem-end rot
- Anthracnose rot
- Phomopsis stem-end rot
- Alternaria rot
- Phytophthora brown rot

**Activity 9.2 – Worksheet**

Complete this table by listing the pathogens that can be controlled by the action in the first column:

<table>
<thead>
<tr>
<th>Preventative Action</th>
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<tr>
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<tr>
<td>Regular removal of fallen fruit</td>
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<tr>
<td>Handling fruit with care during picking and transport</td>
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<tr>
<td>Washing fruit in sanitised water when it enters the packhouse</td>
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<tr>
<td>Treating fruit with the prescribed dosages of fungicides, ensuring sufficient residues</td>
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<tr>
<td>Not packing fruit with low vitality</td>
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<tr>
<td>Storing fruit at 4.5°C as soon as possible after packing</td>
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<tr>
<td>Not storing fruit for long periods</td>
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Module 10
Orchard Sanitation

Contributor: Keith Lesar

Introduction

A packhouse is not a hospital for sick fruit. No treatment or process that can be applied in a packhouse, no matter how well it is done, can repair damaged, injured or sick fruit coming from the orchard.

Regular orchard sanitation and good picking practices is very important so that we can be sure that there is less chance of fruit being damaged, injured, and infected by fungal spores, and arriving in the packhouse in a ‘sick’ condition, where it can spread the fungal spores to the other export fruit. Always remember that fruit is a perishable product.

Postharvest Pathogens – Fungi

There are twelve different pathogens that we must prevent from contaminating fruit in the orchard.

Remember that the word ‘pathogen’ is used for anything that can cause a disease, such as viruses, bacteria, and fungal organisms. Fungal organisms are the sort of pathogen that makes citrus fruit sick. Fungal organisms spread through spores, almost like the pollen of a plant. It is these spores that we must prevent from getting onto and especially into our fruit.

Pathogens

Pathogens are anything that can cause a disease, such as bacteria, a virus or a fungal organism.
Wound Pathogens

The most important pathogens are those that get into the fruit through a wound on the fruit. This can be avoided simply by making sure that the fruit is not injured or damaged during picking so that the pathogens have nowhere to get in. This is also why it is important that fruit with injuries are not placed with the other fruit, because they may be carrying these pathogens to the packhouse.

Latent Pathogens

Then there are also latent pathogens. The word ‘latent’ means something that is there, but not active and just waiting for the right conditions to attack.

Latent pathogens live on deadwood in the trees. When it rains, fungal spores are washed down from the deadwood onto the fruit rind or into the button tissue, where the spores lay dormant until the ideal conditions occur for infection to take place.

The ideal conditions for fungal spores to grow are where it is warm and humid, out of direct sunlight. In the packhouse, and especially in degreening rooms, the pathogens will find these ideal conditions.

Older fruit, and fruit that is picked towards the end of these season, is also much more vulnerable to latent pathogen infections.

Latent Pathogens

Latent pathogens are there but not active, just waiting for the right conditions to attack.

Soil Pathogens

Then we must remember that there are pathogens that live in the soil. If they get a chance to get onto the fruit, they will infect the fruit and start to spread, producing more and more spores. (Have you ever seen rotten fruit on the ground in the orchard? Those fruit rot because the pathogens in the soil got into the fruit and started spreading.)
Fruit fall on the ground for different reasons. They may have fallen off the tree after being stung by a pest insect, or they may have dropped on the ground during picking. Fruit that hang low in the tree, close to the ground, can also get soil pathogens on them. When it rains, water can splash up onto the fruit, carrying the pathogens with it.

**Orchard Sanitation Tasks**

We can now start to see what we must do to keep our fruit safe and healthy.

Firstly, now that we know latent pathogens live on deadwood in the trees, we can remove the deadwood so that they have nowhere to live.

Secondly, we can make sure that there are no branches that can carry fruit that will hang so low that pathogens that live in the soil can get onto the fruit and into the tree, by skirting the trees.

In the third place, no fruit that has fallen on the ground in the orchard must ever be picked up and placed with other export fruit, because it has soil pathogens on it.

And lastly, we must make very sure that we remove all the waste fruit lying on the orchard floor often, so that the pathogens cannot propagate in this fruit and stay in the orchard. Also remember that pest insects, like false codling moth and fruit fly, lay their eggs in fruit.

If rotten fruit is allowed to stay in the orchard, the eggs will hatch in the fruit and the larvae will grow. By leaving the rotten fruit in the orchard you allow the pest insect also to stay ready to attack more fruit.

**Removing Deadwood**

Deadwood is twigs, stems and branches which do not have any leaves or fruit on them and that has become dry and hard. Deadwood is normally found inside the canopy of a citrus tree. Deadwood is removed when the trees are pruned, normally just after the harvest.

To remove deadwood, you need a pair of anvil pruning shears and sometimes a pruning saw. Take care of your own health and safety while using these tools – they are sharp and they can injure you.
Before you start cutting out deadwood, make sure that the shears are working well, that the blades are sharp and that the bolts and nuts are tight.

The shears and saw must be sterilised before you start working, because they can spread latent pathogens that may be living on the deadwood that you are cutting to other trees in the orchard.

The blades of the shears and the saw must be lightly oiled when they are not being used.

The anvil shears are used to cut the deadwood off where it meets the main branch or trunk. If the branch is too thick for the shears, use the saw.

After it has been removed, the deadwood must be taken out of and away from the orchard and burnt or dumped.

Please see the skills sheet on Removing Deadwood.

**Skirting**

Skirting means cutting off the low hanging branches of trees. This is usually also done when trees are pruned.

In terms of equipment, you will need a skirting stick to make sure that all the trees are skirted to the same height. This can be any piece of stick or tubing that is cut to the right length, normally between 600 and 800 millimetres.

To cut the branches, you will also need pruning shears or a pruning saw. For the softer wood you may use bypass shears, instead of anvil shears.

Remember to sterilise the tools and check that they are working properly before using them.

Use the skirting stick to measure the skirting height from the ground, and cut off the branches that hang below that height, preferably where it joins the scaffold, or main, branch.

But be careful not to remove too much plant material, especially on young trees.
Production Guidelines

Please consult volume II, section 5 of the CRI Production Guidelines for more information on crop manipulation.

Removing Decayed and Fallen Fruit

Now we look at how to keep the orchards floor free from fruit that can host pathogens. All fruit lying on the orchard floor must be picked up and removed out of the orchard.

This must be done once a week during the season, and twice a week from after colour break until picking in the orchard is finished. A stick can be used to pick up the fruit and place it in a bag.

From here, the fruit must be taken out of the orchard. In dry climates, the fruit can be chopped up and spread out to dry in the sun, away from the orchard and not on the orchard floor.

But this may cause problems in more humid climates, where the pathogens will still develop in the chopped up fruit. The best practice is to bury the waste fruit at least 30cm deep and at least 400 meters away from the orchard.

Removing Over-Mature and Out-of-Season Fruit

Fruit that ripens late in the season is not as healthy and vigorous as earlier fruit, and it is risky to export such fruit. This fruit is sometimes stripped off the trees, and also disposed of as waste fruit.
After picking all fruit should be stripped from trees, even hard, dry fruit, as these fruit can be infected with pathogens that will hang in the tree until the next season before spreading and infecting more fruit.

It is also important to remove out of season fruit during the year, starting just after physiological fruit drop in November, when the fruitlets are still only the size of marbles.

Out of season fruit is fruit that ripens at a different time from the other fruit. They can carry pest insects and pathogens from one season to the next. This fruit must also be disposed of as we already discussed.

**active learning**

*Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.*

**Activity 10.1 – True or False**

Tick true or false next to each statement in this table, and motivate your answer.

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You have to take part in practical orchard sanitation as part of your learning, by removing fallen fruit for one day, and by skirting trees and removing deadwood for 2 days. Make sure that you follow your company’s standard operating procedures for all these tasks.

Please make sure that your workplace supervisor or team leader observe you while completing these duties and sign your logbook.
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<th>Tools and equipment</th>
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Removing Deadwood

CAUTION:

Deadwood is twigs, stems and branches which do not have any leaves or fruit on them and that has become dry and hard, and is normally found inside the canopy of a citrus tree.

Requirements

- Anvil pruning shears
- Pruning saw
- Sterilising agent

Method

1. Make sure that blades of shears are sharp and bolts and nuts are tight
2. Sterilise blades of shears and saw
3. Cut off deadwood off where it meets the trunk, using shears
4. Use saw for thicker branches
5. Take cut deadwood out of orchard
6. Burn or dump deadwood away from orchard
Skirthing

CAUTION:
Do not remove too much foliage when skirthing trees, especially on young trees

Requirements

☐ Skirting stick (stick or tubing, 600-800mm)
☐ Bypass and anvil pruning shears
☐ Pruning saw
☐ Sterilising agent

Method

1. Make sure that blades of shears are sharp and bolts and nuts are tight
2. Sterilise blades of shears and saw
3. Use skirting stick to measure skirting height from ground
4. Cut off branches hanging below skirting height, preferably where it meets main branch
5. Use bypass shears for soft wood, anvil shears for harder wood, and pruning saw for thicker branches
6. DO NOT REMOVE TOO MUCH PLANT MATERIAL, especially from young trees
Removing Decayed and Fallen Fruit

NOTE:

Do TWICE A WEEK from colour-break until picking is finished
Do ONCE A WEEK during rest of year

Requirements

☐ Stick or other implement to pick up fruit
☐ Large bag
☐ Implement to chop up fruit
☐ Spade

Method

1. Pick up all fruit from the orchard floor using stick or other implement
2. Place fruit in bag
3. Carry fruit OUT OF and AWAY from orchard
4. IN HOT, DRY CLIMATE: Chop up fruit and spread out on ground to dry in sun
5. IN HUMID CLIMATE: Use spade to bury fruit at least 30cm deep, at least 400m away from orchard
Module 11
Pre-Harvest Pest Control

Presenter: Sean Moore

Introduction

Citrus pest management is one of the most dynamic aspects of pre-harvest production of citrus fruit.

There are dozens of different pests that can occur on citrus in Southern Africa, although usually there are only a few that occur and that require any form of control measure and these we would call key citrus pests. These would be pests such as:

- Citrus thrips
- California red scale
- Mealy bug
- Fruit fly
- False codling moth

Key Citrus Pests

Cosmetic Pests

These pests can fall into a number of different categories. The first is cosmetic pests. These are pests cause no harm to the actual quality of the fruit, but blemish the fruit and make the fruit less marketable. An example of a cosmetic pest would be citrus thrips.

Production Pests

The second would be what we would call production pests or pests that influence the crop size of the orchard. An example of a production pest, a pest that affects the yield, would be bollworm. Bollworm can also be a cosmetic pest.
Phytosanitary Pests

Another category of citrus pests would be phytosanitary pests and these are pests which are endemic to the production area, which means that they only occur in the production area.

A production area could be seen as Southern Africa or even Africa and phytosanitary pests are pests that the export markets don't want to get into their countries. These would be things like fruit fly.

Sometimes closely related to this category would be pests that cause waste, postharvest waste problems and fruit fly would also fall into this category, as would false codling moth.

Vectors

A further category would be vectors. Vectors are pests that are no problem to the fruit other than that they vector certain undesirable diseases such as the citrus psylla which is a vector of citrus greening disease.

Pest Control

How do we control these pests? Traditionally on all agricultural crops, chemical control has been the way in which all these pests have been controlled.

But on citrus, from about the 1950's, certain problems were experienced with chemical control. These were problems such as secondary pest outbreaks from the use of broad spectrum harsh chemicals and the increasing cost of chemical control related to rising oil prices.

Another problem was that the pests developed resistance to chemical pesticides. What developed as a result of that was an approach called integrated pest management.

Integrated pest management is the approach that the Southern African citrus industry adopts towards their pre-harvest pest control for the most part.
Integrated Pest Management

IPM is a holistic approach to pest management which consists of three main elements.

The first element is that it is a multifaceted approach and there are three main factors, being biological control, cultural control and chemical control.

The second element would be the use of economic thresholds, intervention thresholds or action thresholds, which would be measurements to determine when one needs to act.

And the third would be environmental responsibility or environmental conservation. This might sound just like an esoteric add-on, but in fact, very strong practical and commercial reasons can be given for adopting environmentally responsible approach.

Very often within the IPM approach the emphasis is laid on the integration of the three approaches – biological, chemical and cultural. However, the emphases should lay on management and management implies an understanding.

In order to be a good manager and to practice a good understanding, one needs to accumulate and interpret relevant, accurate and specific data for each and every orchard and for each and every single pest on that farm.

This will determine not only if and when or what it is necessary to spray, but almost more importantly, it will determine when it is not necessary to spray. This could be a great cost saving to the farmer and could also be very influential in preserving the beneficial natural enemies in that orchard which would be influenced by a spray.

summary

IPM (Integrated Pest Management)

The IPM approach consist of three elements, being:

- **Element 1** – Multifaceted approach, with factors being:
  - Biological
  - Cultural
  - Chemical
- **Element 2** – Economic thresholds
- **Element 3** – Environmental responsibility
The IPM Rating System

The CRI has a rating system that can be used to judge the effectiveness of an integrated pest management programme. Points are awarded with every application of pesticides, and the lower the score at the end of a season, the more effective is the IPM programme. For more information, contact the CRI or visit their website at www.cri.co.za.

Monitoring and Scouting

How does a farmer collect this data? He does so by monitoring. It is often said that monitoring is the cornerstone of an effective integrated pest management approach.

Monitoring is done through the usage of traps. These could either be traps which attract the pest through colour, for example leafhoppers which are attracted to a yellow colour, or through pheromones such as traps for false codling moth and California red scale, or through fruit attractants that is sometimes the case in fruit fly traps.

The other form of monitoring is scouting and most pests would be monitored through scouting. This is extremely important.

Farmers need to appoint their most trustworthy employees on the farm to this duty and make sure that they are properly trained. Also make sure that they are properly incentivised and that they have a proper understanding of the importance of their duties. Scouting also needs to be given priority and precedence on a regular basis on the farm.

Pest Occurrence

The farmer also needs to be aware of when these pests usually occur in the orchards. Certain pests already occur in spring, such as citrus thrips and bollworm. Then there are other pests which only become relevant later in the season. For example green citrus leafhopper would only appear once the fruit starts to colour up, so monitoring for this pest would only begin much later in the season.
Biological Control

Classical Biological Control

Classical biological control is the introduction and release of natural enemies – parasitoids and predators – which do not naturally or did not previously occur in that area. This is outside the hands of the farmer and would be conducted by researchers in the industry.

Conservation Biological Control

Then there is conservation biological control. This involves recognising the potentially highly effective complex of beneficial natural enemies which are already resident in the citrus orchard. These parasitoids and predators can very effectively reduce pest numbers, prevent pest outbreaks and even make any further intervention – particularly chemical intervention – unnecessary.

All the grower needs to do is preserve these natural enemies by only spraying when absolutely necessary and then judiciously selecting minimum-impact, short-residual pesticides. In addition, ants, which can disrupt natural enemies, should be kept out of trees.

Augmentation Biological Control

Finally, there is augmentation biological control. In South Africa there are some commercial insectaries, which rear natural enemies for mass release for the control of certain key citrus pests.

An example is a small wasp for control of citrus mealy bug, commonly called Coccis or Perminutus. Research trials have shown that such releases can effectively control mealy bug, eliminating the need to spray.
Cultural Control

Two good examples of important cultural control are: one, to keep ants out of the tree.

Ants treat sucking insects as if they were their cows. They milk these insects and they protect these insect against the attack of the beneficial natural enemies such as parasitoids and predators. Ants are very often responsible for serious outbreaks of sucking insects such as red scale, mealy bug and leafhoppers.

The second example of cultural control is orchard sanitation. Orchard sanitation is the regular removal of damaged and infested fruit, both from the orchard floor and fruit still hanging in the trees, and the destruction of these fruit.

Research has shown in the case of, for example false codling moth, in certain areas on average 75% of the false codling moth larvae occurring in that orchard can be removed by simple weekly orchard sanitation over the whole season.

Chemical Control

The third and last aspect of the IPM approach is chemical control. Chemical control should only be adopted as a last resort and when one does decide to spray, one needs to select very carefully which chemical to use.

Information on the non-target impacts of most pesticides is available to the citrus industry. This data, generated by CRI research, shows which the most harmful pesticides to beneficial insects are, and which the least harmful.

Unwise selection of a broad range, long-residual pesticide can cause secondary pest outbreaks. The farmer can then find himself on a chemical treadmill, with little choice other than to apply spray after spray or alternatively suffer significant pest damage.

This is where the intervention thresholds mentioned earlier come in. Growers should only spray if absolutely necessary, and if they do spray, they should apply pesticides which will assist, rather than disrupt valuable beneficial insects.
Pest Management Planning

And lastly very important is the planning of one’s pest management program before the season begins.

Planning already begins during the previous season and this would be done by the farmer conducting a pre-harvest blemish analysis in his orchard before he harvests the fruit.

He would do this by doing a survey of the fruit hanging in his orchard and determining what the major causes of damage or blemishes or infestation of the fruit in the orchard are. He would quantify these and the results would dictate which pests would be necessary to control the following season.

Control Options

Some pests are better controlled by preventative treatment. These would be pests such as California red scale and mealy bug.

By preventative treatment we mean that treatments are applied before the pest appears on the part of the plant on which it needs to be controlled, usually the fruit.

Some pests are better controlled only by corrective treatment and this means treatment takes place only once the pests has appeared on the tree or on the part of the plant usually the fruit where it needs to be controlled.

An example of this would be citrus thrips, the reason being that one would want to use a short residual IPM compatible product to treat this pest as there is no point in applying a treatment for citrus thrips before the pest has appeared.

It is essential to use the appropriate traps to monitor the populations of pests that are prevalent just before harvesting, especially pests such as fruit fly and false codling moth that can contribute to postharvest decay.

Orchard sanitation is the most important cultural practice during this time of the year. Good orchard sanitation will not only ensure that the spore load in the orchard is kept down, but also assist in controlling pest insect populations.
Module Reference

More on information on orchard sanitation can be found in module 10 – Orchard Sanitation.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 11.1 – Research Project

Find out who on your farm is responsible for monitoring pest activity. Ask them what the most common pests on the farm are, and what measures are used to control them.

Do research into other ways of controlling these pests that may be more effective and / or environmentally friendly.

Activity 11.2 – Mind Map

In your group, discuss the effect that chemical pest control can have on the environment (including the natural environment and human population) and what can be done to lessen the impact.

Activity 11.3 – Workbook

In your own words explain the difference between the IPM approach and the traditional approach towards pest management.
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In your own words explain the difference between the IPM approach and the traditional approach towards pest management.
Module 12
Maturity Indexing

Presenter: Stephan Verreynne

Introduction

Maturity indexing is used to predict the optimum picking time for citrus fruit. This information, together with yield and fruit size estimates, are used to plan for harvesting and are sent to the packhouse to assist with their planning.

To be able to estimate when the fruit in a certain orchard or block will be ready for harvesting, we measure and plot over a period of time the maturity parameters of a sample of fruit taken from that block.

Maturity Parameters

It is also important to make sure that export fruit meets the minimum maturity standards of the market it is intended for, and that it is not picked before those parameters are reached. Different markets have different maturity parameters, and the producer must always ensure that he is well informed of the minimum requirements for his target markets. There are various parameters that are used to determine the maturity and harvest time of citrus. These are:

- Fruit colour
- Juice percentage
- Sugar content
- Acidity
- Sugar : acid ratio

Fruit Colour

Fruit colour is measured against a colour chart. Different charts are used for the various types of citrus.
**Colour Charts**

Colour charts are available from the CRI (Citrus Research International), at (013) 759-8000 or www.cri.co.za. For more information on how colour charts are used, please view modules 26 and 28.

**Juice Percentage**

Juice percentage is determined by weighing a sample of twelve fruit. The juice is then extracted from the fruit, filtered through a cheese cloth, and weighed.

The juice percentage is the juice weight divided by the fruit weight.

**Example**

Whole fruit weight = 1,300g  
Juice weight = 570g  
Juice percentage = (juice weight / whole fruit weight) x 100  
= 570g / 1,300g x 100  
= 43.85%

**Sugar Content**

Sugar content is measured with a refractometer. The refractometer is set to zero with distilled water before measuring. The average of three readings is used to determine the sugar content.

Please see the skills sheet on Determining Sugar Content (TSS%).
Titratable Acid

Acid, or titratable acid, is measured by titration. We measure mainly citric acid, which is 70 to 90% of the acid in the sample.

Usually we take 20ml well-mixed juice, add 5 drops of phenolphthalein as indicator, and titrate with a 0.1562 normal sodium hydroxide solution, until the mixture turns pink.

The volume of sodium hydroxide in millilitre used in the titration is then read, and is divided by 20 to give the titratable acid percentage.

Titratable Acid

Titration reading – 30ml
Acid percentage = 30 / 20 x 100
= 1.5%

Sugar : Acid Ratio

The sugar reading from the refractometer is divided by the acid percentage, to give us the sugar : acid ratio.
Sugar : Acid Ratio

Sugar content – 8.5  
Acid percentage – 1.5%  
Sugar : acid ratio  = 8.5 / 1.5  
= 5.7

Maturity Indexing

Maturity indexing is necessary to determine the tempo of change in maturity parameters, to predict the optimum picking time and to know when picking should finish. The second reason for maturity indexing is to ensure that harvested fruit meets minimum export standards.

Maturity indexing is done by picking a sample from a uniform block or unit, with trees of the same age, cultivar and rootstock.

Sampling is done weekly, from four to six weeks before the predicted harvest time. Twelve representative index trees are chosen and one fruit per tree, from similar positions on the trees and of similar size, are picked to make up the sample.

The parameters of the sample fruit are determined, and the changes in the parameters over time are plotted on a graph. Minimum and maximum standards can be added to the graph. Trends will become evident on the graph. The picking date can now be predicted and problem areas can be identified.

Index Trees

To build accurate historical data, it is important to measure and test the fruit of the same index trees at the same time every year.
Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

### Activity 12.1 – Workplace Interview

Ask a workplace expert or your supervisor to explain to you step-by-step how maturity indexing is done on your farm.

Compare this procedure to the procedure described in this module, and other information that you can find, and identify any shortcomings.

### Activity 12.2 – Workplace Practical

Ask the person responsible for doing internal quality tests on the fruit from your farm or in your packhouse, to show you how to do the tests, and then perform the tests on your own. Compare your results to the expert’s and explain any differences.
Activity 12.1 – Workplace Interview

Ask a workplace expert or your supervisor to explain to you step-by-step how maturity indexing is done on your farm.

Compare this procedure to the procedure described in this module, and other information that you can find, and identify any shortcomings.

Details of interviewee

Name and surname: ________________________________
Date of interview: ________________________________
Signature of interviewee: __________________________

____________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________
Activity 12.2 – Workplace Practical

Ask the person responsible for doing internal quality tests on the fruit from your farm or in your packhouse, to show you how to do the tests, and then perform the tests on your own.

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Compare your results to the expert’s and explain any differences.
Determining Juice Percentage

Requirements

☐ Scale (weighing up to 5kg, graduated in 1g units)
☐ Sharp knife
☐ Juice extractor (hand reamer, machine, juice press for soft citrus)
☐ Muslin or parachute cloth
☐ 2 x Wide-mouth enamel jugs (1 litre capacity)

Method

1. Select a sample of twelve fruit
2. Weigh fruit and note weight in grams
3. Cut each fruit in half at its equator
4. Extract juice thoroughly, using hand reamer or suitable machine – for soft citrus, peel fruit and use a juice press
5. Keep fruit rest (peel and rag) in one jug
6. Strain juice through two thicknesses of muslin cloth or one thickness of parachute cloth into other enamel jug – gather edges of cloth in one hand and squeeze bag of juice and fruit rag to speed up straining, continue squeezing until remaining rag is not soggy but just damp (twisting bag into ball can assist process), squeezing should take about four minutes
7. Place fruit rests (rag and seeds) remaining in cloth with other fruit rests
8. Weigh fruit rests and note weight in grams
9. Calculate the juice percentage:
   \[
   \text{Juice \%} = \frac{(\text{whole fruit weight}) - (\text{fruit rests weight})}{(\text{whole fruit weight})} \times 100
   \]

   ALTERNATIVELY

7. Weigh extracted juice and note weight in grams
8. Calculate the juice percentage:
   \[
   \text{Juice \%} = \frac{(\text{juice weight})}{(\text{whole fruit weight})} \times 100
   \]
Determining Sugar Content
(Total Soluble Solid %)

Requirements

- Brix refractometer (range 6 to 12% total soluble solids, graduated in tenths of a percent, standardised at 20ºC)
- Brix refractometer (range 11 to 17% total soluble solids, graduated in tenths of a percent, standardised at 20ºC)

Method

1. Mix juice sample well

Hand-held Refractometer

2. Put one or two drops of sample on prism
3. Close daylight plate gently
4. Sample must spread all over prism surface
5. Look at scale through eyepiece
6. Read scale where the boundary line intercepts it
7. Wipe clean sample from prism with a tissue paper

Pocket Refractometer

2. Clean the prism surface
3. Place approximately 0.3 ml of sample onto prism surface
4. Press START key
5. Measurement value will be displayed on screen after arrow blinks 3 times
6. Measurement value will remain displayed for approximately one minute
7. To turn off display, press and hold down START key for approx 2 seconds
8. Remove sample by wiping it off with tissue
9. Use water to remove any remaining sample, dry off excess moisture with clean, dry tissue
Determining Titratable Acid Content

Requirements

- Erlenmeyer flask (200ml capacity)
- Dropper bottle (50ml capacity)
- Phenolphthalein indicator solution
- Burette (50ml capacity, graduated in tenths)
- Burette stand
- Sodium hydroxide (H₂SO₄) solution (0.1562 Normal (N))

Method

1. Mix juice sample well
2. Transfer 20ml juice to Erlenmeyer flask
3. Add five drops of phenolphthalein indicator with dropper bottle
4. Titrate with 0.1562 N sodium hydroxide from 50ml burette
5. Use white tile or white paper under Erlenmeyer flask to see the endpoint more clearly
6. Contents of Erlenmeyer should be constantly mixed during titration
7. When endpoint is approached, solution in Erlenmeyer shows streak of pink arising from the point where sodium hydroxide enters juice
8. Continue adding sodium hydroxide drop by drop
9. Endpoint is reached when pink colour persists throughout solution for at least five seconds after last addition of sodium hydroxide from burette
10. Read the contents of burette at bottom of meniscus
11. Calculate acid percentage by dividing millilitres titrated by 20
Module 13
Picking Practices

Contributor: Otto Frielingsdorf

Reference
For more information on picking export citrus please consult the CRI Production Guidelines, volume IV.

Introduction

Citrus fruit is picked for export from March to October, depending on what type of citrus it is.

On most citrus farms, seasonal workers are used to pick the fruit, and it is very important that these pickers must know what to do and what not to do while picking the fruit.

When you are picking citrus, you must remember that you are working with a perishable product. This means that it is a fresh fruit that can be injured or damaged easily.

The most injuries and damage to citrus fruit happens during picking. Once fruit is injured or damaged, it cannot be exported and the farm will get a lot less money for the fruit. Remember that you are picking your wages off the tree.

Definition

Perishable
The word perishable is used to describe something that can rot or spoil easily.
Citrus Picking Methods

While you are picking, there will be a supervisor or team leader that is in control of your picking team. This supervisor will first of all tell you what sort of picking you will be doing.

Sometimes you will be picking export fruit, which is when you will follow all the instructions given to you in this module.

You may also be told to only pick fruit that has a certain colour, or that look a certain way, and leave the rest of the fruit on the tree. You must listen carefully to these instructions, and follow them.

The other kind of picking that can happen is when the export fruit is already off the trees, and the fruit that is left is going to the juice factory. In that case, you may be told not to use clippers, but just to pick the fruit with your hand. This is called snap picking.

**Remember that export fruit is NEVER snap picked.**

In this video, we will look at how export citrus fruit must be picked. You must follow all these steps very carefully to protect the fruit, and to make sure that the fruit arrive at the packhouse in a good condition.

Personal Hygiene

Before you start picking, you need to make sure that your hands are clean and your nails are short, because long nails can injure the fruit.

You should also not be handling the fruit if you have any open injuries or sores. They must be covered with plaster before you begin.

Picking Equipment

**Gloves**

For some types of citrus, you will receive one glove that must always be on the hand that touches the fruit. So if you are right-handed, the glove will be on your left hand, and your right hand will hold the clippers. Make sure that the glove does not have any holes or tears.
Clippers

You will be issued with a pair of clippers that you will use while picking the fruit. Clippers are made from a steel alloy and the tips of the blades are round so that it will not damage the fruit. The spring keeps the clippers open, and the finger loop helps you to control the clippers while picking.

The blades of the clippers should not overlap. If they do, they may tear the stem, and a long stem will damage other fruit.

Picking Bags

You will also receive a picking bag, to put the fruit in as you pick them.

The picking bag is always slung over the shoulder opposite to the hand holding the clippers. This means that the bag should hang next to the hand wearing the glove.

There are two types of picking bags commonly in use, a bag that can open at the bottom with quick release clips, and a bag that is only open on top.

Make sure that the bag does not have any holes or tears in it, and that it is clean, dry and completely empty before you start. If the bag is torn or ripped, repair it using thread and not wire.

Ladders

When picking tall trees you will also use a ladder to get to the fruit high up in the tree. Ladders can be made from aluminium or wood, and must be strong and sturdy. Ladders can have two legs or three legs.

Check that your ladder does not have any splinters or loose metal pieces that can injure you, the tree or the fruit.

Picking Practices

Now we get to how the fruit must be picked.
**Clipping**

Let the fruit rest in your gloved hand, place the blades of the clipper on the fruit, and cut the stem as close as possible to the fruit – only a short piece of stem must be left on the fruit. Always cut the fruit stem at a right angle to the fruit. If you cut the stem skew it may leave a sharp point that can damage other fruit.

Place the fruit in the bag using your gloved hand – don’t throw or drop it in. If the stem of the fruit is too long, clip it off before putting the fruit in the picking bag. Remember that any long stem will injure the other fruit in the bag.

**Never run** with a picking bag that has fruit in it. This will make the fruit bounce against each other, and cause injuries.

**Using Ladders**

If the tree is too tall to reach the fruit at the top, all the fruit that can be reached from the ground must first be picked before using a ladder, so that the ladder will not press against and injure fruit that is still on the tree.

If you are using a ladder with two legs, lean it against the tree. Make sure that it is sturdy and secure before climbing it.

If the tree has three legs, the third leg is placed under the canopy of the tree to prop up the ladder, so that it does not have to lean against the tree.

Be careful not to bump your picking bag against the ladder if the bag already has fruit in it.

**Soiled Fruit**

If you drop any fruit on the ground **do not pick it up**, ever. Any fruit that is dropped onto the ground must stay there.

You must also not pick any fruit that hangs low on the tree. If the fruit is touching the soil, leave them alone. Even fruit that is hanging low enough so that water might have splashed up onto it, or fruit that has soil on it, must be left on the tree.
This fruit must not be picked and put with the other fruit, because they are infected.

You must also make sure that your glove does not become dirty or wet. If this happens, tell the supervisor and get a clean, dry glove.

**Emptying Picking Bags**

Once your picking bag is full of fruit, you will take it to the picking trailer or bin to empty it. Remember **not to run** to the bin or trailer.

When using a bag that opens at the bottom, place the bottom of the bag either on the fruit already in the bin or onto the floor of the bin and release the quick release catches. Lift the bag and let the fruit gently roll out.

If using a bag that is open on top lay the bag down on the fruit in the bin or on the floor of the bin and gently lift the bag to let the fruit roll out.

**Do not throw the fruit into the bin,** or drop it onto the other fruit, because this will damage the fruit. Once you have emptied the bag of fruit, shake out all the leaves and stems that may still be in the bag, before putting fruit into it again.

Please see the skills sheet on **Picking Export Fruit.**

**Preparing for Tomorrow**

After you finish picking for the day, it is important that you must check your equipment.

Make sure that there are no tears or holes in your glove or in your picking bag and that you picking bag is clean. Clean your clippers and oil them, as instructed by the supervisor.

If anything should go wrong with any of your equipment during picking, tell the supervisor or team leader immediately. Make sure that all your equipment is stored in a safe place, ready for the next day.
active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 13.1 – Keynote List

Make a list of all the different equipment that is used while picking export citrus. Now write down keynotes next to each piece of equipment on your list on the correct and safe way to use it, clean it and store it.

Activity 13.2 – True or False

Tick true or false next to each statement and motivate your answer:

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<th>Statement</th>
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<th>False</th>
<th>Motivation</th>
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**Activity 13.3 – Workplace Research**

Walk around the farm and packhouse with your group, and look for safety signs and hazard notices. Draw them in your workbook and write keynotes next to each picture explaining its meaning.

**Activity 13.4 – Practical**

Ask your supervisor or team leader to observe you during the harvest, while using your glove, clippers, ladder and picking bag. Make sure that you use, clean and store is safely and correctly, and that you do it according to your company’s standard operating procedures.
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Ask your supervisor or team leader to observe you during the harvest, while using your glove, clippers, ladder and picking bag. Make sure that you use, clean and store it safely and correctly, and that you do it according to your company’s standard operating procedures.

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Picking Export Fruit

**PICKING DON’TS**

- DO NOT leave a long stem on fruit that can injure other fruit
- DO NOT cut stem skew so that it makes a sharp point
- DO NOT pick up any fallen fruit – fruit on the ground, stays on the ground
- DO NOT pick low-hanging fruit
- DO NOT throw fruit into picking bag or into trailer or bin
- DO NOT run with a picking bag that has fruit in it or bump it against ladder
- DO NOT continue to use glove or picking bag that is wet, dirty or torn

**Requirements**

- Glove
- Clippers
- Picking bag
- Ladder

**Method**

1. Put glove on hand that touches fruit (left hand for people that are right-handed), use clippers with right hand
2. Let fruit rest in gloved hand
3. Place blades of clipper on fruit around stem and clip stem close to fruit
4. PLACE fruit in picking bag with gloved hand

**Tall Trees**

5. Make sure that all fruit that can be reached from ground has been picked
6. If ladder has two legs, lean it against the tree
7. If ladder has three legs, place third leg under canopy of tree to prop it up
8. Make sure ladder is sturdy and secure before climbing it

9. When picking bag is full, walk to bin or trailer
10. Lay bag on bottom of empty bin or trailer or on top of other fruit
11. Pull picking bag away, allowing fruit to roll out
12. Shake out all the leaves and stems from empty bag
Module 14
Picking Supervision

Contributor: Otto Frielingsdorf

Introduction

Supervising picking starts with good pre-harvest practices.

You need to be sure that the orchards are clean and ready for the harvest. This is critical in avoiding contamination and injuries while the fruit is picked. Good orchard sanitation practices throughout the year contribute to good quality fruit.

Before picking starts, the supervisor must know every day what picking method is going to be used.

The supervisor must also know what restrictions the weather conditions place on picking.

It is then also the responsibility of the supervisor to put together the picking team and to make sure that the members of the team have the equipment they need, and that the equipment is clean and in good working order.

While picking is taking place, the supervisor must check that the pickers are adhering to good picking practices, and that the fruit is not getting injured or damaged. The supervisor then needs to make sure that the fruit is transported to the packhouses in the right way.

Orchard Sanitation

More on information on best practices for orchard sanitation can be found in module 10 – Orchard Sanitation.

Reference

For more information on picking export citrus please consult the CRI Production Guidelines, volume IV.
Citrus Picking Methods

The picking method that is to be used depends on whether you are picking fruit for export, juice or the local market.

Picking Export Fruit

Picking export fruit means that pickers will use clippers to remove the fruit from the tree, and that special care must be taken every step along the way to make sure that the fruit is not injured, damaged or contaminated.

Good practices for export picking are described in detail in the Picking Practices module. Make sure that you are familiar with this module.

Selective Picking

It is also possible that the supervisor will be told to do selective picking. The manager will for instance tell the supervisors to only pick fruit that has a certain colour according to the colour charts, or to only pick export fruit.

In this case you must make sure that you are very clear on what is required. This information must then be communicated to the pickers. Give the pickers very specific instructions, and, if possible, provide them with pictures of exactly what you are looking for.

It is a good idea to have those pictures stuck on the side of the picking trailer or bin while they are picking, because then they can look at the pictures often to refresh their memories.

Snap Picking

The other method that can be used is snap picking.

Always remember that export fruit is never snap picked, because it is very easy to tear the fruit at the stem end when it is snapped off the tree.

Snap picking is used when juice fruit is picked and when the orchard is being stripped after the export fruit has been picked.
**Climatic Conditions**

Citrus fruit must **never be picked while the fruit is wet**. The oil glands in the rind of the fruit becomes turgid and fragile when fruit is wet, and in very cold, humid conditions.

When the fruit is handled in these conditions, the oil glands in the rind rupture, causing oleocellosis. Fruit can therefore not be picked during or just after it rained, or in the early morning when there is dew on the fruit. As a general guideline, harvesting should only take place when the temperature is between 13 and 30°C, and the relative humidity is not higher than 70%.

Lemons should also never be picked during and for at least two days after a cold front – especially if the cold front was accompanied by rain – because this lead to higher incidences of peteca.

**summary**

**Weather Conditions for Picking**

- Fruit must be dry
- **Temperature** – 13-30°C
- **Humidity** – below 70%
- **Lemons** – not for at least 2 days after cold front, especially if it rained

**Your Picking Team**

Pickers are usually seasonal workers that may or may not have done citrus picking before. A picker must be fit, and ready to work hard.

**Fruit Injuries**

Pickers are normally paid per bag that they pick, and they will therefore always try to pick as fast as possible. Because they want to pick quickly, there is the greater danger that they will cause damage and injuries to the fruit. It is the supervisor’s job to check that this does not happen. Remember that injured or damaged fruit cannot be exported, and that every fruit that is lost in this way, costs the farm money – it is your wages that they are picking off the trees.
Health, Safety and Personal Hygiene

You also need to make sure that pickers protect their own health and safety and that they are aware of all possible dangers that equipment might pose.

Make sure that all the pickers keep their nails short and that they wash their hands regularly.

You must also be familiar of the standard operating procedures for emergencies for your farm, so that you can apply them without hesitation if an injury to one of the pickers in your team should occur.

Picking Teams

It is recommended that there should never be more than 20 pickers in a picking team.

If there are more than 20, the team becomes too difficult for one supervisor to monitor, and the danger of injury and bad picking practices increase.

If there are too many pickers, it will also be difficult for the pickers to get to the trailer or bins to empty their picking bags, and there is a greater danger of fruit being damaged as the pickers crowd around the trailer.

Picking Equipment

Picking Bags

To start with, each picker will need a picking bag. It is important to check that the picking bags used by your team are without any tears, rips or holes. Any tear or hole must be fixed with thread and never with wire.

Also check that the straps are sturdy and that they won’t break when a bag full of fruit is carried.
Picking Clippers

If you are picking export citrus, the pickers must each have a pair of clippers.

Check all your team’s clippers before they are given to the pickers, to make sure that they are working well. Check that the spring is not worn out – the clippers must spring open by themselves after being shut. Also check that the finger loop is not loose.

The blades should meet up and not overlap, because if they do, the stems will be torn and not cut through neatly. The clippers must also be clean and sterile before picking starts.

Gloves

In some cases, each picker also needs a glove. Gloves are made of strong material that won’t catch easily on twigs and thorns.

Before giving them to the pickers, make sure that there are no tears or holes in the gloves.

Ladders

If the trees in the orchard are too tall for the pickers to reach the fruit at the top, they need to use ladders.

Ladders can be made of wood or aluminium, and can have two or three legs. Make sure that the ladders are sturdy, free of splinters and burs, and clean.

Picking Trailers and Bulk Bins

In the orchard, the pickers empty their picking bags into either picking trailers or bulk bins. Picking trailers are normally attached to a tractor, and have a capacity of 2 to 3 tons. Some trailers may also have removable bodies that can be loaded onto a truck for transport to the packhouse. Trailers are normally serviced before the picking season starts to make sure that they are in good working order.
Bulk bins are made of wood or plastic. Both types of bins are normally transported on low-bed trailers. Bulk bins have a capacity of 350 to 400 kilograms.

Before wooden bins are used, check that there are no splinters, broken planks, screws or nails sticking out of the wood that can cause injury or damage to the fruit.

Plastic bins must be whole, clean and dry. Bin liners are used to protect the fruit against pressure injury, which leads to oleocellosis.

**Daily Picking Supervision**

It is the responsibility of the supervisor to look after and care for the people working under him.

There must be ablution facilities for the picking teams in the orchard and they must have access to drinking water. Remember that a happy team is a productive team, and one that cares about the product.

At the start of every day, make sure that every picker has the equipment that she or he needs. Also make sure that the pickers’ nails are short and that they don’t have any open injuries or sores – these must be covered with plaster.

The trailer must be parked in the orchard where the pickers do not have to walk too far to empty their bags. They should not be picking more than two rows away on either side of the trailer.

**While the fruit is being picked, check for the following:**

- Fruit are placed, not dropped, into bags
- Fruit that fall on the ground is not picked up
- Low-hanging fruit is not picked
- Pickers are not running with bags containing fruit
- Bags are emptied gently
- There are no long stems on the fruit

Before putting any fruit into a picking trailer or bulk bin, check that there is no fruit waste or plant material, like leaves or stems or twigs, in the trailer. Fruit waste can cause contamination, and twigs or stems can injure the fruit. Also make sure that plastic bins are dry, especially if it has been raining.
Be careful not to overfill picking trailers and bins, because this will cause injury to the fruit. If the fruit is particularly vulnerable to pressure injury, as is the case with certain citrus types and in certain weather conditions, picking trailers should only be filled halfway, and bins should be filled to one plank-width from the top.

**Pre-Sorting**

It is important to remove damaged and clearly infected fruit during picking. Look for fruit that is decayed, stung, injured, squashed, burst or puffy and remove them from the trailers or bins.

**Monitoring Picking Injuries**

It is very good management practice to monitor injuries to the fruit. The following method is a quick and effective way to pick up how many injuries, which are not visible to the naked eye, are being caused to the fruit.

Fill a string bag with fruit coming in from the orchard. In a large bucket, mix 5 grams of indigo carmine, a blue dye, with 10 litres of water. Place the string bag with the fruit into the bucket, and leave it for 5 minutes.

When you take the fruit out, you will be able to see injuries to the fruit. This practice does not damage the fruit – uninjured fruit can be replaced in the bins and sent to the packhouse.

If you find that there are too many injuries to the fruit, you can speak to the pickers and instruct them to be more careful.

**skills**

Please see the skills sheet on **Monitoring Picking Injuries**.
Transport to Packhouse

Once a bin has been filled, it must be covered with tarpaulin in the orchard. If it is not immediately transported to the packhouse, it must be placed in the shade, out of direct sunlight.

If bins are transported on a truck, they are stacked 2 to 3 high. Here it is especially important that the bins must not be overfilled – if they are the fruit on the top will be squashed and will push down on the fruit below. Picking trailers are also covered with tarpaulin once they are filled, and normally transported to the packhouse immediately.

During transport, care must be taken that the fruit is not unnecessarily bounced around in the bin or trailer. It is important that farm roads are repaired before the picking season and the tyre pressure of the trailers must be adjusted, to ensure as smooth a ride as possible for the fruit.

The tractor must not drive too fast on dirt roads, again to protect the fruit against damage, and to prevent dust from getting onto the fruit.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 14.1 – Mind Map and Information Leaflets

Work as a group to draw a mind map explaining the important aspects that must be supervised during picking. For each aspect that you identify, design a small information leaflet for the picking team that can be used to remind them during the daily briefing of the important points that may increase yield and maintain fruit quality.

Activity 14.2 – Research Report

Do research by consulting other resources or asking workplace experts to gather information about pre-sorting in the orchard. Explain the concept in a brief ½ page summary.

Activity 14.3 – Workplace Logbook

You have to complete the tasks associated with monitoring picking injuries as part of your practical learning. Please ensure that your workplace supervisor or team leader observe you while completing this tasks and sign off your logbook.
Activity 14.1 – Mind Map and Information Leaflets

Work as a group to draw a mind map explaining the important aspects that must be supervised during picking. For each aspect that you identify, design a small information leaflet for the picking team that can be used to remind them during the daily briefing of the important points that may increase yield and maintain fruit quality.

Attach examples of your information leaflets below.
Activity 14.2 – Research Report

Do research by consulting other resources or asking workplace experts to gather information about pre-sorting in the orchard. Explain the concept in a brief ½ page summary.
Activity 14.3 – Workplace Logbook

You have to complete the tasks associated with monitoring picking injuries as part of your practical learning. Please ensure that your workplace supervisor or team leader observe you while completing this tasks and sign off your logbook.

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Monitoring Picking Injuries

Requirements

- String bag
- Bucket (minimum 20 litre capacity)
- Clean water
- Indigo carmine

Method

1. Fill a string bag with fruit coming in from orchard
2. Put 10 litres of clean water in the bucket
3. Mix in 5g of indigo carmine
4. Place string bag with fruit into bucket
5. Leave it for 5 minutes
6. Remove fruit and inspect for injuries
Module 15
Packhouse Process Flow

Contributor: Keith Lesar

Reference
More information on packhouse design, equipment and processes can be found in the CRI Production Guidelines, volume IV.

Introduction

Citrus packhouses are central to ensuring that growers get the best possible returns for their fruit. Before deregulation, most citrus packhouses were cooperative, meaning that the fruit of all the growers in an area packed were packed at one packhouse.

Since then, many growers have built their own packhouses. This means that we now have packhouses that pack less than 50,000 cartons of export fruit, right up to huge communal packhouses that pack up to 7 million export cartons every year.

Every citrus packhouse is different – there are no standard designs or hard and fast rules about what a packhouse should look like. Packhouses are designed based on the:

- Volume of fruit they handle
- Types of citrus they pack
- Requirements of the grower or growers whose fruit are being packed there
- Markets that the fruit will go to
Packhouse Actions

Separate Fruit

There are three major market segments for citrus fruit, and they are the export market, the local market and processing, mostly for juice and oils. Of these three, the export market is by far the most profitable and the most important to citrus growers.

The first action what a packhouse must be able to do, is to effectively and efficiently separate the fruit that will go to the three major market segments.

Apply Treatments and Processes

Next the packhouse design must take into account that there are different requirements for the fruit destined for these market segments. The requirements for export fruit is by far the strictest.

The second point is then that the packhouse must be designed so that the right treatments and processes can be applied to the right fruit at the right time.

Meet Export Market Requirements

The third important point is that there are also different standards and requirements for different export fruit. The packhouse must be able to put citrus fruit of the right type, quality, and size, that has been treated in the right way, into the right packaging material and carton, and ensure that that fruit get sent to the market that it is destined for.

Enable Tracing and Tracking

Lastly, the packhouse process needs to make it possible to track fruit through the flow. In communal packhouses, one must be able to tell one grower’s fruit from the fruit of another, and in all packhouses there are traceability requirements that must be provided for.

Although this mostly has to do with recordkeeping, it is still an important factor to take into account in the process flow of a packhouse.
Maintain Fruit Quality and Safety

On top of all of this, the quality and safety of the fruit must be maintained and protected right through the process.

Packhouse Flow Model

In this module, we look at a packhouse process flow model. Remember that this is not necessarily how all packhouses work, or even the right or ideal way for a packhouse to work.

It is rather a model that meets all these requirements for a packhouse, and that includes all the steps that are taken in a packhouse.
Receive

The first step in the packhouse is to receive the fruit coming from the orchard. Fruit is delivered either in picking trailers, or in wooden or plastic bins.

It is very important to identify at this point who and where the fruit came from, and to note both the production unit code, or PUC, and the orchard number. In communal packhouses, the fruit is also weighed and this weight is recorded next to the growers’ name. If the bins are going into degreening, they must be marked with these details and with the fruit colour on arrival.

Drench

Next, if the fruit is going into degreening, it is drenched to remove the field heat, to kill fungal spores and to leave fungicide residues on the fruit to protect it during degreening.

Degreen

Fruit is taken into the degreening rooms, where they are exposed to ethylene gas at a specific concentration and for a certain period of time until they have coloured up to a certain point. Please remember that not all fruit is de-greened.

Dump and Wash

At the wet or dry dump, the fruit is brought into the packhouse process, either after it has been de-greened or directly from the orchard.

At some packhouses, fruit is dumped into water, which is the gentlest way of handling the fruit. This is called a wet dump. In other cases, the fruit is dumped onto a conveyor belt, referred to as dry dumping. The cleaner you get fruit into the fungicide bath, the better, so the fruit is washed in water in the wet dump. In a dry dump, the fruit moves over a set of brushes under nozzles that spray water on them.
Pre-Sort

The clean fruit is now pre-sorted to remove the fruit destined for processing and fruit that is badly infected and that will infect other fruit in the packhouse. Fruit that cannot possibly be exported should not be treated with fungicides and waxed.

A mechanical sizer, usually a pony sizer, is used to remove fruit that is too large or too small, and sorters remove the fruit that is too badly scarred, damaged or infected that it cannot be sold on the fresh fruit market. Factory fruit is directed to special bins, from where they are transported to the factory.

Treat – Fungicide Bath

The fruit is now put into a fungicide bath, where it is very important to get the right residue of fungicides on the fruit.

Dry

After the fungicide bath, the fruit must be dried properly before waxing. Any wet fruit going into the wax application system could cause the wax to break down, resulting in erratic wax coverage on the fruit.

Wax

Wax is applied to give the fruit that lovely shine and to prevent moisture loss and maintain the fruit quality during export. Adding some fungicides is also a standard recommendation in the wax application.

The fruit is now put through a drying tunnel again to dry the wax on the fruit properly.
Grade and Size

The fruit must now be separated into different sizes and grades, or classes.

The local market fruit is taken out and sent on a different packline that leads to where fruit are put into pockets, and export fruit is graded into a number of different classes.

Mechanical graders are used to size the export fruit. Some packhouses use optical sizers that are also able to grade for colour, shape and blemishes.

Where manual grading is used, the best graders are put in place to finally grade the export fruit.

Label

Certain markets require that fruit are labelled. In most packhouses, mechanical fruit labelling is used, but in some cases the packers stick the labels on by hand.

Pack

Export fruit is now packed in the right carton, in the packing pattern that the market requires. The fruit may also be wrapped, if that is what the market wants. In some packhouses automatic packing machines are used. Cartons are then labelled, indicating the variety, grade, size, packing date, packline number, production unit code, and packhouse code.

Weigh

Cartons are now weighed before they are stacked on pallets to make sure that they conform to the minimum weight requirements. This information is also used to make sure that trucks are not overloaded.
Palletise

The packed cartons are stacked neatly on pallets, with the stacking pattern depending on the type of carton. Corner pieces are put in place and strapping is used to stabilise and secure the pallets. For open-top display cartons, securing sheets and pallet caps are also used.

Inspect (PPECB)

The PPECB inspectors will now inspect the packed and palletised fruit to make sure that it complies with the minimum requirements for export.

Store

After being palletised and inspected, the fruit is stored either in a cold room, or in separate area in the packhouse. At some packhouses, the pallets of fruit are packed directly into shipping containers to save harbour handling costs.

Dispatch

From here the pallets are loaded onto trucks for dispatch to the harbour. Alternatively, the pallets are loaded into containers, which are either transported on trucks or by rail.

Other Packhouse Tasks

This is the end of the process flow in the packhouse, but there are various other functions that must be applied generally.
Packhouse Sanitation

The packhouse must be cleaned and sanitised daily – remember that you are working with a perishable product that is vulnerable to infection.

Quality Control

It is very important that food safety and quality requirements are strictly adhered to. Throughout the process, there should be sample checks to ensure that grading and sizing are being done correctly, that fruit is not injured during the packing process, and that the right fruit is ending up in the right place.

Personal Hygiene

Every person that works in the packhouse must be aware of the personal hygiene requirements for working with a perishable product.

Every worker must wear protective clothing, and specifically a hair covering, overalls and, in some cases, gloves. The worker must keep his or her protective clothing clean and neat at all times, and make sure that it is whole and in a good condition.

Workers must wash their hands regularly, and their nails must be kept short so that they will not injure the fruit. Workers should not have any open injuries or sores – these must be treated and covered with plaster or bandages.

No eating, drinking or smoking is allowed inside a packhouse.

Workers must also be aware of all the possible dangers that the machinery, equipment and chemicals used in the packhouse, pose to their own health and safety.
active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 15.1 – Poster Design**

Use poster paper to trace the outline picture of a person. Now find or draw pictures of all the protective clothing and gear that should be worn, also showing how it should be worn, to ensure staff safety and hygiene.

**Activity 15.2 – Workplace Flowchart Presentation**

Draw a flowchart to show the sequence of events in your specific packhouse. Be creative and add as many pictures and information as possible in order to explain the process flow.

Now present you flow chart to the rest of your class or your colleagues during a 5-10 minutes multimedia presentation.
Activity 15.1 – Poster Design

Use poster paper to trace the outline picture of a person. Now find or draw pictures of all the protective clothing and gear that should be worn, also showing how it should been worn, to ensure staff safety and hygiene.

Copy your drawing below and add keynotes.
Activity 15.2 – Workplace Flowchart Presentation

Draw a flowchart to show the sequence of events in your specific packhouse. Be creative and add as many pictures and information as possible in order to explain the process flow.

Now present your flow chart to the rest of your class or your colleagues during a 5-10 minutes multimedia presentation.
Reference

For more information on drenching, please consult the CRI Production Guidelines volume IV.

Introduction

When fruit arrives at the packhouse and before it goes into the degreening room, it is put through the drench.

Fungicides are mixed into the drench water to assist with disease control. The second reason for drenching fruit is to remove the field heat from the fruit, to prevent moisture loss from the fruit rind.

Drenching Chemicals

First of all, we got to treat the fruit after harvest before it goes into degreening to protect the fruit against a number of postharvest pathogens like the penicillium species, sour rot and some latent pathogens like Diplodia and anthracnose.

When we start drenching we got to make sure which chemicals need to be applied. Make sure that the chemicals is mixed adequately and also that these chemicals stay in suspension in the tank of the drencher.

It is also important to take care of which market the fruit will be sent to, in order to prevent the application of certain chemicals which is not allowed for certain markets, for instance Japan or USA.
Coverage

Very important about drenching is, first of all, you must make sure that you get proper coverage of the chemical mixture applied to the fruit and that you have an adequate contact time of at least one minute onto the fruit.

Secondly you must make sure that you apply enough volume of the mixture onto the fruit, otherwise you won’t get the proper coverage of the fruit.

Fruit Drying

Another important factor with regards to drenching is that one should allow the fruit to dry off properly after drenching.

If the fruit is wet when entering degreening, the ethylene gas will be applied spottily onto the fruit and degreening will not take place properly.

We therefore, after drenching, stack the fruit aside and let it stand for approximately one day before it goes into degreening.

summary

Drenching Dos and Don’ts

- Check that chemicals are acceptable to target markets.
- Mix chemicals properly and continue to agitate to keep them in suspension.
- Check **volume** and **exposure time** (at least **1 minute**) to ensure adequate coverage.
- Allow fruit to dry for at least one day before degreening.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 16.1 – Group Activity

Discuss in your groups why fruit should be drenched before degreening, taking into account the sanitizing agent or fungicides that can be used.
Activity 16.2 – Workplace Research

Do workplace research to determine how drenching is done in your packhouse. Draw a poster or flowchart, explaining all the details of the process. Make sure that your poster communicates the following information:

➢ At what stage of the packhouse process flow or in the packline is fruit drenched?
➢ What equipment is used to drench the fruit?
➢ What are the standard operating procedures for drenching in your packhouse?
➢ Are there any potential hazards or cautions that workers involved in drenching should be aware of, in terms of food safety and residues, and personal health and safety?
Activity 16.1 – Group Activity

Discuss in your groups why fruit should be drenched before degreening, taking into account the sanitizing agent or fungicides that can be used.

Make keynotes below on your discussions and conclusions.
Activity 16.2 – Workplace Research

Do workplace research to determine how drenching is done in your packhouse. Draw a poster or flowchart, explaining all the details of the process. Make sure that your poster communicates the following information:

✓ At what stage of the packhouse process flow or in the packline is fruit drenched?
✓ What equipment is used to drench the fruit?
✓ What are the standard operating procedures for drenching in your packhouse?
✓ Are there any potential hazards or cautions that workers involved in drenching should be aware of, in terms of food safety and residues, and personal health and safety?
Module 17
Degreening

Presenter: Paul Cronje

Reference

More information on degreening can be found in the CRI Production Guidelines, volume IV.

Introduction

Citrus fruit is judged by the housewife in the overseas supermarket mostly by what it looks like. It is for this reason just as important to produce a good looking fruit as one that tastes good.

Degreening means accelerating the natural colour change in fruit by using the ripening hormone ethylene. Fruit is exposed to ethylene gas in specially built rooms in the packhouse, for a specific period of time.

Ethylene

Ethylene is a maturation hormone that speeds up all cellular processes associated with the ripening, for instance the breakdown of acids that makes the fruit sweeter.

It also has to do with the abscission layer. When the rind is for instance damaged by a bird, the wound secretes ethylene and the fruit falls from the tree quicker because of accelerated ripening.

The specific action in the rind naturally is to break down the chlorophyll pigments in the flavedo. This process speeds up, and the orange carotene pigments also synthesise quicker. The degreening process has many different steps.
Chlorophyll Pigments

Chlorophyll pigments are the green pigments that give tree leaves and young fruit their colour, and are critical to photosynthesis.

Carotene Pigments

Carotene pigments are the orange pigments that give citrus fruit their colour. As chlorophyll pigments are broken down, carotene pigments synthesise faster and faster, thereby causing the fruit to change colour from green to orange.

Flavedo

The flavedo is the coloured part of the fruit rind, where chlorophyll pigments are broken down and carotene pigments are synthesised.

Fruit Preparation

Harvesting

Degreening starts in the orchard where colour must develop to a certain level. This is called colour break and must take place before fruit is picked. The internal quality of the fruit must also be acceptable before it is harvested. There must also be no blemishes on the fruit rind if it is to be degreened.

The second step is during picking in the orchard to separate fruit with more colour development from fruit that requires degreening, as there can be significant variation in colour development on a tree. The next step is to damage fruit as little as possible, since any injuries to the fruit will become obvious later.

Drenching

Next the fruit is transported to the packhouse, where it is drenched immediately with a mixture of water and fungicides to prevent decay. This practice also takes the field heat out of fruit and prevents moisture loss from the rind. After drenching, the fruit must be left to stand for 24 hours, to allow the water trapped between the fruit to evaporate. Any water on the rind will cause green spots where the ethylene couldn’t penetrate.
Reference

Please consult module 16 – Drenching for more information on this practice.

Degreening Procedures

From there the fruit is put in a degreening chamber. The room must not contain any old, spoiled fruit that can transmit fungal spores. The area must also be regularly sanitised to remove any fungal spores on the surfaces.

Marking

In the degreening chamber every crate must be marked, stating the orchard of origin, as well as the colour the fruit was before degreening.

Ethylene Gas Release

Now the degreening chamber can be closed and the ethylene gas released. The ethylene should be between 1 and 3 parts / million, but not higher than 5 parts / million. Very high ethylene levels cause excessive respiration in the rind that will lead to negative aspects such as physiological defects.

Atmospheric Conditions

Another three aspects that must be monitored apart from ethylene levels are:

- Temperature
- Humidity
- CO₂ levels
Temperature is very important and the rule is: the thinner the fruit rind, the lower the temperature during degreening, even though degreening is better at higher temperatures. Satsumas are degreened at 18-21°C; Clementines, Novas and Mandarins at 19-22°C; navels and other oranges at 21-24°C; grapefruit and lemons at 23-25°C.

It is critical to control relative humidity in order to prevent moisture loss. The vapour pressure deficit in a degreening chamber is very high, so you can get a lot of moisture moving out of fruit.

Ideally, humidity must be kept between 94-96%, but it should not be lower than 90% for longer than an hour. This usually happens when the doors are opened and hot, dry air comes in.

$\text{CO}_2$ levels in a degreening chamber must be monitored carefully. $\text{CO}_2$ competes on a cellular level with ethylene. $\text{CO}_2$ binds on the cell, so the fruit must be exposed to degreening for longer, leading to higher respiration and deterioration in fruit quality.

To protect fruit from high $\text{CO}_2$ levels, $\text{CO}_2$ must be extracted by ventilation fans regularly from the chamber, and kept at a level lower than 0.3%, or 3,000 parts per million.

**Monitoring**

The next aspect of degreening is controlling and monitoring the process throughout. It is essential to buy proper equipment to monitor temperature, humidity and gas levels, and not to only rely on automated equipment.

These parameters must be monitored, because things can go wrong that will affect fruit quality negatively.

Fruit must be checked regularly. It is important to check colour development by sunlight or a torch, and not under neon lights as they can distort the colour.

**Degreening Time**

One of the most critical aspects of degreening is that it must happen as quickly as possible but never for longer than 72 hours.
Post-Degreening Procedures

Finally once the fruit is taken out of the degreening room, it must be kept at normal atmospheric conditions for 6-10 hours.

This will bring the gas composition of the rind and the environment in equilibrium. This means that oxygen must enter the rind and CO₂ and ethylene must escape before the fruit is packed.

This is also important to allow the turgidity of the rind to decrease. If not the oil glands can be damaged during packing, leading to oleocellosis.

After degreening there will be more blemishes on the rind. This is not as a result of degreening, but due to injuries during picking. The injuries are more obvious now because of the orange pigment development.

summary

Degreening Dos and Don’ts

- Degreen fruit only after colour break.
- Pre-sorted fruit according to colour.
- Fruit must be dry – leave for at least 24 hours after drenching.
- Ethylene gas concentration – 1-3ppm, never higher than 5ppm
- Temperature is according to rind thickness:
  - Satsumas – 18-21°C
  - Clementines, Novas, Mandarins – 19-22°C
  - Oranges – 21-24°C
  - Grapefruit, lemons – 23-25°C
- Relative humidity – 94-96%
- CO₂ levels – below 0.3%
- Fruit colour must be checked regularly by natural or torch light.
- Degreening must never take longer than 72 hours.
- Fruit must be kept at normal atmospheric conditions for 6-10 hours after degreening.
Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 17.1 – Flowchart**

Do workplace research to determine how degreening is done in your packhouse. Draw a poster or flowchart, explaining the details of the process. Make sure that your poster communicates the following information:

- At what stage of the packhouse process flow or in the packline is fruit degreened?
- In what condition must the fruit be before it is degreened?
- What are the standard operating procedures for degreening in your packhouse, including the limits and settings for the process?
- Are there any potential hazards or cautions that workers involved in degreening should be aware of, in terms of food safety and residues, and personal health and safety?

**Activity 17.2 – Internet Research**

Do research on the internet to find out why ethylene is so effective for degreening citrus.
Activity 17.1 – Flowchart

Do workplace research to determine how degreening is done in your packhouse. Draw a poster or flowchart, explaining the details of the process. Make sure that your poster communicates the following information:

- At what stage of the packhouse process flow or in the packline is fruit degreened?
- In what condition must the fruit be before it is degreened?
- What are the standard operating procedures for degreening in your packhouse, including the limits and settings for the process?
- Are there any potential hazards or cautions that workers involved in degreening should be aware of, in terms of food safety and residues, and personal health and safety?
**Activity 17.2 – Internet Research**

Do research on the internet to find out why ethylene is so effective for degreening citrus.

Write a short report on your findings below.
Module 18
Fruit Washing Systems

Presenter: Keith Lesar

Reference
More information on fruit washing can be found in the CRI Production Guidelines, volume IV.

Introduction

The wet or dry dump is where fruit enters the packhouse for the first time, either after going into degreening, or directly from the orchard.

At this point, the fruit must be washed to remove spores, organic material, and dirt that may have collected on it in the orchard and during picking and transport.

Washing Systems

There are two types of washing systems in a packhouse. There is a dry dump system and there is a wet dump system. Some packhouses have both systems in place, and they use both systems for washing the fruit. Most packhouses only have one or the other. The cleaner you get the fruit into the fungicide treatments, the better.

Wet Dump System

The softer option is the dump tank option, where you are dumping fruit directly into a bath with a water system.

That is a softer handling system for soft citrus, and is in use especially in certain areas that produce a lot of soft citrus, in other words the easy-peeler types like naartjies. Soft citrus are very susceptible to injuries and the softer the handling of the fruit in a washing system the better it is on the fruit.
The spores and the organic material wash off the fruit into the water. That water has to be sanitised by means of a sanitising system. In the packhouses in the citrus industry, we use chlorine as a form of sanitizer and we use quaternary ammonium compounds. Those are the two compounds that we have for those purposes in the industry.

These products are added into a dump tank. Depending on the size of the dump tank and the concentration recommended, the amount of product will differ. The packhouse must work out their concentrations. They have a test kit that they can test that concentration on a regular basis through the day’s production to maintain the concentration at a level where it is going to work efficiently to keep that system sanitised.

**Dry Dump System**

The same applies to the other washing system, the dry dump washing system, where the fruit moves over a belt and over a bed of brushes with a set of nozzles.

The water is kept and sanitised in a reservoir below the washing system and it gets pump through the nozzles, onto the brushes and the fruit moves over the brushes and gets sanitised that way. This works just as effectively as your wet dump system.

The water used in these washing systems has to remain clean, in other words it has to be sanitised. All the spores that are washed of from the fruit into the system have to be killed. If the concentration of the sanitizing agent is not maintained at the correct levels, a build up of spores will occur. The spores start multiplying in the system and become a source of inoculum.

**System Sanitisation**

So it is vitally important to keep the system as clean as possible right throughout the day’s production. At the end of the day there will be a build-up of spores, a certain amount of spores, and there will be a build-up of organic material, dust and mess in the system.

This build-up eventually leads to a formation of bio-film round the edge of the system, which is an accumulation of microorganisms, fungi, bacteria and your whole system becomes soiled.
So at the end of the day’s production, the systems have to be replenished, on a daily basis. The water has to be replaced in the dump tank – clean water for the next day’s production – so you don’t get a carry over of a build-up of millions of spores and allow it to become so soiled.

At the end of the day, it becomes like a pea soup that you are washing your fruit in. So vitally important, on a daily basis to change those washing systems around, and replenish them and start with a new, fresh system the next day.

summary

Washing Systems Dos and Don’ts

- Use a **sanitizing agent**, such as chlorine or quaternary ammonium compounds, in water.
- Use a **test kit** to check the concentration of the sanitizing agent regularly.
- Check **brushes and rollers** regularly to avoid injuries to fruit.
- **Replace water** in systems on a daily basis.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 18.1 – Group Discussion**

Discuss in your the pros and cons of using a wet dump system or a dry dump system. Make keynotes in your workbook on the conclusions that you reach.

**Activity 18.2 – Research Report**

Write a 2-page report on the fruit washing system used in your packhouse, including details on the monitoring activities that are in place to ensure the correct sanitation. Include a diagram showing the flow of the water through the washing system.
Activity 18.1 – Group Discussion

Discuss in your the pros and cons of using a wet dump system or a dry dump system. Make keynotes below on the conclusions that you reach.
Activity 18.2 – Research Report

Write a 2-page report on the fruit washing system used in your packhouse, including details on the monitoring activities that are in place to ensure the correct sanitation. Include a diagram showing the flow of the water through the washing system.
Module 19
Packhouse Sanitation

Contributor: Keith Lesar

Reference
Please consult the CRI Production Guidelines volume IV for more information on packhouse sanitation.

Introduction

Packhouse sanitation is a critical step to prevent fruit contamination in the packhouse, and especially to prevent fruit from becoming re-contaminated after it has been treated.

The idea is to keep the spore load inside the packhouse as low as possible, by not allowing infected fruit into the packhouse in the first place, and by immediately removing infected fruit from the packhouse if they are found.

Fruit that were removed after being treated with fungicides and during grading should be removed and stored outside the packhouse, because if they decay inside the packhouse, it promotes the development of spore populations that are resistant to fungicides.

Packhouse sanitation also creates a clean working environment for packhouse workers.

An effective packhouse sanitation plan consists of a multifaceted approach. Actions that must be included in this plan are:

- Effective pre-sorting
- Removing and destroying decayed and infected fruit
- Equipment and work area sanitation
- Personal hygiene
- Good recordkeeping practices
Pre-Sorting

Preventing infected and decayed fruit from entering the packhouse is the first very important packhouse sanitation action.

In degreening rooms, fungal diseases start to develop faster because of the favourable conditions in the rooms. There is therefore often severely decayed fruit in the bins when they come out of the degreening rooms. You may also find decayed and infected fruit in the bins coming from the orchard.

These green bombs must be removed before the fruit is dumped into the washing system, and must never be allowed to enter the packhouse. This is the main purpose of pre-sorting.

Even though the fruit washing system contains a sanitizer, green bombs will still contaminate the rollers and brushes and cause the system to become dirty, which means that it will have to be replenished more often. In this regard it is also extremely important that concentrations of sanitising agents in washing systems must be managed very carefully.

During pre-sorting fruit that is obviously not fit to be exported is also removed and channelled to the local market or processing bins. This fruit must be kept outside the packhouse, or in an area that is separate from where the export fruit is handled, and dispatched to its destination as soon as possible.

It will sometimes happen that contaminated fruit is missed during pre-sorting. If such fruit is found on the grading line or in a packing bin, or anywhere else in the confines of the packhouse, the packline must be stopped immediately and the area must be disinfected.

Removal of Fruit

Never allow any fruit to lie around in the packhouse and develop spores. All fruit that has been culled during sorting and grading, or that has fallen on the floor or that has been discarded for any other reason, must be removed from the packhouse environment regularly.

Fruit that is removed from the packline after the fruit were treated with fungicides are especially dangerous. The spores that are active on this fruit are most likely resistant, and can cause major losses.
Also remember that sour rot can be spread from infected to healthy fruit in the packhouse by vinegar flies that are attracted to the sour odour. This fruit must not be allowed to remain in the packhouse environment.

The golden rule is if it is not going to be exported, it must not be in the packhouse. Store fruit that is destined for the local market or for processing outside the packhouse, especially after the fruit has been treated with fungicides.

Fruit that is severely infected and that cannot be sold on any market must be collected, removed, and destroyed, either by chopping it up at a sight away from the packhouse and allowing it to dry out in the sun, or by burying it.

The export fruit must also not be allowed to stay in the packhouse for long periods of time after it has been packed, especially in hot conditions.

Remember that a number of the postharvest diseases develop faster at higher temperatures. Export fruit must either be pre-cooled at the packhouse immediately to stop the development of diseases, or dispatched to pre-cooling facilities.

Store your retention samples of each export batch in a separate area, and check them regularly for the development of diseases.

**Retention Samples**

Retention samples are made up of one carton from each batch of fruit packed in the packhouse. These cartons must be kept for at least three weeks at ambient temperature, and checked regularly for the development of postharvest diseases.

**Equipment and Work Area Sanitation**

In terms of equipment and work area sanitation, the three important aspects are the:

- Sanitising agents that are used
- Method that is used to apply them
- Frequency of application
Sanitising Agents

**Quaternary Ammonium Compounds**

The sanitising agents that are used most commonly in packhouses are quaternary ammonium compounds. Also known as quaternary ammonium salts, these salts are able to clean and disinfect a surface, no matter what the pH balance of the area is.

This property makes quaternary ammonium compounds ideal for cleaning and disinfection in packhouses, where citrus oils and juice can create areas of differing pH that have to be sanitised.

**Recommended Concentrations**

To ensure effective sanitation, the concentration of the active ingredient must be carefully managed when the cleaning solution is mixed.

There is a range of quaternary ammonium compounds on the market. Always follow the manufacturers’ recommendations, as the volume of active ingredients is each product can be different.

**Cleaning Methods**

The cleaning solution is now applied to all surfaces in the packhouse, including surfaces that come into contact with fruit, such as grading tables, brushes, rollers, sizer cups, and packing tables, and the floors and walls of the packhouse. Also remember to sanitise all picking bins and trailers after they have been emptied and before sending them back to the orchard, especially bins that was used for degreening.

It is important to clean all equipment and work areas thoroughly. The most thorough way of applying the cleaning solution is by using knapsack sprayers to douse equipment with the solution, and to use clean cloths to wipe down other surfaces in the work area with the solution. Follow the manufacturer’s recommendation in terms of the concentration and the contact time of the solution on surfaces.
Walls and floors must be cleaned daily, because fungal spores can become airborne. Dirty walls can lead to contamination of fruit by infecting personnel’s hands and clothes and then being carried to the fruit.

**Frequency**

It is important to sanitise the packhouse regularly. Sanitisation costs money and time, and it must therefore also be done efficiently and effectively.

All packhouse areas should be cleaned and disinfected at least once a day. Sensitive areas, such as the pre-sorting lines that easily become infected, must be cleaned more regularly, preferably at every shift change. A cleaning schedule should be used to ensure that the frequency of cleaning is maintained.

Remember that if contaminated fruit is found on the grading line or in a packing bin, the whole line must be stopped immediately and disinfected.

**Personal Hygiene**

Ensuring that packhouse personnel follow good personal hygiene practices is part of a packhouse sanitation strategy, as it will prevent spores from spreading.

Workers must always have short nails and clean hands, and they should not have any open sores or injuries. They must wear protective clothing when in the packhouse, specifically hair coverings, overalls, and, in some cases, gloves. Clothing must be kept neat and clean.

No jewellery, rings, watches, or necklaces are allowed in the packhouse, as jewellery can cause injuries to fruit and also be a source of contamination.

Notices should be posted in the locker room and bathroom areas to remind workers to maintain their personal hygiene, and especially to wash their hands regularly. Supervisors must check all workers before they are allowed in the packhouse to ensure that these practices are adhered to.
Recordkeeping

Recordkeeping is essential in managing and controlling a packhouse sanitation system.

Records must show the frequency of cleaning, as well as the chemicals used and the concentrations of those chemicals in the cleaning solutions. Records should also be kept of personal hygiene inspections and any emergency, or unscheduled, cleaning that takes place.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 19.1 – Mind Map

An effective packhouse sanitation plan consists of a multifaceted approach. Draw a detailed mind map explaining how the following actions associated with packhouse sanitation are handled in your own workplace or at the packhouse where you are completing your practical training:

✓ Effective pre-sorting
✓ Removing and destroying decayed and infected fruit
✓ Equipment and work area sanitation
✓ Personal hygiene
✓ Good recordkeeping practices

Add information on your mind map about:

✓ Why packhouse sanitation is important
✓ Recommendations for your own packhouse on how each of the processes may be improved

Activity 19.2 – Workplace Logbook

You have to complete the tasks associated with cleaning and sanitation as part of your practical learning. Make sure that your workplace supervisor or team leader observe you while completing these tasks and sign off your logbook.
Activity 19.1 – Mind Map

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✓ Good recordkeeping practices

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✓ Why packhouse sanitation is important
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Module 20
Hot Water Fungicide Bath

Presenter: Keith Lesar

Reference
For more information on the application of fungicides in the packhouse, please consult the CRI Production Guidelines, volume IV.

Introduction

Fruit coming from the orchard is often to a lesser or greater degree contaminated with fungal spores. These spores are all around us and will cling to any surface and wait for the right conditions to start propagating.

Citrus fruit are vulnerable to fourteen common postharvest pathogens that can infect the fruit, and destroy its internal and external quality. It is important that the fruit is treated to kill the spores, and to inhibit infection and loss of quality.

The main weapon used in the packhouse to fight these pathogens is the hot water fungicide bath. The effectiveness of this treatment depends on three main factors. These are:

- The temperature of the water in the bath
- The concentrations of the fungicides used
- The contact time of the fungicide mixture with the fruit

The fungicide treatment leaves a residue on the fruit that protects the fruit during transit to the overseas market, and the residue will be insufficient if any of the factors mentioned above are neglected.
Water Temperature

Most of the packhouses in the industry use hot water fungicide baths. Some packhouses prefer to use a cold water bath, but we recommend the use of a hot water bath because hot water serves three purposes. It helps with the drying of the fruit prior to waxing, the uptake of the fungicide into injury points, where there could be an already established infection, and the activity of fungicides is more efficient in a hot water system.

It is important to have the fungicide baths set at the right temperatures. In years gone by, ten years ago, we were recommending temperatures of 40°C, early in the season. But things have changed through the years. Changing environmental conditions have caused more and more rind conditions on the fruit, and the fruit is becoming more sensitive to these rind conditions. To limit these injuries to the fruit rind we decided to drop the recommended treatment temperature down to between 30 and 35°C.

Contact Time

Another important aspect of the fungicide bath treatment is the exposure time of the fruit in the bath.

Fruit comes through the washing system directly into the fungicide bath where it is exposed to the mixture of fungicides and water. To get the right residue on your fruit it must be exposed to this fungicide mixture in the bath for a sufficient time. The industry recommendation is a minimum exposure time of one minute to ensure effective treatment.

Unfortunately, when baths were developed and introduced into the industry, baths weren't properly researched. Most baths in citrus packhouses are too short, only exposing the fruit to the fungicide mixture for 15 to 30 seconds.

This lack of exposure is reflected in the low residue that is eventually left on the fruit. History has shown us that, throughout the years in the usage of these baths, that when the residue is too low on the fruit it is not the ideal situation. We need to set the right type of residue so the fungicide can do the work properly on the fruit during transit to the overseas markets.
Fungicides

The fungicides cost a lot of money. Packhouses have complained about the costs of replenishing fungicide baths on a daily basis.

In order to make the fungicide mixture last longer, the whole idea is to get your fruit in there as clean as possible. To do this, the washing system is the first line of attack. An effective fruit washing system will get the fruit into the fungicide baths as clean as possible.

Then, with clean fruit entering the bath, packhouses can run a week with a clean fungicide bath and change the fungicide mixture on a weekly basis.

But, at the end of the day, if you have any shortcuts at the beginning of the treatment process, before the fruit is packed for the overseas market, and the fruit arrives in the overseas market in poor condition, poor quality fruit, highly infected fruit, full of waste, who is going to pay for it? It comes back to the packhouse.

Fungicide Concentrations

The most commonly used fungicides in the hot water fungicide bath are Guazatine and Imazalil.

By treating fruit with a too low fungicide concentration, we allow fungi populations to develop resistance. The same applies to contact time and temperature.

The industry recommendation is a contact time of at least one minute, at 30 to 35°C, using a concentration of 500ppm Imazalil and/or Guazatine at a concentration of 1000ppm.

We are dealing with about 12 to 14 different postharvest pathogens, and we have three or four fungicides to take care of these pathogens.

So the packhouse has an option in choosing which fungicides to use where. A number of years ago we were recommending the use of two different fungicides in the bath.
Fungicide Resistance

Our most important fungicide is Imazalil. Imazalil takes care of your green and blue mould infections. During the past couple of years we have seen a build up of resistance to Imazalil, so now we have other strategies in place. In order to combat resistance, we introduced Guazatine into the bath as well, which is a fungicide primarily for sour rot, but is very effective against green and blue mould as well.

You now have two different fungicides together in a mixture, which is the preferred way to go to prevent resistance from building up. Both are effective against green and blue mould and have different modes of action. This makes it ideal for one fungicide to knock out Imazalil resistant spores coming into the system, and vice versa with Guazatine resistant spores coming into the system being knocked out by the Imazalil.

More on information on how spore populations develop resistance to certain fungicides can be found in Module 22 – Resistance Management.

Top-Up Procedure

It is recommended that you top up the fungicides after a specific amount of fruit has gone through the bath. For example, if you were to pack 60 tons of fruit per a day, you could divide this amount into three, and top up after every 20 tons. Top up according to the stipulated concentration of fungicide to water ratio.

With a mixture of the two fungicides we cannot do the titration to determine the fungicide concentration in the system. So then we have to exclusively rely on topping up procedures and a topping up procedure was worked out in the industry and packhouses have been topping up the fungicide bath according to this procedure.

Also again this procedure is based on a certain amount of tonnage through the bath and the topping up procedure we have has worked fairly well. It is a bit of a thumb suck situation where you do not exactly know that you have the right concentration on your fruit but it has been working pretty well over the years.
Titration

A procedure has now become available where the concentrations of both Imazalil and Guazatine in a bath can be tested. This is done by firstly separating the two components and then by using a titration procedure to determine the separate concentrations. If these test cannot be performed then other options are available.

For more information on titration procedures, please look at Module 21 – Titration.

Fungicide Treatment in Wax

To ensure effective treatment, we have recommended that packhouses use Imazalil in the bath on its own, do the titration, top up according to the titration and manage our most important fungicide in the bath on its own, then going to the wax application, and applying the rest of your fungicides in the wax.

So we are withdrawing Guazatine out of the fungicide bath putting it in the wax and using Imazalil on its own and managing the use and the proper effect of your main fungicide which is Imazalil.

Conclusion

Inadequate treatment with fungicides leads to an insufficient residue on the fruit, and increases the development of fungal spore populations that are resistant to a certain fungicide.

It is therefore important that this critical step be monitored effectively through titration, and that adjustments are made on a regular interval to ensure the efficiency of the fungicides used.

It must also be kept in mind that certain markets prohibit the use of certain fungicides and all regulations concerning the use of fungicides must be thoroughly researched before the packing season begins.
summary

Hot Water Fungicide Bath Dos and Don’ts

- Use a hot water bath, as opposed to a cold water bath.
- **Water temperature** – 30-35°C
- **Contact time** – at least 1 minute
- **Fungicide concentrations** – Imazalil 500ppm and Guazatine 1000ppm.
- **Effective fruit washing** means the fungicide bath will last longer without being replenished.
- Use titration regularly to determine the concentrations of fungicides in the bath, and top up accordingly.
- As an alternative to having both Imazalil and Guazatine in the hot water bath, split fungicide applications between the hot water bath and the wax application.
- Research market requirements in terms of the acceptability and residue levels of fungicides.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 20.1 – Practical**

Take a stopwatch and measure exactly how long the fruit in your packhouse spends in the hot water fungicide bath, at different times during shift. Note specifically whether there is a difference between the time spent in the bath if the packline is running at half capacity and when it runs at full capacity. Once you have collected this data, analyse it and express an opinion on whether it is adequate or not. Make recommendations for improvements if necessary.

**Activity 20.2 – Group Discussion**

In your group, note and discuss the fungicides used in your hot water fungicide bath and the monitoring activities that take place to ensure effective treatment. Compare these to the recommendations in this module and note ways in which your system can be improved.
Activity 20.1 – Practical

Take a stopwatch and measure exactly how long the fruit in your packhouse spends in the hot water fungicide bath, at different times during shift. Note specifically whether there is a difference between the time spent in the bath if the packline is running at half capacity and when it runs at full capacity. Once you have collected this data, analyse it and express an opinion on whether it is adequate or not. Make recommendations for improvements if necessary.
Activity 20.2 – Group Discussion

In your group, note and discuss the fungicides used in your hot water fungicide bath and the monitoring activities that take place to ensure effective treatment. Compare these to the recommendations in this module and note ways in which your system can be improved.
Module 21
Titration
Presenter: Johann van der Vyver

Introduction

Monitoring the fungicide concentrations in the hot water fungicide bath is vital to ensure the effectiveness of anti-fungal treatment.

Too low a concentration will mean ineffectual treatment, and will promote resistance of fungi to fungicides, and too high a concentration will mean unnecessary expenditure on the part of the packhouse.

The development of fungicide resistance in certain organisms has made it necessary to use a combination of fungicides in the fungicide bath. This has made the job of determining fungicide concentrations all the more difficult.

Titration Principle

The principal of titration is based on determining the concentration of a substance by adding another substance in small increments, with which it reacts.

Because we can measure how much of the second substance we need to add in order to get a specific reaction, we can use the known concentration to calculate the unknown.

In the case of fungicides, such as Imazalil and Guazatine, the concentration of a given constituent in solution, in this case the fungicides, is determined by titrating the unknown solution with a known volume of a standard solution, using an indicator to observe a colour change, and achieving a titration end point that enables you to determine the fungicide concentrations.
Titration Practices

Determining Multiple Fungicide Concentrations

In the past it has been easy to determine the Imazalil concentration in the fungicide bath, and to correct the levels when necessary. The problem we faced was that when Guazatine was added to the bath, the Imazalil level could not be determined.

Recently a new method has become available where Imazalil can be determined in the presence of Guazatine, and of course one would also be able to determine the Guazatine concentration.

The packhouse manager can therefore make adjustments to ensure that either or both the fungicides are at the correct levels, thereby properly controlling postharvest diseases.

Titration Chemicals

The chemicals used during titration are fairly standard for any citrus packhouse.

Firstly we use normal sulphuric acid, secondly dichloromethane and thirdly an indophenol blue solution. The fourth chemical that is used in the titration process is sodium lauryl sulphate.

Two other chemicals that we use, if there is Guazatine in the fungicide bath, are a phenolphthalein solution and 0.1562 normal sodium hydroxide.

Correction Factor

It is important to remember during the whole titration process that, when a reading is obtained from your solution in the fungicides baths, for example 500 parts per million, then a 25% correction factor applies.

This is an international standard. Therefore if the reading is 500 parts/million, it may just as well be 375 or 625 parts/million.
**Topping Up the Fungicide Bath**

Before starting with the titration process, it is strongly recommended that you know one of following two things: you must either know how much water is in the fungicide bath, as the water volume plays a role at the end of the titration process, (you must know with what volume of water you are working) or, and this is strongly recommended, you must correct the water level to the original level before titration, so you will know you are back on for example 2,000 or 3,000 litres.

**Taking a Sample**

Once the bath is refilled to its original level, it must be mixed well with the fungicide, and a sample of 25ml must be taken and put into an Erlenmeyer glass flask.

**Imazalil Titration**

**Equipment**

When testing a solution containing only Imazalil we need the following equipment:

- 25ml burette (0.02 ml graduation)
- 1 x burette stand with clamps
- 1 x 250ml volumetric flask
- 1 x 250ml Erlenmeyer flask
- 1 x indicator dropper bottle
- 1 x plastic wash bottle
- 1 x funnel
- 1 x 250ml beaker
- Measuring cylinders, one each of 25ml, 100ml and 250ml

An Imazalil fungicide concentration was prepared for this demonstration. We’ll follow established procedures. A number of chemicals are added to finally determine the concentration of this solution. 25ml of the Imazalil solution is measured in a cylinder, and poured into an Erlenmeyer flask, to which chemicals will be added.
Adding Chemicals

10ml sulphuric acid is added first. The solution must be mixed well after each new chemical is added. The 10ml sulphuric acid is followed by 25ml of dichloromethane. Next we add the indicator, indophenol blue. Normally we add 10-15 drops, but actually one is only looking for a nice blue colour.

Titrating the Solution

The solution in the Erlenmeyer is now slowly titrated with sodium lauryl sulphate, drop by drop. The flask is swirled until the solution is colourless, which is the endpoint.

Determining the Concentration

A reading is now taken – this one is 4.6ml. We have achieved the endpoint and the result is 4.6ml. If this volume is entered into the standard formula, the result will be 520 parts/million Imazalil. This is the correct standard for the fungicide bath. We normally want about 500 parts/million in the bath.

Imazalil and Guazatine Titration

We have now seen how titration is used to determine the concentration of Imazalil in a fungicide bath that only contains the one fungicide.

When we have a fungicide bath that contains both Imazalil and Guazatine, and we need to determine the concentration of both fungicides, the two must be separated from each other before we can accurately determine the concentration of each.
Separating the Solution

I have put 25ml of this prepared solution into an Erlenmeyer flask. The first step is to add 10-15 drops of phenolphthalein colouring. When sodium hydroxide is added, the colour changes to pink because the pH increases. We want to increase the pH so that the Imazalil free base will settle, and we can continue to separate it from the Guazatine. The next step is to add 50ml dichloromethane. This must be mixed properly.

This is now transferred to the separating funnel, and after 5 minutes we will see the Imazalil and Guazatine solutions separate.

The transparent organic phase of the dichloromethane sinks to the bottom, and that contains the Imazalil component. The pink solution on top is still an aqueous phase, and contains the Guazatine.

The titration method that is now followed is the same as for the Imazalil titration that we already know. All we have done so far, was to separate the two actives. The transparent part is siphoned and used for titration, and then we will titrate the top aqueous phase.

By adding sodium hydroxide to the Imazalil and Guazatine solution, the pH of the solution rises, causing a separation between the aqueous and organic phases in the solution.

Guazatine is found in the aqueous phase because it is a soluble solid, while Imazalil is an insoluble solid and is therefore found in the organic phase.

Siphoning the Organic Phase

We now siphon the organic phase at the bottom, containing the Imazalil. It is important during siphoning not to get any of the top content mixed in. We will then be back where we started, with Imazalil mixed with Guazatine.

As you can see, we now have the clear, organic phase containing the Imazalil, in the Erlenmeyer flask. We now proceed with the Imazalil titration process after adding one or two substances before titrating.
**Imazalil Titration**

To the organic phase with the Imazalil we now add 10ml sulphuric acid.

Before, when it was only Imazalil, we would now have added dichloromethane, but this solution already contains dichloromethane, it is the organic phase. We therefore do not add dichloromethane, but proceed with adding the indophenol blue indicator.

The solution is now ready and can be titrated with sodium lauryl sulphate, and the millilitres can be noted at the endpoint.

**Guazatine Titration**

After the aqueous phase has been drained, 10ml sulphuric acid is added. The colour will change because the pH is lowered. Next we add 25ml dichloromethane.

Give it a good shake and then add the indophenol blue indicator.

Sodium lauryl sulphate is now used to titrate. It is important to note that, unlike with the Imazalil titration, we do not go to a colourless phase here, but we look for the green-tint phase.

**Calculations**

Once you have determined what the current fungicide concentration is in the bath, you need to top it up to get to the right concentration.

To calculate the amount of fungicide that you need to add, you need to know the volume of water in the bath, as mentioned at the beginning of this module.

Two formulas are used for topping up, one for Imazalil, and another for Guazatine.
**Top-Up Formulas**

**Imazalil Top-Up**
Imazalil (g) to be added = volume of water (l) in treatment bath x \[
\{(500 - \text{Imazalil (ppm determined)}) \div 750\}\]

**Guazatine Top-Up**
Guazatine (g) to be added = \[ \text{volume of water (l) in treatment bath} \times (1,000 - \text{Guazatine (ppm determined)}) \times \text{registered volume of Guazatine product required to make up 1,000 liter solution} \div 1,000,000 \]

**active learning**

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 21.1 – Flowchart**

Draw a flowchart explaining the details of the titration process. Make sure that your flowchart includes the following information:

- ✓ Explain why and how titration is performed.
- ✓ What equipment and other consumables are needed to do titration?
- ✓ What are the standard operating procedures in your packhouse for titration, including the intervals at which it should be done, and the details of the chemicals that should be used?
- ✓ Are there any potential hazards or cautions that workers involved in titration should be aware of in terms of personal health and safety?

**Activity 21.2 – Workplace Logbook**

You have to complete practical titration as part of your learning. Please ask your workplace supervisor or team leader to observe you while completing this task and to sign your logbook.
Activity 21.1 – Flowchart

Draw a flowchart explaining the details of the titration process. Make sure that your flowchart includes the following information:

- Explain why and how titration is performed.
- What equipment and other consumables are needed to do titration?
- What are the standard operating procedures in your packhouse for titration, including the intervals at which it should be done, and the details of the chemicals that should be used?
- Are there any potential hazards or cautions that workers involved in titration should be aware of in terms of personal health and safety?
# Activity 21.2 – Workplace Logbook

You have to complete practical titration as part of your learning. Please ask your workplace supervisor or team leader to observe you while completing this task and to sign your logbook.

<table>
<thead>
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<th>Tools and equipment</th>
<th>Handling before, during and after task completion</th>
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Module 22
Resistance Management

Presenter: Paul Fourie

Reference
For more information on fungicide resistance, please consult the CRI Production Guidelines, volume IV.

Introduction

Resistance to commonly used fungicides in packhouses is becoming problematic for the citrus industry.

It is essential that all packhouse managers must be aware of how fungi develop resistance against fungicides, so that they can manage their applications and dosages to prevent the development and multiplication of resistant strains.

Resistance Building

Any fungus population that has never been exposed to a fungicide, you would expect that most of the individuals in that population would be sensitive to that specific fungicide. However due to natural mutation or just natural variety, you might find that one in a few million of these fungal spores might be resistant to that particular chemical.

Should you now start to use that chemical, in this case in the postharvest environment, obviously the chemical will now kill most of the sensitive isolates, depending on how well you treat it.

It will not kill the resistant one, and the resistant one will be able to multiply. The poorer the application, the more of the resistant isolates in the population will survive and these can then even multiply further.
Types of Resistance

Disruptive Selection Pressure

One gets two types of resistance. The first one is called disruptive selection pressure and this is what happens to Thiabendazole (TBZ), which is commonly used against green mould in citrus packhouses.

You will have a population, and as I mentioned earlier, you will have a few resistant isolates in that population, these resistant isolates will be quite remote from the population.

As you use TBZ on this population the sensitive population will start to decline and the resistant one will start to increase.

Directional Selection Pressure

The other type of resistance is called a directional selection pressure and this is what happens in the case of Imazalil, which is probably our most important fungicide against green mould.

Because the fungus needs to make a lot more changes to become resistant against Imazalil, you will find that you have a directional selection pressure. So as the fungus makes changes the population shifts towards resistance.

In the case of Imazalil that is why sticking to the correct fungicide dosage is very important, because the lower the dosage, the more of the population will move towards resistance. The better the dosage that you load onto the fruit, the more of the population you will kill.

Resistance in Practice

To show what Imazalil resistance in practical terms mean, we have done some trials with Imazalil sensitive and Imazalil resistant isolates. Following treatment with Imazalil, one would hope that you control all the decay. Some decay happens and in the case of sensitive isolates, we get sporulation inhibition, which is one of the most important attributes of Imazalil.
However, in the case of the resistant isolates we can see that we have more decay, as well as loss of sporulation inhibition which is really what we don’t want. So this is the situation with green mould and Imazalil.

We could have similar situations with Thiabendazole and Imazalil, and we might also have it with Guazatine and Imazalil. You can get fungus populations developing resistance against a variety of active ingredients used to control them. It might also happen in other postharvest diseases, although green mould is our most important disease and research is focused on this disease at present.

**Sporulation**

Sporulation is the act or the process during which fungi forms spores.

**Sporulation Inhibition**

Sporulation inhibition is the act or process where fungi can cause some fruit decay, but will not produce spores.

**Managing Fungicide Resistance**

**Fungicide Residues**

So how do we manage fungicide resistance? It is vitally important to get the correct fungicide residue onto the fruit, because the lower the residue that you leave on the fruit, the more of the resistant population will survive.

**Fungicide Usage**

Secondly, it is really important to use a fungicide only once in the packhouse environment. If you use a specific chemical in the drenching system, you should not use the same chemical again in the packhouse environment.

Any resistant spores that survived the treatment in the drench will be taken into the packhouse environment where it will be very difficult to control.
Combined Usage

A third option to manage fungicide resistance would be to use a mixture of two different chemicals to control a specific disease.

In that case it is like a double barrel shotgun: you hit the fungus from two sides. Thereby you would also manage fungicide resistance.

**active learning**

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 22.1 – Workplace Interview**

Ask a subject matter expert working in your packhouse about his view on how spore populations develop resistance to a certain fungicide. Summarise your findings in your workbook.

**Activity 22.2 – Group Activity**

In your group, discuss the different ways of managing resistance, with specific reference to the method practiced in your packhouse. Make keynotes in your workbook.
Activity 22.1 – Workplace Interview

Ask a subject matter expert working in your packhouse about his view on how spore populations develop resistance to a certain fungicide. Summarise your findings below.

Details of interviewee

Name and surname: 
Date of interview: 
Signature of interviewee:
Activity 22.2 – Group Activity

In your group, discuss the different ways of managing resistance, with specific reference to the method practiced in your packhouse. Make keynotes below.
Introduction

Fruit goes through drying tunnels after the hot water fungicide bath and after being waxed. In the first drying process, it is very important that the fruit is dried well; if not the wax application will not be effective. After the wax is applied, the fruit goes through another drying tunnel to set the wax properly.

A drying tunnel can damage fruit if it is not operated correctly. Citrus is produced in various areas in South Africa in diverse climatic conditions. The relative humidity and temperature have an effect on how fast moisture is evaporated from the fruit in the drying tunnel. It is therefore difficult to set guidelines concerning temperatures and time spent in the drying tunnel that can be followed by all packhouses. Each packhouse has to perform their own tests to establish the optimal drying condition for their climate.

Drying Practices

Brushes and Rollers

Some packhouses, directly out of the fungicide bath, have a lot of brushes and doughnut rollers and that tends to remove some of the fungicide residue off the fruit, which you have just applied in the fungicide bath.

The whole idea is to remove any superfluous water off the fruit, to make the drying of the fruit easier in the tunnels but over brushing can cause a loss of residue.
Fans

Some packhouses have a set of fans before the drying tunnel, to get rid of the superfluous water as well. After the fans the fruit moves through the drying tunnel on rollers. Packhouses can use either cold air or hot air drying tunnels.

Hot Air Tunnels

The hot air drying tunnels must be set at certain temperatures. The recommended temperatures for soft citrus is 40 to 48°C maximum, because they are very susceptible to any injury through heat. Other drying tunnels for the hard citrus, that is your oranges and your grapefruits and your lemons, can be set up anything from 56 to 58°C maximum.

Time in Tunnel

The time that the fruit spends in the drying tunnel and the length of the drying tunnel determines how effectively your fruit will be dried. That can be tested, at the end of the drying tunnel, to see how dry your fruit comes out.

You can always check on the speed of your belt moving through the drying tunnel and reset it if your fruit comes out on the other side with the fruit still wet to ensure efficient drying through the tunnel. You could also adjust your temperatures slightly and you could slow down the conveyor in the drying tunnel for the fruit to spend more time in the tunnel for more efficient drying.

Drying Processes

Drying of Fungicide Residue

It is important to dry your residue on your fruit and also important to get dry fruit coming out of the tunnel because you cannot apply wax to wet fruit. Applying wax to wet fruit will cause very erratic and smudgy waxing on the fruit. The wax application will not be effective at all. Waxing is a vitally important aspect of citrus production.
Drying of Wax

After the waxing of the fruit, the wax has to be dried on the fruit as well, because you cannot allow the fruit to air dry with the wax.

The fruit passes through a drying tunnel again. Some packhouses have cold air drying tunnels here whilst others use hot air drying tunnels.

Conclusion

It is important to adhere to the recommended drying temperatures and not to exceed them.

For fruit with a thinner rind, like soft citrus the temperature should be between 40 and 48°C. For fruit with a thicker rind such as oranges, lemons and grapefruits the temperature should be between 56 and 58°C.

Check the fruit coming out of the tunnels to judge whether they are drying properly.

summary

Drying Tunnel Dos and Don’ts

- **Test drying tunnel** to determine correct time and temperature for climatic conditions.
- Do not have too many **brushes** and **rollers** coming out of the fungicide bath.
- **Temperature** for hot air drying tunnel:
  - Soft citrus – 40-48°C
  - Hard citrus – 56-58°C
- Check that fruit are properly dry, and adjust speed of belt and / or temperature.
- Make sure that wax is not applied to wet fruit.
active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 23.1 – Practical

Perform tests by speeding up the conveyor belt that carries fruit through the drying tunnel in your packhouse to its fastest speed. Assess the effectiveness of the drying process. Now bit by bit, slow the belt down to its slowest speed, noting the effect on the dryness of fruit coming out the other side.

Note your findings. Make a recommendation for the speed setting for the belt to achieve optimum dryness, adding an explanation on why you make this recommendation.

Activity 23.2 – Worksheet

In your own words, explain why there is a difference in the temperature setting for the drying tunnel for different fruit.
Activity 23.1 – Practical

Perform tests by speeding up the conveyor belt that carries fruit through the drying tunnel in your packhouse to its fastest speed. Assess the effectiveness of the drying process. Now bit by bit, slow the belt down to its slowest speed, noting the effect on the dryness of fruit coming out the other side.

Note your findings. Make a recommendation for the speed setting for the belt to achieve optimum dryness, adding an explanation on why you make this recommendation.
Activity 23.2 – Worksheet

In your own words, explain why there is a difference in the temperature setting for the drying tunnel for different fruit.
Module 24

Wax Application

Presenter: Keith Lesar

Reference

For more information on wax application in the packhouse, please consult the CRI Production Guidelines, volume IV.

Introduction

There are three main reasons for applying wax to citrus fruit. These are to:

- Extend its shelf-life by limiting moisture loss
- Protect the fruit against cold damage
- Improve the appearance of the fruit

Tests have shown that a wax coated fruit will have 20 to 30 percent less moisture loss during transport than an uncoated fruit. This means that, all other things being equal, the shelf-life of wax coated fruit is a lot longer than uncoated fruit.

With the opening of new markets in the Middle and Far East, the cold sterilisation protocol during shipping has become more and more common. A decent wax coating can protect fruit from damage during this process. Waxing also gives the citrus rind a good shine that makes it more attractive.

Another less common reason which has come to the fore in the recent past is that, due to increased resistance of some postharvest pathogens, fungicides can be mixed with the wax in order to control these pathogens and protect the fruit.

When choosing a citrus wax we must always take into consideration the exchange properties of the wax. Older, resin-based waxes tended to give the fruit more of a shine, but blocked the pores in the rind. This prevented respiration of the fruit rind, where carbon dioxide is exchanged for oxygen. This caused the fruit to develop an off flavour, due to an excessively high level of ethanol in the fruit caused by the high levels of carbon dioxide.
Citrus Waxes

There are two different types of citrus waxes. You get your poly-ethylene waxes, which are synthesised waxes, and then you get your natural waxes which are your carnauba waxes. Carnauba waxes are the waxes that actually come from a palm tree, so it is classified as a natural wax.

Certain markets require certain waxes. Poly-ethylene waxes used to be the only waxes in the industry many years ago, so they were acceptable in all markets.

But because they are synthesised and there are certain products in there that certain markets do not want, some markets look more to the natural waxes. A number of markets stipulate the use of only natural waxes and in other markets both waxes can be used.

Wax Application Procedures

Application Volume

Each manufacturer has their own recommendations on how many litres of wax must be applied to a ton of fruit. Those recommendations must be adhered to rigorously.

Over application can lead to wax that does not dry properly, and can interfere with the respiration of the fruit and can end up causing rind defects on the fruit. Over application can also lead to very serious and major losses in the industry and, at the end of the day, in the overseas market.

Monitoring Applications

One can normally see with the naked eye, after the drying of the wax, how well it has been applied, or how well it has not been applied.

If the application is insufficient it has to be rectified, because you cannot export fruit in that condition. If you do you are going to lose the quality of that fruit before it has even reached the overseas market.
Fungicides

Over and above the clean wax being applied to the fruit, we have fungicides that are mixed into the wax as well and applied with the wax. The fungicides that are usually in the wax are normally Thiabendazole, sometimes 2,4-D and also Guazatine.

The mixture of the wax and the fungicides are made up in a separate container. The container must be continually agitated because some of the fungicides applied in the wax, especially Thiabendazole, settle out. If that happens, you may get a patchy application of the fungicide onto your fruit through the wax.

So that container needs to be agitated continuously during application so that you get that uniform application of your wax and that uniform spread of the fungicide.

It is important that the right residue of the fungicide below the wax layer on your rind of your fruit is set to ensure the effectiveness of the fungicide treatment on export fruit.

summary

Wax Application Dos and Don’ts

- When choosing a wax, take into account its exchange properties, and export market requirements.
- Comply with the manufacturer’s instructions on application volume.
- Make sure that fruit is properly dry before wax application.
- Make sure that wax is applied evenly.
- Agitate wax continuously while applying to keep fungicide in suspension.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 24.1 – Group Discussion

Find out which types of waxes are available for use in your packhouse. As a group, discuss the pros and cons of each type of wax, and why a specific wax will be used for specific fruit types.
Activity 24.2 – Case Study

A packhouse manager notices that the wax on all the fruit coming out of the drying tunnel after waxing is spotty and that there are areas where there is no wax on the fruit at all.

☐ What can cause this?
☐ What can the packhouse manager do to rectify this problem?
Activity 24.1 – Group Discussion

Find out which types of waxes are available for use in your packhouse. As a group, discuss the pros and cons of each type of wax, and why a specific wax will be used for specific fruit types.
Activity 24.2 – Case Study

Consider the case study below and answer the questions based on it.

A packhouse manager notices that the wax on all the fruit coming out of the drying tunnel after waxing is spotty and that there are areas where there is no wax on the fruit at all.

✓ What can cause this?

✓ What can the packhouse manager do to rectify this problem?
Module 25
Sizing
Presenter: John Perold

Reference
For more information on fruit sizing equipment and practices, please consult the CRI Production Guidelines, volume IV.

Introduction
After fruit has been treated and waxed in the packhouse, it is separated into different classes and sizes, so that whole cartons and pallets of the same grade and size fruit can be sent to the buyer.

Sizing of citrus fruit can be done mechanically or optically, and there are a range of different machines used for this purpose. The first and most accurate way of sizing citrus fruit that we will look at, is using an optic sizer.

Sizing Equipment
Optic Sizers
It is the most modern sizer at the moment. An optic sizer can size fruit according to colour, shape, size and weight.

The varieties that you are going to pack will influence the sizer that you are going to choose, because if you have very big fruit the pitch between the two fruit, it is going to be too large, as small fruit is going to give you a small pitch. So you need to decide what chains you are going to use to suit your packing needs.

The transfer mechanism is also very important, because fruit is cingulated, and then gets transferred onto the belt. The correct carrier or the cups are also critical, as well as the pitch that is also effective there.
**Cingulated**

The term cingulated is used to describe any object that is round or ball shaped.

**Mechanical Sizers**

You then also have mechanical sizers, of which there are three P’s, there are roper, rollers and many other types of sizers that people have build.

**Pie Tape**

Sizing equipment used to accurately size fruit is the pie tape. The pie tape needs to be checked regularly for accuracy as the band tends to stretch from time to time. What's important about using the pie tape is that we all have quality control people in the packhouse and if they pull on the fruit on the pie tape, you'll see that they will get a different reading.

So understanding how hard to pull on the pie tape is important, so that you can ensure that the circumference of the fruit is being measured equally by yourself and your quality control people.

**Monitoring**

To check that your sizing is correct, use a sizing sheet on which you indicate the size of fifty separate fruit and the shape of fruit. Remember round and long fruit will fill the box differently. Also indicate the weight of the carton, as a minimum weight is required.
Count References

There are international count references that are used to determine the amount of fruit that must be packed into a carton. If you have a look at the count 88 navel and a count 88 lemon, you'll see that they both count 88, but the count reference that is referred to, is different.

On soft citrus we have a count, but on the count is also a range, the size range, is indicated to show that those are the only sizes that are allowed into that carton.

Sizing Standards and Requirements

The minimum standards and requirements for fruit sizes allows for a small size difference between fruit in the same carton.

The difference in diameter between the largest and the smallest fruit of the same size reference must not be more than 7 millimetres for lemons.

For oranges the bigger fruit with size reference 0 to 2 is allowed by 11 millimetres between the largest and smallest fruit, for fruit falling into the size reference 3 to 6 it is 9 millimetres and for the smaller fruit falling between size reference 7 and 13, not more than 7 millimetres.

For soft citrus, it may not exceed 9 millimetres for fruit of size reference 1 to 4, 8 millimetres for size reference 5 to 6, and 7 millimetres for size reference 7 to 10.

However, in the case of soft citrus these references are rarely used anymore as there are so many different carton designs with different weights that the diameter range is now indicated on the size reference label. Only fruit within that range may be found in that carton.
Sizing Variations

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Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 25.1 – Research Report**

Contact a company that supplies optical sizers to the citrus industry. Find out from them what type of machine and what size grader cups should be used when grading and sizing lemons, clementines and navels. Explain why specific cups and machines are used for different citrus types.

**Activity 25.2 – Comparison**

Study this picture and explain why the counts on the cartons are the same (88), but the count references are different (7 and 3).
Activity 25.1 – Research Report

Contact a company that supplies optical sizers to the citrus industry. Find out from them what type of machine and what size grader cups should be used when grading and sizing lemons, clementines and navels. Explain why specific cups and machines are used for different citrus types.
Activity 25.2 – Comparison

Study this picture and explain why the counts on the cartons are the same (88), but the count references are different (7 and 3).
Reference
For more information on sorting and grading practices, please consult the CRI Production Guidelines, volume IV.

Introduction
In any packhouse there are at least two places where fruit is sorted or graded, and in many packhouses more than two.

At the sorting and grading stations the fruit is separated firstly for the different market segments that it is going to, which are the export market, local market or processing, and then the export fruit is separated into different classes, according to the packing specifications that come from the export agent.

The skills that workers need to work at any of the sorting or grading stations are the same – the better you get at your job and the more experience you have, the further up the packline you work.

Pre-Sorting
Pre-sorting is where fruit that is clearly not fit for being sold as fresh fruit is removed before the fruit enters the packhouse. This is done for two reasons.

Firstly, by taking out fruit that is obviously infected with postharvest diseases, we keep that fruit out of the packhouse and away from the other fruit so that it does not increase the spore load in the packhouse.

Secondly, by not letting that fruit go into the packhouse we save the money of treating it with fungicides and wax.
During pre-sorting all fruit must be removed that is:

- Decayed
- Stung
- Injured
- Squashed
- Burst
- Puffy
- Green
- Under- or oversized

Some of this fruit is good enough to be sold on the local market, while fruit that is in a worse condition is sent to the factory where it is processed into fruit juice or citrus oils.

You may also find fruit that is very badly infected and diseased, even though this fruit should be taken out already in the orchard when the fruit is picked. This fruit must be destroyed. If you find a lot of badly infected fruit, tell your supervisor so that he can tell the picking team in the orchard.

The role of pre-sorting differs from packhouse to packhouse. Some packhouses expect growers to do thorough pre-sorting in the orchard while harvesting, while others are happy to receive all the fruit that comes off the trees and sort it at the packhouse.

The best practice is to pre-sort fruit already in the orchard as it is being picked. If this is done, all fruit that is clearly not in a state to be sold as fresh fruit is removed. But even then some poor quality fruit can still end up being sent to the packhouses.

**Grading**

Grading is when the fruit that has been prepared for export in the packhouse is separated into different grades, or classes. This happens after the fruit has been treated with fungicides and waxed and usually before the fruit is sized.

In some packhouses, an optic sizer is used that can also detect fruit shape, colour and blemishes, but in most cases sizers only separate the fruit into size categories, and it is up to graders to manually separate the fruit into classes.
Fruit Classes

Export fruit can be separated into any number of classes, depending on the citrus type and the packing specifications and instructions from the export agent, which in their turn depend on the target export market.

But to explain grading in this module, we will assume that our fruit is graded into two major export classes, being class 1 and class 2. Fruit that is below class 2 quality is either exported as industrial fruit, or sold locally as fresh fruit or sent for processing.

Export Standards

How do we then know whether a fruit is class 1, class 2 or below class 2?

We use the minimum export standards that are issued by the Department of Agriculture, Forestry and Fisheries for our citrus type. These are international standards and requirements, meaning that these are the standards that are used for grading export citrus across the world.

Market Requirements

There can also be specific requirements from your target markets or buyers that may be above these minimum standards.

It is important for a grader to know the minimum standards for all the citrus types that you work with in your packhouse, but you must also know if the buyer wants you to apply higher standards. The supervisor or packhouse manager will inform you about the standards that you need to apply.

Grading Fruit

The standards that we use to grade fruit into classes have to do with the internal and external quality of the fruit.
Internal Quality

Fruit samples are taken and tested to make sure that the fruit comply with the internal quality specifications. These specifications have to do with what goes on inside fruit, and includes:

- Juice percentage
- Level of granulation
- Seed content
- Sugar (brix)
- Acid content
- Sugar : acid ratio

External Quality

External quality is what the grader looks at, and this has to do with the:

- Shape
- Colour
- Blemishes
- For some citrus types, skin texture

Methods and Equipment

Methods and equipment used for grading and sorting is different at various packhouses. In this module, we discuss procedures that are a guideline to show how grading and sorting takes place in most cases.

Training and Selection of Graders

Colour Blindness Test

Before the packing season starts, sorters and graders are selected and trained. It is important to make sure that sorters and graders can see small colour differences, and packhouse management may choose to give potential sorters a test to see if they are colour-blind.
These colour vision examinations are very basic and can either be done by an outside firm or by the packhouse itself, using tests like the commonly available Ishihara test.

**Ishihara Test**

The Ishihara colour blindness test can be obtained from [www.ishiharacolourblindnesstest.com](http://www.ishiharacolourblindnesstest.com) or can be ordered from Internet shopping sites such as [www.kalahari.net](http://www.kalahari.net).

**Colour and Blemish Charts**

After sorters and graders have passed the colour blindness test, they are introduced to the Colour Prints for Blemish Standards.

These charts are published by Citrus Research International and are available to all packhouses. On these charts are pictures of fruit with colours varying from green to orange, and pictures of fruit with varying degrees of different kinds of blemishes, fruit with various shapes, and fruit with different rind textures.

Sorters and graders are taught to see the difference between fruit that can be exported, sold on the local market or that must be sent to processing, and the differences between the grades of export fruit.

The colour and blemish charts are an international standard, with the same pictures used all over the world in every packhouse to grade citrus fruit.

The charts are used by comparing the fruit that you have in your hand with the picture on the specific chart. Colour and blemish charts should be put up at all the sorting and grading stations, so that the sorters and graders can refer to them to refresh their memories.

The DAFF minimum export standards tell you exactly the shape, colour, blemishes and skin texture that is allowed for fruit in every class, by using the colour and blemish charts.
In the minimum standards document it says for instance for class 1 Navel oranges, using colour chart number 34: ‘Maximum colour print no. 5 with a tolerance of 20% to print no. 6’. If we now look at colour chart number 34, we can see what this means: the Navel oranges that can be exported as class 1 must be the same colour as picture number 5, with a maximum of 20% that can be the same colour as picture number 6.

This is an example of a blemish chart, showing wind scarring blemishes. The level of blemish that is aloud for the different grades are also prescribed by the export standards and requirements.

Can you find the export standards for the citrus types that you work with, and identify the colour charts and pictures that you must use when grading the fruit?

**Testing and Placement**

After training, all sorters and graders, old and new, are tested. This test involves sorting fruit into different classes and grades. The higher you score on this test, the later you will be placed in the sorting and grading line. Usually the lowest scores are used for pre-sorting and the highest scores for final grading and sorting.

The sorters used for pre-sorting can then again be put into two groups.

The first group, standing at the beginning of the line, concentrates on removing fruit that is decayed, stung, badly injured and squashed.

The second group concentrates more on blemishes and colour. Fruit taken out by the first group is usually sent for processing or destroyed, while fruit taken out by the second group will be sent to the local market.

**Protective Clothing and Personal Hygiene**

In the Packhouse Process Flow module we discussed the protective clothing and personal health and safety rules that everyone in the packhouse must comply with. Please remember that you are working with a perishable product that can be injured, damaged and infected.
Sorting Tables

The design of the grading table is important to make sure that the graders and sorters can do their work properly.

The recommendation is that a grading table should be 0.9 metres high with rollers moving the fruit along the table. Fruit on belts have to be turned by hand so that the graders can inspect them and this can slow the process down and lead to injuries.

The norm is for that the maximum width between rollers should be 26 millimetres, but it can be less if you are handling soft citrus that is prone to injury.

Normally a grading table is 1.2 meters wide, with a 300 millimetre division in the middle where fruit that is removed can be placed, but this differs from packhouse to packhouse.

In some instances, fruit that is removed are placed on another line above the grading table. This other line will take fruit to the next step in the packhouse, which can be to the processing bins or to where fruit is packed for the local market. When you are grading export fruit, fruit belonging to the different classes will be placed on different lines.

When standing or seated next to the table, you must be able to reach across the grading line without too much stretching. It is important that you can reach all fruit passing before you.

Lighting over grading tables is very important. If wrong lights are used or if the lights are too dull, graders and sorters will get the wrong impression of the fruit colour and they may remove fruit from the line that should have stayed on. Best practice is to use fluorescent daylight tubes number 5.

Lights should be installed 1 metre above the tables. All lights must be covered with plastic screens to protect the light and so that glass will not fall onto fruit if the light should break. Normally shields on the side of the lights prevent light from shining directly into the graders’ eyes and blinding them.

If you are not comfortable with the lighting at your grading table, if it is too bright, shining in your eyes or too dull, inform your supervisor.
Sizing

In most packhouses pre-sorting takes place after the first sizing. Here fruit that is too small or too large is removed from the line and automatically sent for processing. This sizing is done by a machine that is operated by the supervisor. If you see fruit on your grading table that is very small or very large, and you think that the sizer may be allowing fruit through that it should be removing, you must tell the supervisor immediately.

Export fruit is normally sized mechanically after being graded. There are different types of sizers that are used for this purpose. This is discussed in more detail in the module that about Sizing.

Sorting Practices

The sorting and grading procedures that we look at in this module are for when we use a grading table with a tray with a conveyor belt in the middle of the table. It may be different in your packhouse, so check with your supervisor and make sure that you understand your system.

Fruit comes from the dump and fruit washing system to the sizer if you are pre-sorting, or from the drying tunnel after it has been waxed if you are grading export fruit, and passes over the grading table in front of you.

Knowing the Standards

Before you start sorting or grading, make sure that you know exactly what you are looking for and what standards are being used. If you are unsure about whether or not to remove a fruit, it is best to allow the fruit through at pre-sorting and leave the decision to the final graders.

If you are at the export grading station, be very careful to apply the standards consistently – remove the fruit and carefully compare it with the colour charts if you are in any doubt about which class it belongs to.

At first you will find that sorting and grading can be slow, but as you gain experience you will be able to sort fruit a lot faster and more accurately.
**First Pre-Sorting**

If you are in the first group of pre-sorters, look at the condition of the fruit in front of you and check it for injuries and damage.

Take out all the fruit that is decayed, stung, badly injured or squashed and place it in the tray in the middle. The belt on this tray will take the fruit to where it will be loaded for processing. If you are not sure, pick the fruit up and inspect it more closely.

**Second Pre-Sorting**

If you are part of the second group of pre-sorters, look at the colour and blemishes of the fruit going past you. Keep the colour and blemish charts at hand so that you can check fruit against it if you are unsure.

If the fruit is below export quality according to the instructions that were given to you by your supervisor, remove it and place it in the tray in the middle. From here it will be taken to the processing bins or to where they pack the fruit into pockets for the local market.

**Final Grading**

If you are at the grading station for export fruit, your job is more challenging, because you need to distinguish between the fruit that belongs to the different export classes. You must keep your colour charts on hand, and refresh your memory regularly.

If you are just separating the fruit into two different classes, you will in most packhouses move either the one grade or the other onto a different line, moving for instance the class 2 fruit onto another line and leaving the class 1 fruit on the line in front of you, or vice versa.

The packline system for grading more than one class is unique to each packhouse and you must make sure that you understand this system and where what fruit should go.
Recommended Grading Hours

The efficiency and accuracy of grading and sorting depend on various factors, of which fatigue is the most important. Best practice is for sorters and graders not to work for longer than 2 hours at a time, with 15 minute break in between each session.

Quality Control

The quality control people will take samples of fruit after pre-sorting to check that the right quality of fruit is allowed into packhouse.

If they find any problems they will report it to the supervisor, who will tell you.

Sorting Line Hygiene

It is important that we keep the grading tables clean and hygienic. The fruit passing over the table can be infected and can leave spores behind, which can infect other fruit.

Best practice is for the grading table to be cleaned every two hours. An effective method is to use a knapsack to spray disinfectant on the rollers while they are turning. After spraying the rollers, use a cloth to wipe all the surfaces.

Make sure that the line is clean before you start sorting or grading again.

Conclusion

In the packhouse we receive fruit from one source – the orchard – and send it out to a great many different destinations.

Separating the large volume of fruit that is received at the packhouse into lots of the same quality is essentially the work of sorters and graders.

This is the principle of their job, even though the manner in which it is done may be unique to every packhouse.
active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 26.1 – Group Practical**

Ask your supervisor to prepare a sample batch of 50 fruit of different classes. Take turns in your group to grade fruit while timing each other. Discuss the results and allow people to defend their choices. Make keynotes in your workbook.

**Activity 26.2 – Worksheet**

In your workbook explain what the following means. The minimum requirements for the fruit are:

- Colour – 3 of set 37
- Shape – 3 of 38
- Skin texture – 7 of 37

**Activity 26.3 – Workplace Logbook**

You have to complete practical grading and sorting tasks as part of you practical learning. Please ask your workplace supervisor or team leader to observe you while completing these tasks and to sign your logbook.
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Module 27
Packing Material and Specifications

Presenter: Dawid Groenewald

Reference
For more information on packing material specifications, please consult the CRI Production Guidelines, volume IV.

Packing Material Guidelines

There is a wide range of export cartons and other packaging material that is used when citrus is exported.

The minimum specifications for cartons and pallets are set out in the Packaging Material Guidelines document that is published by the CRI.

Ensuring that the cartons and pallets used in your packhouse meet these minimum specifications helps to make sure that your fruit reaches its intended market safely and in a good condition. Using only reputable and experienced packing material manufacturers, helps in meeting the standards set out in the guidelines.

Packhouse managers must also take into account any specifications for packing material that the exporter might include in their packing instructions. Generally, sticking to the guidelines given by the CRI should ensure compliance with market requirements and specifications. To begin with we look at pallets.

Pallets

All citrus fruit is stacked on wooden pallets at the packhouse. The specifications of the pallets are of cardinal importance. Pallets are distributed all over the world. They are transported over long distances from the far northern parts of the country, from the packhouse to the harbour where fruit is refrigerated. It is very important that the pallets must be of good quality.
ISPM 15 Mark

All export pallets must carry the ISPM 15 mark. To obtain this certification, pallet manufacturers must follow strict guidelines regarding the construction and treatment of pallets. Pallets have to be strong and sturdy – remember that when a standard pallet is stacked with A15C cartons, it has to be able to carry a weight of almost one and a half tons.

Wood Used for Pallets

As an example of the sort of minimum specifications contained in the Packaging Material Guidelines, let’s look at the specifications for pallets.

Only SA Pine may be used for the base blocks and SA Pine or Saligna for the rest of the pallet. The wood must have a density of 400 kilogram per cubic meter at 12% moisture content. Wood with a moisture content of more than 20% must not be used for pallets. The number and size of the knots in the wood are also specified in the guidelines, because this can influence the strength of the wood. All the wood used must be treated according to ISPM 15 Guidelines for Regulating Wood Packaging Material.

Pallet Dimensions

A pallet must be exactly 1.21 meters long, 1.01 meters wide and 153 millimetres high. All nails have to be annular, which are ringed, or ring shank, type nails.

The positioning and the number of nails are clearly shown in the Packaging Material Guidelines document.

Pallet Inspections

Please remember that when pallets are inspected for use in exporting, they are checked in lots of 200, of which five are chosen randomly and scrutinised. It is therefore possible that pallets may slip through that are not up to standard. It remains the ultimate responsibility of the packhouse manager to ensure that their pallets are according to specifications and meet the standards, and that the pallets will not damage the cartons or fruit.
You can now see the importance of using and knowing the content of the Packaging Material Guidelines document, as it will enable you to implement quality control on packing material in your packhouse.

Next we look at the different types of cartons in which citrus is exported.

**Cartons**

Here are a few examples of cartons used in the citrus industry. This is the small 2.3kg carton used for soft citrus.

**Open-Top Display Cartons**

The three on top are examples of open-top display cartons of various sizes. All these cartons are assembled and glued together in the packhouse using a carton erecting machine.

In the supermarket, these cartons are displayed on shelves, and the consumer selects fruit from the carton, which is weighed and paid for accordingly. That is the main purpose of open-top display cartons.

**Telescopic Cartons**

The other cartons used in the industry are these full telescopic cartons. When I open and close the carton like this it illustrates what we mean by a full telescopic carton. Some markets are not willing to accept open-top display cartons. One example is grapefruit that is exported to Japan, which is mainly packed in telescopic cartons.

**Ventilation in Cartons**

We live in a changing environment. As new world markets open, new standards and requirements are set by buyers. An example is that some countries require fruit to undergo cold sterilisation.

When fruit is loaded in a container or on a conventional ship, cooling is vertical. Air flow through the pallets and cartons must be ‘cooling friendly’. Pre-cooling of fruit in harbour facilities occurs horizontally, so cartons must be
adapted horizontally as well to allow for cooling within the protocol periods.

When looking at the export of citrus, it is of utmost importance – and it also determines the eventual shelf-life of the fruit – that fruit is brought down to the required temperature as quickly as possible.

This carton is the current A15C carton, but when we look at cooling and the ability of the carton and the position of the ventilation holes, we can see the carton is not really ventilation friendly.

This is why we started at the packing workgroup with the development of what we call a new ‘super-vent’ carton.

We are able to get the fruit, inside the protocol period, right throughout the pallet, even inside where airflow can be difficult, we get the fruit cooled to the required temperature.

**Mass Container**

The last aspect looking at the spectrum of packing material is we have what we call the mass container. This is used for industrial grade citrus that is exported, fruit that is mainly used for juicing in the overseas market. To pack this fruit in individual cartons does not make economic sense.

On the inside, to lend additional stacking strength to the container, we have extremely strong paper cores in the four corners. Because of the extreme bulging of the fruit, with 500kg of fruit inside the container, we have plastic straps in the form of a cross. The flaps are tied with these plastic straps to the pallet. When the mass container is full, they are stacked two high.

When they are stacked, on the top that is open we place a pallet cap, similar to the one used when stacking open-top display cartons, to close the mass containers properly.
Packing Material Quality

When a new supplier approaches the packhouse, please make sure that their cartons comply with all the relevant specifications as shown in the Packaging Material Guidelines.

The supplier must be able to provide evidence of compliance with specifications. Remember the old rule: if it sounds too good to be true, it probably is. Do not compromise on carton quality.

The strength of the glue used at the carton erecting machine must also be tested regularly, because glue loses strength over a period and can cause cartons to fall apart.

All other packing material, such as pallet caps used with open-top display cartons and bulk bins, securing sheets, laminated corner pieces and the strapping used to secure cartons on a pallet, should be bought from a reputable supplier. Don’t try to save a few cents on cheap packing material, which will spoil the product and ultimately cost you lots of money.

In the next segment we look at specifications for wrapping paper.

Wrapping Paper

Normal wrapping paper, used mainly for the Middle East, is used for two reasons. The paper is treated with a thin layer of oil to make packing easier, because it prevents the papers from sticking to each other.

The main reason is if there is fruit decay, it will prevent the decay from spreading. The wrapping paper also helps to absorb moisture or condensation that may be on the fruit. This is why the Middle East requires fruit exported to them to be wrapped in this wrapping paper.

Fruit wrapping paper sizes vary depending on the size of the fruit that is being packed. For example, when packing count 36 oranges, the wrapper size is 325 by 300 millimetres and when packing count 162 lemons, it is 200 by 175 millimetres. The size and type of paper to be used are specified by the exporter. Most of the fruit wrappers used these days are printed with beautiful colours.
Fruit Labels

Small labels, called fruit labels, are stuck on the fruit, by various machines and methods at the packhouse. Certain information is printed on the fruit label, such as the fruit variety. It looks good, and is mainly used for fruit going to niche markets.

Conclusion

Staying within the specifications for packing material is another controllable factor in citrus exporting. Specifications and guidelines are put in place to help ensure that fruit makes it to market in a sound condition.

Trying to get away with a cheaper substitute of lower quality, can cost a lot of money in the long run, and is a risk that is not worth taking.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 27.1 – Mind Map

Do research about the Citrus Cold Chain Forum. Draw a mind map that includes the following information:

✓ When was the CCCF established?
✓ What brought about the establishment of the CCCF?
✓ What are the main objectives and activities of the forum?
✓ Which organisation drives the forum, and which organisations are represented on it?

Activity 27.2 – Research Report

Gather information about the packing material specifications for the three types of cartons that are used mostly in your packhouse. Record the dimensions for these cartons in a table, along with requirements for the cardboard that should be used in the construction of each carton type.

Shortly explain the meaning of the terms ‘calliper’, ‘corrugation’, ‘liners’, ‘fluting’ and ‘mass load at failure’.
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Module 28
Packing Market Specifications

Presenter: Neil Malan

Reference
For more information on packing market specifications, please consult the CRI Production Guidelines, volume IV.

Introduction

In previous modules, we discussed in detail the minimum standards and requirements for export citrus from South Africa. We have also said that specific markets and buyers may have their own requirements above the minimum standards.

All of these requirements are as a rule presented to packhouses and growers in the form of a packing specifications document that is compiled and updated by export agents at the start of every season.

The specifications in these documents are what the exporter and buyer have agreed on, and are often based on templates that are provided by the PPECB.

In this module, we look at how these packing specifications are used in the packhouse, by hand of an example.

It is extremely important that every person in the packhouse is aware of the packing specifications that have bearing on his or her specific tasks, where they come from and why they must be enforced.

We will then also have a short look at the weekly packing instructions sent by the export agent.
### Packing Specifications – Lemons to Far East

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<tr>
<td><strong>Layers per Pallet</strong></td>
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<td>Fully Wrapped (Inventory Code: FW)</td>
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<tr>
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<td>250 x 225mm 225 x 200mm</td>
<td>200 x 175mm 250 x 225mm 225 x 200mm 200 x 175mm</td>
</tr>
<tr>
<td><strong>PLU Codes</strong></td>
<td>Please see weekly packing instructions</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
All fruit must be uniform and elongated
Corner pieces are compulsory on all pallets.

### Packing Specifications

Before we look at the example, let’s just have a quick look at the content of the rest of the exporter’s packing specifications document.

There are general guidelines for packing, including tasks such as pallet stacking, and guidelines for internal and external quality, including how these should be measured. There would normally also be instructions on how and with what documentation fruit should be dispatched to the port.
This is followed by detailed guidelines for each citrus type, accompanied by packing specification tables, like in the example that we are using. The export document may then also include guidelines for industrial fruit, and confirm the time and temperature protocols that are applicable this year.

Lastly, the exporter may include packing patterns, to show how fruit of different types and sizes should be packed in various cartons.

Please remember that this is just one example – every exporter’s document will look different, but it should contain the same sort of information.

If we look at an example of packing specifications, we can divide the specifications into three groups, having to do with:

- Internal quality
- External quality
- Packing

**Internal Quality**

The specifications that have to do with internal quality in our example are:

- Seed
- Juice percentage
- Brix (also called solids or sugar content)
- Acid percentage (for which you get a minimum and maximum requirement for some citrus types)
- Sugar and acid ratio

Granulation is another internal quality specification that is important in some citrus types, but this is discussed in the general guidelines section, and not specified here.

Internal quality is tested during maturity indexing, and the fruit should only be picked once these parameters are reached.

**Reference**

For more information on maturity indexing, please look at Module 12 – Maturity Indexing.
External Quality

The specifications that concern external quality in our example are:

- Colour, for which they sometimes also set a minimum and a maximum specification
- Blemish deviation
- Shape
- Skin texture for some types

Most of the time these specifications are given by way of colour and blemish charts published by the CRI. As an example, let us look at the minimum colour specification for class 1 fruit. The specification states 3 of set 37. What does this mean? It means that if we look at chart 37, the fruit that is packed for this market must all look at least like picture number 3. If we look at the specification for class 2, we see that there is a tolerance, which means that, while the lemons that you pack should look like picture number 3, they will allow at inspection 5 percent of the fruit to look like picture 4.

Judging the external quality of fruit is mostly the job of the graders and sorters.

Packing

Now we look at the specifications that have to do with packing itself. In our example, these are the:

- Count
- Packaging
- Brand
- Gross weight
- Pallet strapping
- Securing sheets
- Pallet caps
- Cartons and layers per pallet
- Wax
- Wrapping
- PLU code, which have to do with fruit labelling

First we look at count or fruit size categories, packaging, and weight specifications.
Fruit Size Categories, Packaging and Weight Specifications

We are all aware that we have different citrus varieties. Soft citrus are usually Mandarins, Satsuma and Clementines. There are a lot of varieties. These are usually packed for export in open-top display cartons, ranging from 10kg to 15kg cartons.

The fruit also varies in size. Soft citrus works on counts 1X or 1 or 2. The higher the count, the smaller the fruit. Smaller fruit is usually jumble packed, meaning it is loose packing, without a packing pattern.

There are two methods. Markets require either a certain number of fruit in a carton, for example, in a 15kg carton with size 5 fruit there must be at least 300 fruit, or 280 size 4 fruit. But if the fruit is sold by weight, allowance must be made for a weight loss of at least 5%. So a 15kg carton will contain 16kg to 16.5kg fruit.

Bigger fruit, from size 2 to XXX, are packed in a pattern, especially in a 10kg carton. This prevents damage to the fruit, and it looks neat.

Looking at oranges, navels and Valencias are categorised in counts. This is the number of fruit packed in a 15kg telescopic carton. It can also be packed in 15kg or 10kg open-top display cartons, with of course a packing pattern to make the carton look neat and full.

Lemons work much the same as oranges. It is also based on the number of fruit packed in a 15kg telescopic carton.

Carton Type

The carton code that is given in this line indicates the type of carton that must be used. The carton dimensions and specifications are set out in the general part of the packing specifications document.
Brand

The brand that the fruit is exported under is printed on the carton, and in some cases on for instance the fruit wrappers.

Packing Method

In the general part of the document you should find instructions on what counts of different fruit types should be jumbled or place packed and packing patterns for different types and counts.

These instructions must be given to the packers.

Gross Weight

The next specification that concerns packing in our example is the gross weight.

All cartons should be weighed once they have been packed, to make sure that they achieve the required gross weight specification.

The gross weight of cartons varies, even if there is the same number of fruit in every carton. Fruit with higher solids, or sugar content, are heavier, and the gross weight of the carton is therefore higher.

This information must also be used to make sure that trucks are not overloaded.

Palletisation

The next five specifications apply to palletisation, and these instructions must be given to the workers in that section.

The strapping specification indicates which layers of the pallet should be strapped.

Securing or locking sheets and pallet caps are normally only used with open-top display cartons.
In the general section of your document, you should also find pallet stacking patterns that will help to make sure that the required number of cartons is stacked on each pallet.

**Wax**

Some markets do not want synthetic wax on their fruit, and this is how the export agent indicates whether the market has a requirement in this regard. If this line is not on your packing specifications, you can use any type of wax.

**Wrapping**

The next two specifications indicate whether and how the fruit should be wrapped. The options are fully wrapped, as in the example, which means that all fruit must be wrapped, or alternative layer, meaning that the fruit in every second layer will be wrapped, or alternative row, which means that every second row of fruit will be wrapped.

The type of wrapper that must be is indicated by the inventory code. More details of the different wrappers used by your export agent should be in the general section. The dimensions of the wrappers depend on the fruit size, and the required dimensions are indicated in the second line in our example.

**The Price Look Up (the PLU)**

The last line shows the PLU, or price look-up, code. Some supermarkets require that each fruit is labelled with this code, which they use at the checkout counter when the consumer buys the product. This is put onto the fruit as a fruit label, either by machines or by hand.

Wrapping and PLU instructions must be given to the packers, to make sure that all the fruit will uniformly meet these requirements.
Weekly Packing Instructions

Lastly, we look at the weekly packing instructions that the packhouse receive from the export agent.

In this example, the exporter indicates that they need this grower to supply them with 174 pallets of various sizes and grades of delta valencias during week 30 of the season. On the instruction document they indicate all the relevant information.

Can you see how these instructions connect with the packing specifications that you received for the season?

One of the most important columns here is the target market (TM) column, Remember that the fruit that is packed for each of these line items may be slightly different in terms of external and internal quality, depending on the requirements of the target market, and that the manner in which it will be treated, packed and stacked may also be different.

---

Weekly Packing Instructions

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<th>Cnt</th>
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</table>
active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignment(s) below.

Activity 28.1 – Internet Research

Do research on the internet and find packing specifications for three varieties of citrus not packed in your packhouse. Note the differences in specifications, and discuss them.

Activity 28.2 – Group Project

Use all the packing specifications that the members of your group gathered during their research. Design your own specifications for a fictional citrus variety.
Activity 28.1 – Internet Research

Do research on the internet and find packing specifications for three varieties of citrus not packed in your packhouse. Note the differences in specifications, and discuss them.
Activity 28.2 – Group Project

Use all the packing specifications that the members of your group gathered during their research. Design your own specifications for a fictional citrus variety.
Module 29
Packing
Contributor: John Perold

Reference
For more information on packing practices consult the CRI Production Guidelines, volume IV.

Introduction

By the time the fruit reaches the packer, it has been washed, treated, waxed, sorted and sized. This means that money has been spent on preparing the fruit for export, and a lot of value has been added to it.

It is important for packers to understand the processes and treatments that fruit go through before it reaches you, and to have a good understanding of export market specifications, so that you are able to understand why you have to do things in a certain way.

We strongly recommend that you watch the module 15 on Packhouse Process Flow, and module 28 on Packing Market Specifications.

Protective Clothing and Personal Hygiene

In the module on Packhouse Process Flow, we look at the protective clothing and personal hygiene rules that everyone in the packhouse must stick to.

These rules are especially important for packers, because they handle the fruit after a lot of value has been added to it.
Packing Specifications

In the module on Packing Market Specifications, you would have learnt about the different sizes, counts and grades of citrus fruit. Take the time to find out about the types of citrus that is packed in your packhouse, the markets that the fruit is packed for, and the market specifications for those fruit.

It is also important that you must be well aware every day of what you will be packing that day, for which market, and according to what specifications.

Fruit Quality

In your packing tray you should have fruit that is all of the same size and grade, and that meets those specifications in terms of external and internal quality.

It is the job of the graders and sizers to make sure that you get the right fruit to pack, but it is still important that you keep an eye out for fruit that is not the same as the rest.

Remember that you are the last line of quality control when it comes to the fruit itself – nobody in the packhouse will see the fruit again after you pack it.

Wrapping and Labelling

The packing market specifications also indicate if the fruit that you are packing should be wrapped or labelled.

Your supervisor will tell you at the beginning of every shift what the wrapping specifications and patterns are, and will see to it that you have the right wrappers in hand.

In most packhouses, fruit is labelled by machines, but it may happen that you need to label the fruit by hand. The supervisor will again make sure that you are aware of this if it is the case, and see to it that you have the right labels.
Marking

When you finish packing a carton of fruit the carton will be labelled. On this carton label it states, amongst other things, the grade and size of the fruit.

You need to make very sure that every fruit in that carton is of that size and grade. You also must make sure that every carton you pack according to a set of specifications, are uniform – every carton must look the same, inside and out.

Packing Patterns

A very important market specification that has to do particularly with packing is the packing pattern. To fit the right number of fruit into a specific carton, you need to pack it in a certain way.

Using a packing pattern also makes the carton look neat. Packing fruit in such a pattern is called place packing.

Here are a few examples of packing diagrams. The first one is the placing pattern for lemons in an A15C telescopic carton when you are packing count 88. The number in brackets after the count – in this case 5 – is the number of layers that you pack in the carton.

The next diagram is for count 113 lemons in an A15C carton. Even though you will still pack 5 layers you will place more fruit in each layer and in the carton, because they are smaller.

Can you now, with these diagrams on hand, tell how the second layer will be placed?

Here is an example of a packing diagram for oranges, for count 64, in an A15C telescopic carton.

Take the time to study the packing patterns for the citrus types that are packed in your packhouse so that you have a clear picture of what a packed carton should look like.

Smaller fruit of some citrus types are sometimes not packed in a pattern, depending on what the market wants. When fruit is just placed loosely into a carton without any pattern, it is called jumble packing.
Packing Cartons

There are many types of cartons that are used for export citrus from South Africa, but the two that are used most often are A15C telescopic and open-top display cartons.

The A15C carton is called 'telescopic' because it has a lid, or outer, that fits completely over the inner carton. The outer carton is usually specially designed and printed with the logo and other information of the brand, grower, packhouse or market agent.

The other commonly used type is an open-top display carton. This carton does not have a lid and is also usually printed with the brand information of the product.

The methods used for packing the different types of cartons are basically the same, but the number of fruit that can fit into each type of carton varies.

It is important that you know the different types of cartons that are used in your packhouse, and the packing diagrams and specifications for each type.

There are also minimum standards that are set for each type of carton, to make sure that the carton is strong enough and well-constructed. For more information on this, please look at the module on Packing Material and Specifications.

Packing Preparation

Before you start your shift, make sure that you know what and how you are going to be packing. Once the lines start rolling there is little time to get the information and supplies that you need.

Always check before your shift starts that you have enough labels, wrapping paper and other supplies.

Also make sure that you comply with the rules about personal hygiene and food safety, so that you can handle fresh fruit without contaminating it.
Cartons

Before packing fruit into a carton, you must make sure that the carton is in a fit state to be used. In most packhouses, cartons are folded and glued by the carton erection machine.

As a packer, check that the carton has been glued and folded properly, that there are no loose flaps, and that the carton is sturdy. Also check the ventilation holes of the carton. These must all be open, with the little piece of carton that closed them punched out.

Packing Practices

Place the carton next to you on a flat surface where you can easily reach it. Take the first fruit from the packing tray and place it in the bottom left-hand corner of the carton. Do not squeeze fruit into a corner too tightly because this can bruise the fruit.

Pack the first row according to the packing pattern for your variety and count. The fruit in the second row should now fit into the gaps between the fruit and the side of the carton.

Complete the bottom layer so that it looks like the packing pattern. Remember not to squeeze or force the fruit into the carton – the carton is big enough and will take the required number of fruit. Now you can pack the second layer. The fruit should nest into the bottom layer.

Continue to pack the fruit until you have packed the number of layers as shown on the packing pattern. If you are packing a telescopic carton, put the lid in place and press it down gently.

Put the carton labels in place, making sure that you put it on the right end of the carton, in the space where it should be, and that it is straight and neat. You can now place the carton where it will be taken for palletisation.

When you jumble pack smaller fruit, remember to still handle the fruit gently and not to drop or force it into the carton.

At the end of your shift or when you change to different packing instructions, make certain that your packing tray is clean and that all the fruit is removed.
**Spoiled Fruit**

If at any time you find a spoiled fruit in your packing tray that has been contaminated by a disease, **immediately stop packing**, and call the supervisor or packline manager.

This fruit will infect all the other fruit that it comes into contact with and the packline and packing equipment itself, which will in turn infect the other fruit that is still coming through the process. If this happens, the packline must be stopped, cleared and sanitised immediately.

**Wrapping**

Some markets require some or all of the fruit to be individually wrapped. Wrappers come in different sizes for different citrus varieties and sizes.

In some packhouses fruit is wrapped by a machine, mostly when the wrapper needs to be slightly shrinked on the fruit with a heat treatment, but it is more common for the packers to wrap fruit by hand.

Before starting, make sure that you know whether all the fruit needs to be wrapped or just some of them, such as alternative layers or diagonal rows.

Wrapping paper is usually has a thin layer of oil or wax on, and feels slightly slippery to the touch. This makes the paper easier to handle while wrapping the fruit, and helps to protect the fruit when it is packed. The wrappers are already cut to size and one wrapper per fruit is used.

To wrap the fruit, take a fruit in your non-dominant hand – for most people this is their left hand – and a piece of wrapping paper in the palm of your other hand.

Place the fruit on top of the paper and wrap the paper around the fruit. Make sure that the whole fruit is covered by folding the paper over the top of the fruit. Do not twist or turn the paper. Place the fruit in the carton.

With practice, this will become easier and by the end of a packing season you will not even notice the difference between packing with or without wrappers.
Packing Machines

In some packhouse automatic packing machines are used. These machines are very advanced and can be used to pack a great range of varieties and fruit sizes. Always remember that even machines can make mistakes and must still be monitored.

Quality Control

Every now and then a packed carton will be checked by the person doing quality control. They will take a carton out of the line and check the fruit inside.

First they will check to see that the fruit in the carton agrees with what it says on the label in terms of size and grade – this is to make sure that the graders are working according to the specifications. Then they will check to see that the right number of fruit is in the carton, and that the weight of the carton is according to what is required.

They will also check to see that the wrapping is done according to the packing instructions, and that the fruit is being handled with care and not bruised or injured.

If they find any problems they will give feedback to the supervisor who will speak to the graders and packers.

Pay attention to this feedback – it is very important to make sure that the packhouse delivers a product that is always of the best quality.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 29.1 – Worksheet

Explain what these pictures are, and how they are used.
Activity 29.2 – Table

Find the packing instructions for a citrus variety packed in your packhouse, and complete the table below.

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<td>PLU Codes</td>
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Activity 29.3 – Workplace Logbook

You have to complete practical packing tasks as part of your practical learning. Please ask your workplace supervisor or team leader to observe you while completing these duties and to sign off your logbook.
Activity 29.1 – Worksheet

Explain what these pictures are, and how they are used.
Activity 29.2 – Table

Find the packing instructions for a citrus variety packed in your packhouse, and complete the table below.

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<tr>
<th></th>
<th>Class 1</th>
<th>Class 2</th>
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<td>Count</td>
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Module 30
Palletisation

Contributor: Dawid Groenewald

Reference
More information on how cartons should be palletized can be found in the Packing Material Guidelines published by the Citrus Cold Chain Forum.

Introduction

After being packed, citrus fruit is ready to take the next critical step in the journey to the market. The fruit is now clean, treated, waxed, sorted, and packed in cartons, and has had a lot of value added to it. We must be very careful how we handle these cartons from this point on.

The first important task is to stack the packed cartons neatly and securely on pallets so that they will not be damaged during the journey of thousands and thousands of miles that lies ahead.

We must make the product look good and at the same time stay within the specifications laid down by the different local and overseas authorities.

On arrival on the world market, the buyers of our fruit must immediately get the impression that we are supplying them with cared-for products.

In the citrus export business there is enough risks that cannot be controlled, like road accidents, stormy seas and so on. We must make certain that we control and eliminate those risks that we can.
Pallets

Before stacking a pallet, ensure that the pallet complies with the pallet specification. Poor quality pallets can damage the cartons and fruit.

Pallets must be smooth, with no wood splinters, nails or screws that can catch on or stick into the cartons and fruit. Check that there is no fungal growth on the wood, because this can contaminate the fruit during the journey ahead.

Also make sure that the pallet is sturdy. The top deck slats must all be of the same thickness – slats of various thicknesses will damage the cartons. Every pallet must also have an ISPM 15 stamp on. This stamp shows that the pallet has been treated and approved for use.

Packaging Material Guidelines

Specifications for pallets used for exporting citrus can be found in the Packaging Material Guidelines document, published by the CRI.

This document not only states the specifications for pallets, but also sets out palletisation protocols for every type of carton. It is very important that you must know the protocol for every type of carton that you work with.

This document shows the stacking pattern for each type of carton and how the cartons should be stabilised on the pallet. It also contains handy tables for standard and high-cube pallets, that show for each carton type the number of cartons that there should be in each layer, the number of layers on the pallet, and the number of cartons that there must be on a pallet. It also tells you where the pallet should be strapped, and where securing sheets should be placed.

Please remember that these protocols are regularly updated, and you must make sure that you have the latest guidelines in hand.
Stacking Frames

A metal frame is used to help with stacking cartons on the pallet. The frame is used to make sure that cartons stand neatly on top of each other and that the stack is straight and do not lean to one side or the other.

In smaller packhouses, these frames are placed on the packhouse floor. In large packhouses, these frames are part of hydraulic palletising stations. The hydraulic stations allow the workers who are stacking the cartons on the pallets to work at hip level all the time.

Frames should always be clean and well maintained with no protruding pieces of metal, welding, nuts or bolts that can damage the cartons.

The pallet is placed in the bottom of the frame, and cartons are then stacked on it in the prescribed pattern inside the frame. When the required height has been reached, the pallet is carefully removed from the frame and the cartons are secured with corner pieces and horizontal strapping.

Pallet Stacking Practices

Before you start stacking cartons on the pallet, there are a few general rules that you need to know.

All the cartons we use for exporting citrus have ventilation holes, which are there to allow air to flow through the carton when it is cooled. There are ventilation holes in the bottom and the sides of the carton.

On ships and in containers, cooling is done vertically, which means that the air must be able to move vertically through the pallet. If you stack the bottom layer of cartons so that their ventilation holes are blocked by pallet slats, air will not be able to get in and the fruit will not be cooled quickly, which may cause waste.

You must therefore make sure that the ventilation holes in the bottom of the first layer of cartons correspond with the gaps between the pallet slats. You must also make sure that the cartons in the bottom layer are always positioned so that the four corners of each carton rest squarely on wood.
As we have already said, the Packaging Material Guidelines gives protocols for the palletisation of different types of cartons that is used for exporting citrus.

The carton types that are used most often are full telescopic cartons and open-top display cartons, and we will look at the stacking procedures for these cartons in detail, so that you can understand how the protocols are applied.

**Stacking A15C Cartons**

The first one we look at is the A15C full telescopic carton, used mainly for exporting oranges and lemons.

While stacking the pallets, make sure that the labels on all the cartons are on the outside and visible on the same side of the pallet. These end panels are referred to as the ‘business-end’ of the cartons.

To stack A15C telescopic cartons on a pallet, place three cartons lengthwise on the one long side of the pallet, and another three next to them. Then place four cartons crosswise next to these, to complete the bottom layer of the pallet load. Remember not to place the cartons so that their ventilation holes are blocked by the pallet slats.

Place two more layers of cartons exactly like the first layer. You now have three layers, stacked in the same pattern. Stacking the bottom three layers in the same pattern with cartons on top of each other, helps to distribute the weight of the stack and ensures that the bottom cartons won’t collapse. This is called column stacking.

On the fourth layer, stack the cartons opposite to the three layers below. This means that you will place lengthwise cartons on top of crosswise cartons, and the other way around.

The cartons on the fifth and seventh layers must now again be stacked like layers 1 to 3. Layer number 6 must be stacked in the same pattern as the fourth layer. The stacking for layers 4 to 7 is called brick stacking.

You have now stacked a standard pallet of A15C cartons with seven layers. For a high-cube pallet, an eighth layer is added in the same pattern as the fourth and sixth layers.
Stacking T64 Cartons

The second carton we look at is the T64 carton that is 170 millimetre high. This full telescopic carton is used for grapefruit exported to Japan.

The palletisation and stacking pattern principles are the same as for the A15C cartons. Stack three cartons crosswise on the one long side of the pallet. Then place two cartons lengthwise next to these to complete the bottom layer of the pallet load.

The bottom four layers are column stacked this way, and from layers 5 to 11, the brick stacked pattern is used, which gives you a standard pallet. A high-cube pallet is stacked 13 layers high, with layers 5 to 13 brick stacked.

Stacking Open-Top Display Cartons

The third type of carton we use is the open-top display carton. These cartons are mainly used for exporting fruit to supermarkets in the United Kingdom. Open-top display cartons are designed to fit on top of each other with locking tabs and slots.

To stack open-top display cartons on a pallet, stack three cartons crosswise on one long side of the pallet. Now add two cartons lengthwise next to them to complete the bottom layer. You must make sure that the ventilation holes in the bottom of the carton are not blocked by pallet slats, and remember that the carton labels, or business ends, must be on the outside.

When the layer is complete, put a securing sheet on top of the cartons on the first layer. Securing sheets are manufactured from corrugated board paper. Make sure the locking tabs correspond with the slots in the securing sheets. Now stack the cartons on the second layer in the same pattern as the first, making sure that the locking tabs fit into each other and that the cartons are secure on top of those below. Place another securing sheet on top, and add layer three.

Repeat this procedure with the same stacking pattern for all the layers, meaning that you are using column stacking. Stack the cartons in this way until you reach the required number of layers. The securing sheets are used to spread the weight of the cartons stacked on top and to ensure that the columns do not open up.
Open-top display cartons of various heights are used for different varieties and fruit sizes. For full details regarding the various sizes of open-top display cartons, the number of layers on a pallet for conventional vessels and high-cube containers, and the number of securing sheets and straps that must be used per pallet, please see the palletisation protocol section of the Packaging Material Guidelines.

**Pallet Caps**

To protect the fruit in the top layer of a pallet of open-top display cartons, a pallet cap is placed on the top layer. A pallet cap is a corrugated board paper ‘lid’ that fits neatly over the five cartons in the top layers.

Bulk bins used for exporting industrial grade fruit are stacked two high, and the top bulk bin is also covered with a pallet cap.

**Securing and Stabilising Pallets**

**Corner Pieces**

The stabilisation of the cartons on a pallet is extremely important. Pallet loads must be stabilised with four laminated paper corner pieces and horizontal straps.

Corner pieces not only protect the cartons and the fruit, but also ensure that the pallets reach the overseas markets in a neat, square and stable condition.

The Packaging Material Guidelines shows the requirements for the corner pieces that must be used on standard and high-cube pallets.

**Strapping**

The corner pieces are placed on top of the pallet, catching the bottom of the cartons on the first layer. The first strap is placed in the middle of the cartons stacked in the bottom layer. The strapping is tightened, sealed and cut with special tools.
The strapping that is used on the rest of the pallet depends on the carton type that is used, and the number of layers. The general rules are that the bottom three layers of A15C full telescopic and all open-top display cartons must always be strapped and the bottom four layers of the T64 cartons.

In addition, the top layer of all pallets must be strapped, for all carton types. More straps are placed between the third or fourth and the top layers.

You can see where these straps must go in the Packaging Material Guidelines, where it is indicated as for example 1, 2, 3, 6, 9 and 12, being the numbers of the layers that must be strapped.

**Pallet Marking**

After stacking and wrapping the pallet, a barcode sticker is stuck onto the pallet. This EDI, or Electronic Data Interchange, sticker helps with tracking the pallet on the rest of its journey.

This system is currently being developed by the PPECB in conjunction with the DAFF, and role players in the South African citrus industry. The aim is to develop an EDI tag that can be placed on every pallet so that a pallet can be tracked right from the packhouse through every link in the chain.

At the packhouse a small barcoded EDI label is attached to the pallet. This barcode is registered on an international database. Anyone that scans the barcode will immediately be able to see where and when this pallet was packed, where and when it was stored and cooled, and how it was shipped.

In some packhouses the system is already in place, and is proving beneficial to the packhouse and producer.

**Pallet Inspection**

Before pallet loads can be exported fruit must be inspected and approved by PPECB representatives. For this purpose two spare cartons are placed on top of every stacked pallet.

When the PPECB inspector arrives, the pallet is broken down and the inspector selects two cartons for inspection. The inspector then verifies that the load complies with the minimum export standards.
The pallet is then re-stacked, using the two spare cartons to replace those that were removed for inspection. Remember that the pallet must again be stacked and secured in the manner we discussed before.

This inspection procedure is prescribed by law, and every single pallet must be inspected in this way.

**Preparing Pallets for Transport**

After the pallets have been inspected and approved, they are stored, ready to be loaded for transport.

Wrapping pallets with black plastic is essential as the pallets are transported on flatbed or tautliners trucks. Over long distances by road, serious scuffing of cartons occur, caused when the outside faces of the pallet loads rub against those of the pallets next to it.

By the time the load arrives at its destination, the cartons will not look good any longer and may be damaged. To prevent this from happening, you must drape plastic sheeting from the top to the bottom around three sides of every second pallet.

The plastic must be taped at the top of the pallet to prevent the plastic from sliding own. Only every second pallet has to be wrapped.

On a flatbed truck, the pallets are covered with a tarpaulin after being loaded. Liner board, which is single face corrugated board, must be placed on top of the load, between the cartons and the tarpaulin. The liner board absorbs that moisture from the fruit, and prevents the top layer of cartons from dampening and weakening.

**Conclusion**

Incorrect palletisation can cause huge financial losses for the packhouse and the grower.

When a load of citrus arrives in an overseas market and is off-loaded at the harbour, there is nothing that shows how well a product has been cared for, than the first impression given when seeing neatly and correctly packed and stacked pallets and cartons.
active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 30.1 – Group Activity**

Make a sketch indicating – with the minimum amount of writing – how to stack and secure a pallet of T64 cartons in high-cube formation. Swap sketches within your group and stack a pallet using only the sketch. Discuss the results and shortcomings afterwards.

**Activity 30.2 – Table**

Make a table with details of all the equipment needed to secure cartons on a pallet, including the name and description of every piece of equipment, an explanation of how it should be used with attention of health and safety, and how it should be stored, cleaned and maintained.

**Activity 30.3 – Workplace Logbook**

You have to complete practical palletisation as part of your practical learning. Please ask your workplace supervisor or team leader to observe you while completing these duties and to sign off your logbook.
Activity 30.1 – Group Activity

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Module 31
Palletisation – High-Cube versus Standard Stacking

Contributors: Mitchell Brooke and Paul Hardman

Background

In the past, fruit were predominantly exported in specialised reefer ships. The height in the decks of these vessels only permitted a pallet height of two meters.

These pallets are referred to as standard pallets, and they were restricted to this height while conventional transportation was utilised.

Recently, with the development of the high-cube integral container, with a height of 2.4 meters, the height of stacks on pallets could be increased by one or two layers of cartons, depending on the carton type. These pallets are called high-cube pallets.

Twenty high-cube pallets could be loaded into a high-cube integral container, while remaining within the maximum permissible height in order to allow for sufficient air circulation within the container.

To load a high-cube container with pallets of 15kg cartons, three standard pallets had to be broken down so that those cartons could be added to twenty other standard pallets to make up high-cube pallets. In the case of 16kg cartons, two pallets were broken down and the cartons added to standard pallets before the container could be loaded.

Receivers began to complain about this practice, because cartons with different counts were ending up on the same pallet. Another issue was that when standard pallets were packed into high-cube containers in this way, there were always a few loose cartons, and these cartons were packed at the back of the container by the doors.

Receivers also began to complain that the loose cartons were being damaged in transit, and that they were a hassle to receive and manage.
High-Cube vs. Standard Stacking

Packhouses and growers also soon realised that the fee charged by the cold store for breaking down standard pallets and building high-cube pallets could be saved by simply stacking high-cube pallets with uniform counts at the packhouse.

This also eliminated the harbour handling charge for the three additional pallets, and addressed the concerns raised by receivers. If the cost saving of doing this at the packhouse is calculated on an FOB basis, it is estimated to be about R1.00 per carton.

Here is a simple comparison to give you some indication of difference in carton load per pallet. From this table we can see that 10 more of both A15C telescopic and open-top display cartons can be stacked on a high-cube pallet.

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<tr>
<th>Carton</th>
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<tr>
<td></td>
<td>Standard pallet</td>
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<td>A15C 10 x 7 layers = 70</td>
<td>10 x 8 layers = 80</td>
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<tr>
<td>Open-top display 5 x 11 layers = 55</td>
<td>5 x 13 layers = 65</td>
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**FOB Basis**

FOB stands for free on board, and is a trade term used when the seller is required to deliver the goods on board a vessel designated by the buyer. Under an FOB arrangement, the seller fulfils his obligation when the goods pass over the ship's rail.

**High-Cube Constraints**

We can therefore see that there are cost savings in using high-cube pallets. More cartons can be stacked onto each pallet, saving on per costs of the pallet itself and harbour handling. There is however certain constraints that must be taken into account.
Cold Store Facilities

Port fruit bulk terminals and the older cold stores have racking systems that were built using fixed drive-in type units. These racking systems were built to handle standard height pallets for conventional shipping.

The number of high-cube pallets that are being used has grown substantially over the last three years due to the growth in containerised exports, although a true value of the number of high-cube pallets in relation to the total volume of exports has not been determined.

Cold store facilities have not yet adapted infrastructure sufficiently to handle the volume of high cube-pallets that are being sent. Some facilities have managed to convert a limited number of cold room racking systems to handle high-cube pallets by extending the height of the racking units, but the majority of high-cube pallets sent to these facilities either have the top layer removed from the pallet, or pallets are placed in the centre isle of the bottom tier of a rack location.

The two constraints here are that the top layer cartons are consolidated with other high-cube pallets and then retrieved and placed with the original pallet when the container is packed, and this causes a time delay. The other constraint is that cold store capacity cannot be fully utilised as space is reduced by high-cube pallets that use only the bottom tier of a rack location.

There is also an obvious concern that loose cartons removed from the top layer of the high-cube pallet, may not be successfully returned to their original pallet, which means traceability is compromised.

Carton Stress Levels

During the transport and handling of high-cube pallets, the bottom layer of cartons are subjected to higher stress levels with moisture development in cold rooms weakening the carton strength and resulting in collapsed cartons. Fruit damage and squaring of fruit has been noticed as a result of this. It must be kept in mind that mass load failure tests on cardboard are done on the assumption that standard pallets are used. The extra weight carried by the bottom layer of cartons in high-cube pallets, are not provided for in these tests. Cardboard that only just comply with specifications, may not be strong enough to carry the extra weight.
Please Note

The information in this module was accurate at the time of going to print, which was after the 2009 citrus season. Please enquire about the current high-cube storage capacity of your preferred cold store facility.

Regarding carton stress levels: carton specifications have since been adapted to ensure that cardboard is strong enough to handle the extra weight when high-cube pallets are used. Packhouses must ensure that they use a reputable supplier that manufactures cartons to these specifications.

Conclusion

A grower needs to know how his fruit will be shipped before making the decision on how to stack pallets.

There is a cost saving factor when stacking cartons in a high-cube formation, but this must be weighed against the risks of fruit being damaged and the shortage of storage facilities able to accommodate the pallets.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignment(s) below.

Activity 31.1 – Interview

Interview your packhouse supervisor and find out how many pallets were stacked in standard and how many in high-cube formation during the previous season. Ask him about what he believes to be the benefits of using high-cube pallets. Make notes in your workbook on this responses.
Activity 31.1 – Interview

Interview your packhouse supervisor and find out how many pallets were stacked in standard and how many in high-cube formation during the previous season. Ask him about what he believes to be the benefits of using high-cube pallets. Make notes in your workbook on this responses.

Details of interviewee

Name and surname: 

Date of interview: 

Signature of interviewee:

Additional notes:
Module 32
Marking

Presenter: Marius Scholtz and Niel Malan

Introduction

The marking requirements of cartons of export citrus is prescribed by the standards and requirements set by the Department of Agriculture, Forestry and Fisheries. As part of its inspections, the PPECB, as the assignee of DAFF, ensures that these marking requirements are met.

The prescribed labelling and marking requirements are international standards, as agreed between the importing and exporting countries. Labelling cartons correctly is essential to enable traceability and track-ability, and to make sure that the right fruit is delivered to the right market.

Traceability

Traceability is the ability to trace any product back to its original source. In terms of fruit production and exports, traceability is the ability to trace back a specific carton of fruit through the entire process to the orchard in which the fruit was grown.

Track-ability

Track-ability is the ability to track any product to its final destination. In terms of fruit production and exports, track-ability is the ability to track a specific carton of fruit through the supply chain as it moves between organisations towards the final point of process or sale. Tracking is also referred to as forward traceability.

Marking Requirements - Example 1

The PPECB apply the standards and regulations on behalf of the Department of Agriculture, Forestry and Fisheries. There are a few marking requirements that we have to apply. Using this example, we can have a look at those requirements.
Exporter Information

There have to be certain information on the carton before it can be exported.

Firstly we look for the name and the physical or the postal address of the producer, the exporter or the owner of the fruit. In this case it is a postal address, which is fine.

Fruit Information

Then the type of citrus which is oranges and the cultivar of oranges, in this case valencias. The class must also be indicated, in this case class 1.

Fruit Size

There must also be mention of the diameter of the fruit for which they use a size code.

This is size 6 which is a reference to the diameter of the fruit. If the fruit is place packed as the case is here it must be indicated, also the count, in this case count 72, which is the amount of fruit in this box.

The Date Code

And then a date code, which is an indication of the packing date which is this number. In this case it is a code that was used which is fine, as long as it have been registered with the Department of Agriculture.

The PUC and PHC

And then the PUC or the PHC, which means the production unit code or the packhouse code, must also be shown on the carton. That is basically the farm or the packhouse reference.
PUC

A PUC is a **Production Unit Code**, and is a code issued by the Department of Agriculture, Forestry and Fisheries (DAFF) to producers that qualify to produce fruit for export.

PHC

A PHC is a **Packhouse Code**, and is issued to packhouses by the DAFF to packhouses that qualify to pack produce for export to overseas markets.

**Post Harvest Chemicals**

If any postharvest chemicals have been used, then it must also be indicated on the carton. In this case it is indicated on the top of the carton, which is fine.

**Target Market Requirements**

Sometimes some target markets have additional marking requirements, like China. A market might also require that, somewhere here on the business side of the carton the legend ‘Peoples Republic of China’ must be shown in English, and in Chinese writing.

**Summary**

All export cartons of citrus must have the following information:

- Exporters name and address
- The ‘Origin of South Africa’ mark
- The packhouse code
- The production unit code
- The date code for when the fruit was packed
- What chemicals were used during packing
- The fruit information, such as fruit variety, cultivar, size and count reference
Different cartons will have different looking labels. In the next part we look at another example of carton labelling.

**Marking Requirements - Example 2**

Firstly we have the name of the exporter and his address. It is also important to have ‘Origin of South Africa’ legend.

Then we have the variety, the count and the size reference, also known as the calibre and count.

Next we have the PHC, or Packhouse Code, indicating where the fruit was packed. This brings traceability back to the packhouse.

Every carton must also have a PUC code. This is the Production Unit Code and it stipulates which farm the fruit comes from. The PUC must be registered with DAFF. This helps with the traceability of fruit, should the client want to know from which farm or grower the fruit comes, they can trace the origin through the PUC.

Then it must have a date code. This reference indicates exactly in which week and on which day the fruit was packed, as well as the number of the line in the packhouse where it was packed.
The Date Code

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<tr>
<th>33</th>
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<tbody>
<tr>
<td>Week</td>
<td>Day of week</td>
<td>Packline</td>
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This is only an example of a date code. Included in the packing instructions provided by export agents are normally instructions on the particular date code that the packhouse should use. Date codes must be registered with DAFF before they can be used.

Pallet Marking – Electronic Data Interchange (EDI)

Apart from carton marking, pallet marking is also becoming common practice in the citrus industry.

The PPECB, in collaboration with industry role players, have been working on the development of an Electronic Data Interchange, or EDI, system. Once this system is in place, all pallets will also be marked with barcode labels, which will enable any person to access information about the pallet and the fruit on it by merely scanning the label.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 32.1 – Reference Table

Draw up a table, listing the minimum marking requirements with a short description of each item, and an indication of where this information comes from.

Activity 32.2 – Research Report

Find out what date code is used in your packhouse. Explain what the code indicates, and find out how it was registered with DAFF.
**Activity 32.1 – Reference Table**

Draw up a table, listing the minimum marking requirements with a short description of each item, and an indication of where this information comes from.

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<thead>
<tr>
<th>Marking requirement</th>
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Activity 32.2 – Research Report

Find out what date code is used in your packhouse. Explain what the code indicates, and find out how it was registered with DAFF.
Module 33
Inspections – PPECB

Presenter: Shubesco Heilbron

Introduction

South Africa is a member of the inter-governmental Codex Alimentarius, which develops international food safety standards. These regulations are legislated and published in South Africa by the Department of Agriculture, Forestry and Fisheries.

In South Africa, the PPECB is the assignee of DAFF who conduct inspections on their behalf. The task of the PPECB is to check that all the standards and requirements for the export of fresh produce are adhered to, before they allow the product to be exported.

The PPECB physically inspects and approves products and systems before the exporting of fruit is authorised.

The PPECB

The Perishable Products Export Control Board is an independent service provider. The PPECB derives it mandate from the following legislative provision, APS Act number 119 of 1990, which mandates the board as an assignee for the Department of Agriculture, Forestry and Fisheries to conduct quality inspections on agricultural, perishable products destined for export.

The PPECB acquired the European Union accreditation which means that, the effectiveness and the efficiency of the inspection systems are equivalent to the European Union requirements.

This accreditation contributes to the cost saving for the South African perishable export industry, as products are not inspected again on arrival in the importing country. Therefore we can say that the PPECB inspections provide our clients with a passport to international trade.
The operating environment in which PPECB does the various inspections for the various products, gives us a national geographical footprint which comprises of 42 offices and 1,350 inspection points, giving us a client base of 1,611 and a supplier account base of 1,764.

The 42 offices which we operate from nationally consist of 11 regional offices which are located in the following regions:

- Cape Town
- Paarl
- Grabouw
- Worcester
- Ceres
- Citrusdal
- Port Elizabeth
- Durban
- Nelspruit
- Tzaneen
- Johannesburg

**PPECB Inspections**

At these locations we do more or less 220 different types of product inspections, which comprises of the following groups:

- Deciduous fruit
- Citrus fruit
- Subtropical fruit
- Vegetables
- Grain
- Processed products
- Animal feeds
- Flowers

Each and every food business operator, that is the producer who produces products for export, must provide PPECB with a room on the premises where inspection can take place. This room must be separate from production and packing areas and not shared with the other packhouse functions.
Export Standards

The products that we inspect for export are being checked according to product standards, which are compulsory minimum quality standards. The purpose of these standards is to provide for a disciplined export and a minimum quality platform.

These standards are updated annually with input from the various industry bodies, the Department of Agriculture Forestry and Fisheries, and the PPECB. These updates include international developments as well.

Now the standards prescribe requirements for:

- Quality
- Food safety
- Traceability
- Containers
- Packaging
- Marking
- Sampling

The standards also prescribe the methods according to which these products must be evaluated. The tolerances are also prescribed, which gives allowance for maximum permissible deviations from the quality defects on the products.

On citrus for example we look at the internal quality of the citrus product, with regard to the juice content, the brix, that is the sugar content, and also we look at the sugar to acid ratio of the fruit.

The external quality of these products are covered by the colour and blemish charts that we use to determine the specific colour as per market segment and as per season, and also the defects allowable or the blemishes on the outside surfaces of the fruit.
Export Standards

For more information on citrus export standards, please look at Module 5 – Citrus Export Standards.

Inspection Procedures

At the inspection point, PPECB inspectors look at sample cartons from every pallet of export citrus.

They open the cartons and remove the fruit, counting it to check that the correct number of fruit is in the carton. They measure the fruit to confirm that the right size reference was used, and use colour and blemish charts to determine whether the fruit was graded correctly.

After this, internal quality tests are performed on a selected sample and checked against the minimum requirements. If the fruit passes all these inspections, the whole pallet is approved for export.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 33.1 – Flowchart

Observe how the PPECB do inspections at your packhouse. Draw a flowchart in your workbook, showing how this process works, and when and how they do what tests.

Activity 33.2 – Practical

Observe a PPECB inspection in your packhouse, and record their findings in terms of the internal and external quality of the fruit. Take a sample of the same fruit, and perform your own inspection on the sample. See if you get the same results as the PPECB inspectors. If not, explain why this is the case.
Activity 33.1 – Flowchart

Observe how the PPECB do inspections at your packhouse. Draw a flowchart in your workbook, showing how this process works, and when and how they do what tests.
Activity 33.2 – Practical

Observe a PPECB inspection in your packhouse, and record their findings in terms of the internal and external quality of the fruit.

Take a sample of the same fruit, and perform your own inspection on the sample.

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<th>Tools and equipment</th>
<th>Handling before, during and after task completion</th>
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SOPs:

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<th>Time spent on tasks</th>
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See if you get the same results as the PPECB inspectors. If not, explain why this is the case.
Module 34
Inspections – DAFF

Presenter: Kuben Naidoo

Introduction

The Department of Agriculture, Forestry and Fisheries are the governing body that legislates and implement all laws regarding the production and export off all agricultural products in South Africa.

The Department has the power to assign certain tasks to independent agencies, such as the PPECB, who are the assignee of DAFF for conducting inspections on product quality of fresh produce destined for overseas markets.

Inspections concerning phytosanitary requirements that products and producers must adhere to, is preformed by the Department’s own inspectors.

In order to become an approved producer of export produce, a grower must obtain a Production Unit Code, or PUC. This code is issued by the Department of Agriculture and is only issued after a physical inspection of the farm and a look at the chemicals used for pest control.

The International Plant Protection Convention (IPPC)

South Africa is a signatory member of the International Plant Protection Convention. One of the requirements of the International Plant Protection is that contracting parties must adhere to importing countries phytosanitary requirements and that any consignments of citrus fruit to be exported must be certified free of quarantine pest and diseases.

The Department of Agriculture Forestry and Fisheries is the national plant protection organisation in South Africa, and therefore we ascertain the phytosanitary import requirements of the importing country therefore inspections will be conducted to ensure fruit is free from pest and diseases.
Inspections

**Orchard Inspections**

After registration the Department of Agriculture and Forestry inspectors will conduct orchard inspections and ensure compliance according to each market’s protocols and requirements.

After orchards have been approved by the Department of Agriculture, Forestry and Fisheries inspection services, the fruit can be harvested.

**Packhouse Inspections**

At the packhouse our assignees the PPECB conducts quality inspections and also makes sure the packaging, the cartons complies with marking requirements.

Once the consignment has been approved by PPECB at the packhouses and meets the marking requirements and the quality requirements, the consignment is transported to the final point of discharge.

**Phytosanitary Inspections**

Thereafter the Department of Agriculture, Forestry and Fisheries’ APIS inspectors conducts phytosanitary inspections.

The first step in phytosanitary inspections involves the evaluation of documents, to see that the consignment correlates with the documents.

If the documentation is in order, a random representative sample would be drawn at the inspection point and inspected by APIS inspectors to look for pests and diseases, according to the import requirements of the importing country.

Some markets require that it is stated on the phytosanitary certificate that the fruit should be disinfected, and the mitigation option is cold treatment. The fruit is therefore pre-cooled for a certain period and thereafter loaded into reefer ships and containers with the required temperature.
After the consignment has been approved, a phytosanitary certificate is issued confirming the South African exporter has met the phytosanitary import requirements of the importing country and the phytosanitary certificate must accompany the consignment.

**APIS**

APIS stands for Agricultural Products Inspection Services. This is a directorate of the Department of Agriculture, Forestry and Fisheries.

**Summary**

In order to obtain a phytosanitary certificate to export citrus fruit, a producer must be able to show that the chemicals used for pre-harvest pest control and in the packhouse are in line with regulations stipulated by the importing country.

The Department of Agriculture will use their APIS, or Agricultural Product Inspection Service, inspectors to inspect the fruit to ensure that it is pest and disease free, and adhere to other phytosanitary requirements that the importing country might have. All phytosanitary requirements that a producer need to adhere to can be found on the DAFF website.

**active learning**

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 34.1 – Flowchart**

Draw a flowchart that shows the process a new producer must follow before he will be allowed to export fruit.

**Activity 34.2 – Workplace Research**

Do research and interview managers in your workplace to find out what inspections are conducted on the citrus that is exported to one of your major markets. Write a 1-page report on these inspections, stating who is responsible for conducting them, where they are done, what the inspectors look for, and what documents are issued if the inspection is successful.
Activity 34.1 – Flowchart

Draw a flowchart that shows the process a new producer must follow before he will be allowed to export fruit.
Activity 34.2 – Workplace Research

Do research and interview managers in your workplace to find out what inspections are conducted on the citrus that is exported to one of your major markets. Write a 1-page report on these inspections, stating who is responsible for conducting them, where they are done, what the inspectors look for, and what documents are issued if the inspection is successful.
Module 35
Export Shipping Overview
Presenter: Mitchell Brooke

Introduction

In 1906, the first ever consignment of 3,000 cases export oranges arrived in London from the then Transvaal. Over the last 100 years, citrus exports from South Africa have grown to almost 90 million cartons in 2008, amounting to about 1.4 million tonnes.

Exporting this volume of citrus requires considerable infrastructure, both inland and in terms of port and shipping capacity. All citrus fruit is refrigerated while being shipped with some of the fruit pre-cooled at the packhouse and other pre-cooled only once it reaches the harbour.

On the ship fruit is kept at optimum temperatures to preserve the quality and vigour of the fruit, and to suppress the development of postharvest diseases.

There are mainly two types of vessels that are used for exporting citrus, being reefer ships and container ships. On reefer, or refrigeration, ships loose pallets are loaded in the decks, where the fruit is kept cold during the voyage. Container ships transport containers that have already been loaded with pallets of citrus, either at the packhouse, or at the port.

Growth in citrus export volume in the late 1990s resulted in fruit terminals becoming congested. From that time on, there were a number of cold store facilities built around the ports. The facilities stored or pre-cooled citrus, which was then trucked to the citrus terminals for loading on a specialised reefer ships.

Containerisation growth was marginal and only since the turn of the century began to escalate annually.
Production Regions and Harbours

This map illustrates the main production regions relative to the port of export being Cape Town, Port Elizabeth, Durban and Maputo. It can be seen that the Western and Eastern Cape regions, which are in close proximity to ports, have the advantage to load containers at either packhouse facilities or inland cold stores, which are then transported directly to container terminals.

This trend in shipping has grown phenomenally in these regions and in recent years offers a more competitive price structure as opposed to trucking the fruit to fruit terminals to be exported on board reefer ships.

Container Shipping Growth

From the illustrated chart, high growth in container shipping can be seen during the last five years, with a severe decline in exports on reefer ships. Also illustrated is the growth towards loading containers at inland production points.

The next chart illustrates the percentage growth towards container shipping. Where in 2004 only 30% of citrus was exported using containers, in the more recent 2008 citrus season, growth in container shipping has escalated to over 60%. It is estimated that growth in the next five years will reach possibly above 70% of citrus exports.

Western Cape Growth

The next chart shows the high growth in container exports from the Western Cape hinterland, from 45% in 2004 to an estimated 80% in the next five years.

Eastern Cape Growth

Similarly, in the Eastern Cape container growth can be seen from 30% in 2004 to an estimated 80% during the next five years.
Northern Regions Growth

Growth in container volume can be seen in the northern regions hinterland, which is exported from Durban and Maputo ports. Growth has escalated from under 30% in the 2004 citrus season to an estimated 70% in the next five years.

The reason for the high growth in container volume is that container ships can load far more cargo under deck as well as on deck and in most cases it is more economical than reefer ships and therefore reduces the cost of the supply chain.

Container Shipping Savings

Another important factor that contributes to the increase in containerised exports is that harbour handling fees can be reduced by loading containers at inland production facilities.

Container Export

Northern Europe and UK

The following chart illustrates that the growth in container exports can be seen predominately to Northern Europe and the UK from a mere 30% in 2004 to 70% of exports to that region using containers in the 2008 citrus season.

Southern Europe

Southern Europe, which is predominately shipped on reefer ships, has grown from 10% to over 50% towards container shipping.
Middle East

Middle East, which is one of the bigger markets, second to Europe, has seen similar growth in container volume from around 20% to around 80% during the last season.

These markets specifically have seen higher growth towards container shipping during the current 2009 season than what was originally anticipated. The main markets where specialised reefer ships still dominate are Russia, Japan and the United States.

Conclusion

There are advantages to be had both from shipping fruit in reefer ships and from using containers. The infrastructure that is available for handling and transporting containers is the main factor that will determine developments in future.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 35.1 – Mind Map

Have a group discussion about the growth towards container exports and the impact it will have on the South African citrus industry. Draw a mind map in your workbook detailing the outcomes of your discussions.

Activity 35.2 – Research

Use information from earlier modules and conduct internet research to gather information about the following:

✓ What is a ‘cold sterilisation protocol’?
✓ Why do certain countries require fruit to be exported using a cold sterilisation protocol?
✓ Which countries require this protocol at the moment?
Activity 35.1 – Mind Map

Have a group discussion about the growth towards container exports and the impact it will have on the South African citrus industry. Draw a mind map below detailing the outcomes of your discussions.
Activity 35.2 – Research

Use information from earlier modules and conduct internet research to gather information about the following:

- What is a ‘cold sterilisation protocol’?

- Why do certain countries require fruit to be exported using a cold sterilisation protocol?

- Which countries require this protocol at the moment?
Please Note

The information in this module was accurate at the time of going to print, which was after the 2009 citrus season. Please keep up to date with the latest developments in terms of infrastructure availability and usage by consulting the regular logistics report issued by the Citrus Growers’ Association (www.cga.co.za).

Introduction

Citrus is a perishable product. The infrastructure that is required to transport, load and ship the almost one-and-a-half million tonnes of citrus that is exported from South Africa annually therefore needs to be adapted for the special needs of our product. Infrastructure can be defined as the basic services, physical structures and facilities needed for the operation of citrus exports. The term typically refers to the technical structures that are required such as roads, rail lines, cold store facilities, port terminals and shipping, and so forth.

Production and Export Ports

On the map we can see the production regions in relation to the ports utilised for exporting citrus, being Cape Town, Port Elizabeth, Durban and Maputo. A high concentration of citrus production can be seen in the northern part of South Africa, which is sent to Durban and Maputo ports.

Here we can see that, from the citrus tree planting data in each of the provinces, we are expecting an increase of 20% in production in the next five years. If we align this data from each region and link it to a shipping port, then we can ascertain what volume of growth can be expected to be shipped from each port.

If we consider the data that is reflected in the next slide, it can be ascertained that each port is likely to expect volume growth in the next five years.
The Durban and Maputo ports combined ship about 60% of citrus exports, which is a lot higher than what is shipped from Cape Town or Port Elizabeth. The Durban and Maputo ports combined are expected to ship a further 15% of citrus between them, which may eventually exceed one million pallets of citrus in the next five years. This is based on the tree citrus planting information provided from the northern regions.

The Cape Town and Port Elizabeth ports are also expected to grow about 15% and 10% respectively. When considering this data in terms of infrastructure we need to evaluate what the future demands are going to be required to ensure that this volume of citrus will be efficiently and effectively managed.

Infrastructure Requirements

Rail Transport

Rail transport handled less than 5% of citrus exports during the 2009 season, and therefore rail transportation is considered a critical strategic element for citrus exports.

Cold Store Capacity

Further we need to evaluate what cold store capacity is available in each region and consider proposals to increase capacity where a shortfall can be identified.

Container Shipping Growth

We can see that high volumes of citrus are being exported in containers. From the 2004 season to the 2008 season, a three fold increase in container volume was seen where now 60% of citrus is shipped this way.

Further growth in container exports are expected in the next five years, where it is estimated that 70% of citrus exports will be transported by containers to markets.
Mobile Racking Units

If we consider this, it will be essential to ensure that cold store facilities adapt infrastructure to manage this volume. This will entail the development of mobile racking units and extra container bays will be needed.

Stock Dwell Time

Short term solutions to ensure that volume growth can be managed sufficiently with the current infrastructure, is to reduce stock dwell time so that a higher volume of citrus can be handled by cold stores, as lower dwell times will mean that products will move quicker through the cold stores facilities.

Increasing Rail Transport

Another important aspect is to increase the use of rail transport, and rail will ensure that the product flow from packhouse to port facilities and terminals is a seamless operation.

Conclusion

It is also critical that industry stakeholders are aware of the volumes of citrus that is expected to be exported in the next five years in order to evaluate infrastructure demands.

The Citrus Growers’ Association makes available information on current and projected citrus production and export volumes, and infrastructure usage and requirements.

Please visit their website at www.cga.co.za for more information.
Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 36.1 – Research Report**

Contact your local railway offices and transport operators to determine the price difference between transporting citrus fruit by rail or by road from your packhouse location to the harbour.

Write a 2-page report, summarising the cost comparison – remember to take into account all costs involved in each mode of transport – and discussing the advantages and disadvantages of the two modes. Make a recommendation based on your findings and conclusions.

**Activity 36.2 – Group Discussion**

In your group, discuss where capital investments in infrastructure should be made to ensure that the expected growth in citrus production and exports can be adequately handled. Make keynotes on your discussion in your workbook.
Activity 36.1 – Research Report

Contact your local railway offices and transport operators to determine the price difference between transporting citrus fruit by rail or by road from your packhouse location to the harbour.

Write a 2-page report, summarising the cost comparison – remember to take into account all costs involved in each mode of transport – and discussing the advantages and disadvantages of the two modes. Make a recommendation based on your findings and conclusions.
Activity 36.2 – Group Discussion

In your group, discuss where capital investments in infrastructure should be made to ensure that the expected growth in citrus production and exports can be adequately handled. Make keynotes on your discussion in your workbook.
Module 37
Road Transport Overview
Presenter: Lynette Grobler

Introduction

Citrus are produced in all of South Africa’s nine provinces. In most cases this means that fruit must be transported for thousands of kilometres before it even reaches the harbour from where it will be loaded onto ships and exported.

Citrus fruit are transported to the harbour either by rail or by road. When transporting citrus fruit by road, there are a number of different factors that must be taken into account to ensure the safe transport of your fruit.

Transport is a very important link in the supply chain, and if not monitored well, it can lead to substantial financial losses. Firstly, the grower will contract a transport company to transport his products.

Citrus growers have different transport needs. The different trucks that can be used to transport citrus are:

- Refrigerated trucks
- Tautliners (trucks with curtains)
- Flatbeds

The type of product determines which type of truck is used. For fruit in open-top display cartons we suggest using tautliners, as the fruit will be damaged if the drivers walk on the cartons. Fruit in telescopic cartons can be loaded onto flatbeds and covered with tarpaulins.

Transport Companies

A transporter is contracted, and his trucks must comply with the various standards. It must either be a 34 or a 36 ton truck. Sometimes tri-axle trucks are used for fruit delivered to Maputo. For soft citrus we use refrigerated (reefer) trucks.

Before a producer contracts a trucking company there are certain legal requirements and documentation that must be in place.
**FBO Code**

All transporters must register with the Department of Agriculture. They receive a FBO (Food Business Operator) code, which has to do with food safety.

DAFF requires information of up to ten previous loads transported by a vehicle to control contamination.

**Truck Permits and Licences**

Every truck must have a port permit so that it can enter the harbour and offload.

Every truck must be roadworthy, the driver must have a licence, and every truck must comply with the industry standards.

The trailer must be flat, so that pallets can be loaded onto it safely, without damaging the pallet base.

**Loading of Trucks**

When the load has been inspected and approved by the PPECB, the producer contacts the transporter to send a truck. Pallets are placed together to make up a load, depending on the fruit type.

Usually you can load between 32 and 34 pallets of open-top display cartons, and 28 pallets of telescopic cartons when using standard pallets. The number of pallets is decreased pro rata according to the pallet weight.

**Weighing of Cartons**

Packhouses must weigh their various cartons, every count and type of packaging. The weight of the same fruit size can vary, even if packed in the same type of carton.

We want to avoid overloading. En route to Durban there are many weighbridges, and even if a truck is slightly overloaded, by for example 80kg, pallets will be offloaded and stored at the side of the road until another truck collects the pallets.

In this situation everybody loses money and fruit quality is negatively affected. So it is important to know the weight of each count and pallet.
**Truck Usage**

The type of truck used for transporting fruit, depends on the type of fruit loaded. We use refrigerated (reefer) trucks when loading fruit that has already been pre-cooled. Refrigerated trucks must be certified by the PPECB and must be able to monitor the airflow and provide a print out of the temperature afterwards. A maximum temperature fluctuation of 2°C is permitted. It is important to remember that a refrigerated truck is there to maintain the fruit temperature and not to bring the temperature down.

We have trucks with curtains on the side, mostly used for open-top cartons, and then flatbed super link vehicles.

**Overloading**

Every truck trailer has a disc indicating its maximum legal carrying mass. There are two overload scenarios. The truck can be overloaded totally, exceeding 56 tons, which is the legal weight limit for truck and freight combined.

The load weight can also be spread incorrectly over the axles. The idea is to place the load in the middle of the trailer across the axles and not towards the front or the back. If the cargo is loaded incorrectly on the axles, it can be shifted at the weighbridge, but you will incur a fine. But if the load weighs more than 34 tons, pallets must be removed.

Currently there is a 2% weight tolerance on our roads, but it also depends on the province that you are in. This tolerance is however not there to be abused – it is only a precaution.

**Transportation Process**

**Documentation**

Once the truck is loaded, the driver gets a consignment note at the office. He must ensure that the number of loaded pallets on the truck agrees with the consignment note. He must also check the delivery address. The address on the consignment note is often that of the export agent, which can be totally different from the receiver’s address where the load must be delivered.

He must make sure that he has all his documents and that he is ready to depart.
Load Inspection

After travelling about 100 kilometres the driver should stop and inspect the load, checking that all the straps securing the load are tight, that the load is properly covered, and that there are no tears in the tarpaulin, where water can get in and wet the cartons.

Reporting

If, en route to the harbour, the driver finds that there is a problem with the load, that the load has shifted or pallets have toppled over, or if he is detained at a weighbridge, or have any other problem, he should contact his depot immediately. The depot must contact the packhouse and report the problem so that corrective action can be taken.

Insurance

Every load must be insured with goods-in-transit insurance. Should the truck be involved in an accident and the whole load or part of the load is lost, the money can be recovered for the product.

Offloading

When the truck reaches the delivery point, the driver takes the consignment note to the office and presents it to the person that handles intake.

They check the number of pallets on the truck against the numbers on the consignment note. If all is in order, the fruit is offloaded. Any shortages are noted and written down, and the consignment note is handed back to the driver. This is his proof of delivery and is given to his depot to invoice the grower for payment.
Conclusion

It is important to use service providers that know your product and industry, that know the rules and regulations that are applicable to the packhouse, that can maintain the correct standards up to the delivery point, and that are able to make the right decision at the right time.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 37.1 – Mind Map

Do research by speaking to your logistics manager and local transport companies about the different trucks that are used for transporting export citrus. Hold a group discussion around the costs involved in using the different modes of transport. Record the details of your discussions on a mind map in your workbook.

Activity 37.2 – Case Study

A flatbed truck is used to transport high-cube pallets of A15C cartons to the harbour. As the truck pulls away from a weighbridge after being stopped, half the pallets on the truck topple over and all the cartons and fruit on those pallets are damaged and has to be destroyed.

The insurance company refuses to pay for this loss as they say the transport company was negligent in securing the load. The transport company blames the packhouse for loading unstable pallets.

✓ How should the load have been secured?
✓ What questions will you ask of whom to determine who is culpable in this case?
✓ Assume that the packhouse was at fault: What critical control point(s) in the packhouse should be addressed in terms of critical limits, monitoring activities and corrective actions to prevent a recurrence of such an incident?
Activity 37.1 – Mind Map

Do research by speaking to your logistics manager and local transport companies about the different trucks that are used for transporting export citrus. Hold a group discussion around the costs involved in using the different modes of transport. Record the details of your discussions on a mind map below.
Activity 37.2 – Case Study

Consider the case study below and answer the questions based on it.

A flatbed truck is used to transport high-cube pallets of A15C cartons to the harbour. As the truck pulls away from a weighbridge after being stopped, half the pallets on the truck topple over and all the cartons and fruit on those pallets are damaged and has to be destroyed.

The insurance company refuses to pay for this loss as they say the transport company was negligent in securing the load. The transport company blames the packhouse for loading unstable pallets.

✓ How should the load have been secured?

✓ What questions will you ask of whom to determine who is culpable in this case?

✓ Assume that the packhouse was at fault: What critical control point(s) in the packhouse should be addressed in terms of critical limits, monitoring activities and corrective actions to prevent a recurrence of such an incident?
Module 38
Truck Loading

Contributor: Lynette Grobler

Introduction

From most places where citrus is produced in South Africa, export citrus is transported over long distances from the farm or packhouse to the harbour where it is loaded onto ships. The most common form of transport used in South Africa is road transport.

Pallets stacked with cartons of export fruit are loaded onto trucks at the packhouse. Strict guidelines must be followed for the manner in which trucks are loaded.

Types of Trucks

There are three types of trucks that are generally used to transport citrus, and the type of truck that is used for a particular load depends on the citrus type and on the type of carton in which it is packed. You need to know the different procedures and loading restrictions for each type of truck.

The three types of trucks that are used are:

- Refrigerated trucks, also called reefer trucks
- Tautliners
- Flatbed trucks

Refrigerated (Reefer) Trucks

Refrigerated trucks are used when the market requires fruit to be pre-cooled before shipping, and is used mostly for transporting soft citrus.
**Tautliners**

Open-top display cartons are transported on tautliners. These are the trucks with curtains on the sides. The reason why we use these trucks is that one cannot walk on top of pallets loaded with open-top display cartons without damaging the fruit, even if it is covered with a pallet cap. A tautliner with a ceiling is therefore suitable.

**Flatbed Trucks**

Flatbed trucks are used to transport pallets stacked with telescopic cartons. These are the most commonly used cartons for exporting citrus from South Africa.

**Load Inspection**

Before loading begins, the pallets that are ready for loading must be lined up and inspected by the driver.

The driver must check that the pallet bases are not broken, that every second pallet is wrapped in black plastic to protect the cartons from damage chafing, and that the number of pallets agrees with his loading instructions.

The forklift operator and the driver must make sure that the right number of pallets is loaded onto the truck and that the truck is not overloaded.

The general guideline for standard pallets is 32 pallets of open-top display cartons per truck, and 28 pallets of telescopic cartons.

If the pallets are stacked in high-cube formation, we calculate the number of pallets that can be loaded according to the pallet weight and the legal carrying capacity of the vehicle.

The forklift operator is the last line of quality control in the packhouse and he must check that the cartons on the pallets are properly stacked and tightly strapped before he loads the pallets on the truck.
Truck Inspection

The forklift operator must also check the truck he is about to load. For flatbeds and tautliners he must check that the bed of the truck is smooth and will not damage the basis of the pallets being loaded onto it. Refrigerated trucks should be clean and the floor and walls must be smooth so that the cartons will not be damaged.

If the forklift operator is unsure about the suitability or condition of the truck, he must inform his supervisor. Remember that it is always better to be safe than sorry.

After loading the truck, the forklift operator must check that the load is properly secured by the truck driver, and that the straps and nets or sails used to secure the load, is in a good condition.

Truck Loading

Trucks are basically loaded in the same way. To load a truck with pallets of the same type, pallets are placed one per side starting at the front of the trailer. Make sure that the load is spread evenly over the trailer. The weight must be distributed evenly over the axles – the front axles of a trailer must not carry more weight that the back axles. Refrigerated trucks are loaded from the back of the vehicle.

For a mixed load of both A15C and open-top cartons, the A15C cartons are loaded on the front and back end of the trailer with the open-top cartons in the middle. This loading pattern is more stable and the cargo is less likely to shift during transport.

Always remember to spread the weight evenly over the axles and never to overload a truck. Never rush while loading – damage to fruit will mean a loss of income to the farmer, the packhouse and ultimately you.

Securing the Load

Once all the pallets has been placed on the truck, the load must be secured to make sure that the pallets do not shift and the cartons do not topple over during transport. The load in a refrigerated truck is enclosed so the cargo is not likely to shift. On a tautliner and flatbed truck, corner pieces, straps, nets and tarpaulins are used to secure the load.
On flatbed and tautliner trucks, there will often be gaps between the pallets at the front of the truck and the front railings of the truck, and on a tautliner also between the back row of pallets and the back of the truck.

When this happens spaces must be filled by using dunnage bags. Dunnage bags are spacers that are filled with air to stabilise the load so that the pallets do not shift during transport.

Pallets that can shift can easily fall over damaging the cartons and the fruit. This happens most often when high-cube pallets are transported, when fewer pallets are placed on the truck before the maximum weight is reached.

Corner pieces are placed on top of the pallets and then tied down with straps. The straps are attached to the truck and tightened using a pulley with a ratchet.

Always remember that you are not transporting a load of bricks and that over-tightening the straps can damage the cartons and cause them to collapse.

On a flatbed truck, a tarpaulin is put in place over the load to protect it from the elements.

Liner board is put on top of the load between the tarps and the cartons. Citrus fruit tends to sweat and produce moisture under the sail. There are also changes in temperature as the truck gets closer to the coast and the harbour, adding to condensation under the sail.

The corrugated sheets absorb this moisture and prevent the top layer of cartons from becoming wet and falling apart.

**Overloading**

Overloading can easily be prevented by just following the basic loading guidelines.

On every truck you will find a disc indicating the maximum load mass of the truck. Pallets must be weighed at the packhouse before they are loaded, to make sure that this maximum weight will not be exceeded.

This is the first overloading scenario, where the total load on a truck is over the legal weight limit. If this happens, the extra pallets will be removed at the weighbridge and kept at the side of the road until it can be retrieved by another vehicle, causing unnecessary loss of income for the packhouse and the grower.
The second scenario is where one of the axles is overloaded because of uneven weight distribution. Incorrect weight distribution of cargo is dangerous because it affects the handling of the truck and may cause accidents.

This problem can be fixed at the weighbridge by shifting the load before the truck is allowed to carry on, but the transport company will be fined and that fine will be passed on to the packhouse.

**Conclusion**

Transport is an important link in the supply chain and we have to make sure that we manage as much of the risk as we can. By loading trucks properly and in the prescribed manner, losses that result from shifting cargo or overloading can be minimised.

Always remember that it is your wages that are being sent out on that truck.

**active learning**

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 38.1 – Diagram**

Draw a diagram showing the placement of pallets on a flatbed truck for a mixed load of 12 pallets of A15C cartons and 13 pallets of open-top display cartons. Now draw and label the items that you will add to secure the load.

**Activity 38.2 – Research Report**

Find out from your logistics manager how many trucks were used last season to transport how many cartons of different fruit. Using this information, develop a logistics plan that makes better use of the available resources.
Activity 38.1 – Diagram

Draw a diagram showing the placement of pallets on a flatbed truck for a mixed load of 12 pallets of A15C cartons and 13 pallets of open-top display cartons. Now draw and label the items that you will add to secure the load.
Activity 38.2 – Research Report

Find out from your logistics manager how many trucks were used last season to transport how many cartons of different fruit. Using this information, develop a logistics plan that makes better use of the available resources.
Introduction

All citrus fruit is cooled in transit to overseas markets, mainly to maintain the quality of the product and extend its shelf-life, and to stop the development of postharvest diseases. Fruit is cooled to bring it down to the required temperature, after which the temperature must be kept stable.

Fruit can be cooled down already at the packhouse and then transported in reefer trucks to a cold store where it is kept in holding rooms. The second option is to transport fruit from the packhouse to a cold store, where it is cooled in pre-cooling chambers and then transferred to holding rooms.

Thirdly, fruit can be loaded into a container at ambient temperature and then cooled inside the container. The fourth option is to load fruit onto specialised reefer ships at ambient temperature, where it is cooled down and kept cool in the decks.

Always remember that the cold chain must be maintained once it is started – once fruit has been cooled, it must be kept cool.

We have two types of cooling; fruit can be cooled for sensitive or non-sensitive markets. Fruit cooled for sensitive markets must be cooled down to -0.5°C for period of at least 72 hours before it can be loaded into vessels for export. The cooling of fruit for non-sensitive markets is done according to the protocols as set out by the PPECB.

Pre-Cooling

Pre-cooling can be described as the process where the field heat of the product is removed and the product is cooled to the optimum storage temperature.

This process must be completed as fast as possible to slow down respiration and the associated ripening process.
Dead Products

We now have to look at the temperature requirements for two different types of products. Dead products are products that do not ‘breathe’, and therefore do not generate heat on a continuous basis. Examples of this are cheese, meat and chocolates.

Live Products

Then I am going to be talking about live products. These products generate heat, caused by the maturing process and respiration, and include products such as fruit and vegetables. The implications during storage for these products are that packaging must be well ventilated, and high air circulation is also needed to keep the temperature throughout the room constant.

Ripening vs. Maturing

Ripening means the process whereby the internal and external quality of a fruit improves in terms of becoming more suitable for consumption. Maturing means the diminishing of internal and external quality. After being picked, a citrus fruit does not ripen any further – the internal quality of the fruit will not improve. The fruit continues to mature, using the available resources (water and carbohydrates) in the rind to develop colour, but generally diminishing in quality.

Heat Load Transfer

The purpose of cooling is heat load transfer. Heat enters the cool area and the refrigeration plant must remove the quantity of heat that has penetrated the room. Some of the things that effect heat transmission are the difference in temperature inside and outside the cold store, the type of insulation of the cold room and the thickness of the insulation.

There are lots of sources of heat that must be controlled by the refrigeration process. There is heat given of the by the lights in the cold room and the fans, heat given of by forklifts, and air entering the cold room from the outside. There is also product heat and the heat of given of by the fruit respiration. We also have packaging heat and heat entering through the insulation.
Cold Store Mechanics

For more information on how a cold store functions and an explanation of the principles of heat load transfer, please look at Module 44 – Cold Store Mechanics.

Product Cooling Requirements

There are specific regulations about which products can be loaded at ambient temperatures and which products must be pre-cooled before being loaded onto vessels. As an example, soft citrus may not be loaded onto vessels at ambient temperature, and must be pre-cooled before shipping. The PPECB issues a document on the cooling requirements for all perishable products. This document is available on the website of the PPECB, at www.ppecb.com.

We have pre-cooling protocols for in-transit cold sterilisation. The cold sterilisation process is required by some countries. It means that product is pre-cooled to a minus temperature to get rid of insect larvae and eggs. These requirements are very specific and must be strictly adhered to. Non-conformance will result in the product either being destroyed or returned to South Africa to go to another market.

PPECB Temperature Checks

The PPECB shall take product temperatures prior and during the transportation and shipping process with a calibrated thermometer. We also monitor and audit temperatures prior to the final departure of the vessel or the container. Non-conformance or deviation from the specified carrying conditions and any corrective action taken must be communicated to us at the PPECB.

Packing Requirements

When they prepare the cargo for refrigeration and storage, there are a few package and palletisation issues. The packaging should allow for adequate and unobstructed airflow in both the vertical and horizontal planes. Carton ventilation must also align with the pallet base openings. Load stabilisation interleaves must allow unobstructed airflow throughout the total load. Cardboard must be strong enough not to collapse during the cooling conditions.
active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 41.1 – Group Discussion

In your group, list and discuss the differences between the cooling requirements for dead products and live products. See if you can think of other dead and live products that are exported from South Africa.

Activity 41.2 – Research Report

List the conditions that export citrus has to comply with to be loaded at ambient temperature.
Activity 41.1 – Group Discussion

In your group, list and discuss the differences between the cooling requirements for dead products and live products. See if you can think of other dead and live products that are exported from South Africa.
Activity 41.2 – Research Report

List the conditions that export citrus has to comply with to be loaded at ambient temperature.
Module 42
Cold Store Requirements

Presenter: Peter Hoekstra

Introduction

In the previous module we looked at the pre-cooling requirements for export citrus. Before a cold store can be used as a pre-cooling or holding facility, it must be inspected and approved by the PPECB.

Cold Store Exterior

Surrounding Area

A PPECB inspection starts of by looking, when we get to the cold store, at the surrounding area. What does it look like? Is it very dusty? The entrance way to the cold store, how does it look?

We don’t want bins of old fruit standing around, whereby you going to get all sorts of insects and fruit flies which are going to breed there.

Loading Platforms

Thereafter we are going to look at all the loading platforms, where the fruit are loaded onto trucks. Especially at those cold stores that don’t have loading docks, as we have here, where the fruit gets loaded outside and in dusty conditions, which is not good for the fruit. You get this dust blowing on the fruit, especially in windy areas.
Cold Store Interior

Looking at this particular cold store, you can see that it is a neat cold store, and it is well laid out. They have spent a bit of money on it, and they have ensured that it is very neat and clean.

Insulation

If we have a look then at the construction – it is a well insulated cold store, as for every cold store it should have insulation.

The thickness and the type of insulation will depend on what the temperatures inside the cold store are going to be and what type of products will be stored in the cold store.

Cleanliness and Damage

We are going to look at is the cleanliness of the cold store. Generally the ideal place to look first, if there is going to be any dust, is all around the edges. It always tends to migrate around the edges off the cold store.

After that we are going to look at damaged edges and damaged insulation. We have a look at the side walls. How clean are they? Are they dusty? We are not talking about stains we are talking about actual dirt and dust on the walls.

Doors

And then we are going to look at things like the cold store doors. What condition are the cold store doors in? Are they warped? Are they damaged? The cold store seals, the rubbers, do they operate nice and neatly? You don’t want people to have to open the cold store doors with a forklift for example, it must move easily.
Water

The next step is to look for water lying on the cold store floor. Some operators, because their humidity within the cold store tends to be a little bit on the low side, take water and spray it on the floors. This is something we don’t want to see. The water migrates into the cartons and into the wooden pallets, causing growth of bacteria and can cause the cartons to collapse. We don’t advice this. There are other ways to increase the humidity and we can advice people on those.

Air Curtains

You will notice that this particular cold store does not have any air curtains or plastic curtains, simply because it has an airlock which is also temperature operated, so it doesn’t need plastic curtains. But in the event that the cold store does not have an airlock, we expect the door to have plastic curtains so that when the forklifts go in and out and people go in and out, the heat from outside does not enter.

Sensors

Then we look at the sensors and where the control sensors are placed. We also look at where the temperature recorder sensors should be. We say that the sensors must be in the delivery air, in other words, the air that is being delivered to the product itself to prevent top freezing. That will also prevent the air from going colder or below the set point. So we say for a chill store the sensors must always be in the delivery air. For a deep frozen store it is different, it can be anywhere in the room.

Lights

Lighting has to be of such strength that one is able to read markings on cartons. The forklift drivers must also be able to see where they are driving. It must also be bright enough to see whether there is any damage to cartons on the pallets. We also look at the light coverings. Very often you tend to find that the globes burst, depending on what type of globes is in there, but we can’t take the chance that glass might end up in the product, so all lighting has to have a cover on it.
Conclusion

Citrus is subtropical fruit, and is by nature sensitive to changes in temperature. If a fruit is cooled to too low a temperature, it can be harmed by chilling injury. If it is not cooled down enough, the fruit will keep respiring and mature too quickly. The fruit will lose too much moisture, and its shelf-life will be a lot shorter.

It is critical to keep citrus fruit at the correct temperature according to the protocol, and to monitor that the required holding temperature is maintained throughout the cold chain.

All cold stores must comply with the regulatory requirements that may be placed upon them by food safety accreditation systems. For example, a HACCP system will require that a floor plan of the store is available and that records are continually kept of temperatures in the store. Procedures concerning corrective actions that need to be taken in case of temperature loss or gain must also be available and their effectiveness must be confirmed.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 42.1 – Group Activity

Contact your local PPECB office and get the form used for cold store inspections. As a group, perform an inspection on a cold store in your area (remember that this does not have to be a cold store used for fruit of fresh products). Attach a copy of the completed form to your workbook.

Activity 42.2 – Worksheet

List the faults detected during your inspection in activity 42.1 and recommend corrective actions.
Activity 42.1 – Group Activity

Contact your local PPECB office and get the form used for cold store inspections. As a group, perform an inspection on a cold store in your area (remember that this does not have to be a cold store used for fruit of fresh products). Attach a copy of the completed form to your workbook (insert copy here).

Make keynotes on your experience below.
Activity 42.2 – Worksheet

List the faults detected during your inspection in activity 42.1 and recommend corrective actions.

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Module 43
Cold Store Handling

Presenter: Mitchell Brooke

Introduction

Cold stores receive citrus fruit from many different sources. A cold store must have systems in place to ensure that product traceability is upheld, and to ensure that the cold chain is maintained for all the products it handles. One of the most important functions of the cold store is to consolidate the fruit received from the different sources and to ensure that the correct fruit goes to the correct markets.

Cold Store Handling

Cold storage handling is quite an important aspect in the logistics chain. The main aspects of cold store handling are:

- Data capturing
- Pre-cooling
- Planning
- Inspection
- Loading

Each aspect is important and accuracy of such will ensure the product is loaded at the right time, to the right place and in the right condition.

Data Capturing

When a truck is loaded at a packhouse, a consignment note is generated that details the product on the truck. When the truck arrives at the cold store, the data capturer captures the information onto the system.

The tally clerk will then authenticate that the consignment note and the physical load match each other. This is a vital procedure, as it is important to make sure that the correct information is captured to avoid sending the wrong fruit to the wrong market.
If mistakes are found, a discrepancy report is sent to the packhouse so they can then correct the information on their side.

The truck is then offloaded, and the fruit is checked to make sure that the quality of the cartons and the pallets were not damaged during transport.

The information is also sent back to the packhouse if damages were received, and if they are severe, the product is then loaded back on to the truck or otherwise, if it can be repaired, it can be taken off the truck and repaired.

The consignment note is then accepted and the fruit is brought onto stock.

**Pre-Cooling**

Most cold stores have pre-cooling chambers, where the pallets are placed in sealed, forced-air cooling chambers for up to 24 hours to bring the temperature down from ambient to the required holding temperature.

Once the fruit is at the required temperature, it is then transferred from the pre-cooling chamber to the holding rooms. The fruit is then grouped in the holding room by market and by commodity. This makes the retrieval a lot easier when the fruit is required to be loaded out.

**Loading**

When an export agent has confirmed the shipment of fruit to an overseas buyer, and the arrangement for shipping has been confirmed, a load out instruction is issued to the dispatch planner at the cold store at least 48 hours before the shipment. The dispatch clerk then captures the required pallets to be loaded out and creates a dispatch document.

Each shipment is accompanied by an official document called a Q67, which details the information of the vessel and the date of the shipment.

The Q67 document is the official release document that is sent from Perishable Products Export Control Board, advising of the intended shipment.
There are two methods of shipping the fruit overseas being, either by containers or by break bulk in specialised reefer ships. Containers are loaded directly at cold store facilities, which are then sent to container terminals to be loaded onto ships.

It is critical when containers are to be loaded that the dispatch planner coordinates with the transporter to make sure that the correct sequence of delivery of containers reaches the cold store on time. This ensures that fruit can removed from the cold store in an orderly sequence per container. Break bulk shipments are loaded from cold store onto trucks which are then sent to the fruit terminals to be loaded onto reefer ships. The dispatch planner will coordinate the sequence of the trucks to ensure that there is a constant supply to the ships. This is done to ensure that vessels work productively.

**Inspection**

When the fruit is ready to be loaded out, PPECB then inspect the fruit to ensure the fruit is of a good quality and that the fruit is at the required temperature. It is important that the fruit is at the correct temperature at load out, to ensure that the cold chain is maintained during transportation. Once all the fruit has been loaded out, a mate’s receipt is generated, which is sent to the exporter. When this has been done the fruit is then released from stock.

**Cold Store Systems**

It is important that qualified and experienced staff is employed at a cold store. This will ensure that the integrity of information is kept, which will in turn ensure that claims are kept to a minimum. Drivers of forklifts must be adequately trained, so as to ensure that the product is handled with care. Each cold store is required to undergo an annual audit process in order to comply with PPECB regulations. Increasingly cold stores are required to comply with food safety regulations.

There are very good information systems available on the market, which are fully automated, which allow ease of access of product through the cold stores, and ease of access for products through onto the vessels. This will increase the turn around time of product and increase the productivity of loading containers and vessels.
active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 43.1 – Worksheet
List and shortly discuss in your own words the main objectives of cold store handling.

Activity 43.2 – Internet Research
See if you can find cold store handling software on the internet that can be used to ensure the correct and accurate handling of products and shortly explain how the system works.
Activity 43.1 – Worksheet

List and shortly discuss in your own words the main objectives of cold store handling.

- Objective 1
- Objective 2
- Objective 3
- Objective 4
- Objective 5
- Objective 6
- Objective 7
- Objective 8
- Objective 9
- Objective 10
Activity 43.2 – Internet Research

See if you can find cold store handling software on the internet that can be used to ensure the correct and accurate handling of products and shortly explain how the system works.
Module 44
Cold Store Mechanics

Contributor: Koos Bouwer

Introduction

It is essential that the grower and packhouse manager understand the basic mechanics of cooling, in order to make the right decision about cooling their product, whether they are choosing a cold store facility, or thinking about having a cold store constructed at the packhouse or another convenient location.

Principle of Cooling

Heat Load Transfer

Fruit are pre-cooled in a cold store using a heat-load transfer principle. This means that we are actually not cooling the product down, but removing heat from the product. This may sound as if we are merely restating a fact, but it is important to understand the distinction, as it will help you realise the importance of airflow during cooling. The basic principle of cooling is based on the absorption of heat during the evaporation of the cooling agent from a liquid to a gas.

Cooling Components

There are five main components in any cooling system, being the:

- Compressors
- Condensers
- Liquid receiver
- Expansion valve and
- Evaporators

There is then also the cooling agent, also known as the refrigerant, which can be a gas or liquid.
**Compressor**

The cooling agent enters the compressor as a low pressure gas returning from the evaporator. The compressor places the gas under pressure, thereby heating the gas. The gas leaves the compressor as a high pressure, high temperature gas and goes to the condenser.

**Condenser**

At the condenser the gas is cooled by the air being forced through the plates by the condenser’s fan. The effectiveness of this cooling depends on adequate air flow around the condenser.

In the condenser, the gas is condensed into a high pressure, high temperature liquid and then moved to the liquid receiver.

**Liquid Receiver**

From the liquid receiver the high temperature liquid is forced to the expansion valves.

**Expansion Valve**

The expansion valve only allows a small amount of this liquid through at a time, thereby lowering the pressure on the liquid. The lower pressure causes the temperature of the liquid to drop. The lower pressure liquid, at the lower temperature, is then moved to the evaporator.

**Evaporator**

During the evaporation process, the cooling agent absorbs heat from the air being forced through the evaporator coils by the fans at the evaporator, cooling the air. The liquid refrigerant absorbs the heat and starts changing into a gas. The low pressure, low temperature gas leaves the evaporator and is sucked to the compressor to start the process again.
Air Temperature Reading

Two air temperatures are of importance in a cold room, being the delivery air temperature (DAT) and return air temperature (RAT).

The DAT is the temperature of the air that has been cooled by the evaporator that is entering the cold store and being blown onto the fruit through the evaporator coils and fans. When the DAT is too low, it may cause chilling injury to the fruit. The RAT is the temperature of the air coming off the fruit. The difference between the two temperatures gives an indication of how much heat is removed from the fruit.

Cold Store Design

To help facilitate the process of removing heat from air, there are a few things that we must look at when building or choosing a cold store.

Cold Store Types

The first thing we need to decide is whether the cold room is going to be used for pre-cooling or for holding pre-cooled fruit, or for both. As we have already explained, both a pre-cooling chamber and a holding room are needed during the citrus cold chain.

The average temperature of fruit entering a pre-cooling chamber is of course considerably higher than that of fruit entering a holding chamber.

This means that a lot more heat must be removed from air in a pre-cooling chamber, which means that a pre-cooling chamber must have high airflow to exchange cooled air and hot air quickly, and a compressor, evaporator and condenser big enough to cool down the higher temperature and volume of return air.

A holding room receiving fruit that has been cooled already is therefore a lot cheaper to build and operate, as the difference between the DAT and the RAT is a lot smaller than in a pre-cooling chamber. Pre-cooling chambers also tend to be smaller than holding rooms, because fruit spends the minimum amount of time in the pre-cooling chamber before being moved to the holding room.
Site Selection

After we have decided what sort of cooling facilities we need, we must look at where we are going to build the cold store.

The area where the cold store is built should be naturally higher ground than the surrounds, because we do not want water collecting on the site during rain, while still being protected from the wind, because we also do not want the area to get too dusty.

The area must also be flat, and large enough to also allow for the construction of loading bays, where fruit can be loaded and offloaded. They should be easily accessible for trucks and preferably under cover so that the pallets of fruit waiting to be loaded will be protected.

Volume and Climate Conditions

In terms of cold store design, the first determining factor is of course the volumes that the cold store will have to accommodate in a season.

Secondly, we look at the climatic conditions of that area, and specifically at the temperature and relative humidity. The ambient relative humidity influences the air's ability to exchange heat. In an area with higher relative humidity, more cooling power is needed.

In some areas that have very dry conditions, with a low relative humidity during the packing season, a humidifier will need to be placed in the cold room. The humidifier helps to keep the relative humidity in the cold room fairly high to stop fruit from losing too much moisture during storage. Never put water on the floor to increase the humidity, as this can compromise the packing material and fruit.

Cold Store Entrances

In warmer areas, with a higher average daytime temperature during the time that the store will be in use, more insulation is needed to prevent the loss of cold air. Another option is to build the cold store with an airlock. A forklift enters the airlock, the outer doors are sealed, and only then does the forklift proceed into the cooling chamber.
This is done to minimise hot air entering from outside. It costs extra to build an airlock entrance to the cold store, but in the long term this airlock can save the cold store operator money as less temperature loss occurs.

In colder areas it is usually not necessary to build an airlock entrance and door curtains give enough protection.

**Racking Systems**

Another factor that determines the design of a cold store is the type of racking that will be used. With the advent of high-cube containers, more and more pallets are being stacked in high-cube formation.

Traditional racking system designs are not able to accommodate high-cube pallets. It makes sense to choose a racking system that is able to accommodate both standard and high-cube pallets, and design the cold store accordingly.

**Floor Insulation**

The floor of a cold store is also insulated to minimise temperature loss. Various methods can be used for this and all of them work to one degree or another. The floor in store must be smooth and easy to clean.

**Mechanical Equipment**

**Compressors**

The type and size of compressor that is needed are dictated by various factors, such as the:

- Purpose of the store
- Volume of the cold store
- Required temperature
- Outside temperature and relative humidity

Redundancy should also be built into the system – it is always better to have a little extra cooling power, than too little or just enough.
**BTUs**

The size of the compressor needed in a cold room is determined by the volume of air that it needs to cool, and is measured in **BTU**.

BTU stands for British Thermal Unit and technically it means the amount of energy needed to cool one pound of water down one degree Fahrenheit. (You may know of BTUs from the air conditioner in your house or office – the power of air conditioners are also expressed in BTUs).

BTU calculators are available widely and are used to determine the amount of cooling power needed to cool the cold room to the desired temperature.

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**Condensers and Evaporators**

The design of the cold store and the type of compressor determine the size of the condenser and evaporators needed.

The predicted and required DAT and RAT must be kept in mind, as the evaporator and fans must be able to handle cooling the predicted air volume.

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**Fans**

The number and placement of evaporator fans are critical, as the fans must circulate the cold air in the room.

Fans should be big enough to handle the airflow, and positioned where cold air is blown into the room, so that the air cools the product and does not just circulates without coming into contact with the product.

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**Lighting**

Inside the cold store there must be adequate lighting. There are specifications and minimum requirements for the type of lights that are used.

All lights must be covered, so that if they should break, the glass does not fall on the fruit, and must be placed where they cannot easily be damaged by pallets being moved.
Drainage

There must be adequate drainage in the cold store. Water used for cleaning must be able to flow away without obstruction. Water left on floor may damage cartons and fruit. It may also freeze and become slippery, creating a hazard that can cause injuries.

Doors

Seals and Design

The doors of the cold store must have seals so that the store is airtight when they are closed. The doors must also be big enough and placed where they allow easy access for forklifts. A door that is too small or badly placed will be damaged often, and require constant repairs.

Door Curtains

Door curtains hang inside doors to minimise temperature loss when the cold store doors are opened. These curtains must be durable and made of a clear plastic, so that a forklift driver entering the cold room can see if there is anyone inside. Door curtains are only used when the cold store does not have an airlock entrance.

Aluminium Corner Pieces

All corners inside the cold store must be moulded with aluminium corner pieces to lessen damage to corners, and because it is easier to keep clean.

Placement of Racking Systems

Regulations stipulate that no food may be stored directly on a floor. The cartons of citrus in the cold room must be stacked on pallets or in racking systems. When designing the placement of these racking systems, ensure that when stacked with pallets the air flow will not be interrupted or obstructed. In most cases areas on the floor are painted where pallets should be stacked, to ensure adequate airflow.
Temperature Sensors

The types of temperature sensors are determined by what the cold store is used for. Different types of sensors are available on the market, but usually air temperature sensors and pulp sensors, used for measuring the temperature inside a fruit, are used in a cold store.

Sensor Placement

Air sensors must be placed where they can record both the delivery air temperature and the return air temperature. The cooling temperature is set electronically and the air flow and cooling are automatically regulated to achieve the required temperature.

Calibrating Sensors

All sensors must be checked regularly using a calibrated thermometer to make sure that temperature readings are accurate. It is recommended that sensors are checked at least once a week during peak times.

Standby Sensors

Temperature probes and sensors are sensitive pieces of equipment that are prone to breakdown. At least three new sensors of each type should be kept on hand to replace broken sensors immediately.

Cold Store Maintenance

Annual Service

The effectiveness and lifespan of your cold store depends on good maintenance. Compressors, condensers and evaporators should be serviced by a professional company at least once a year.
Before the packing season starts, all sensors and probes should be removed and properly calibrated with the help of a hand-held thermometer, using temperatures within the normal operating parameters of the sensors. Sensors that are not working properly should be replaced immediately.

**Ongoing Maintenance**

Condensers must be kept clean and free from dust. It is recommended that they are washed at least once a month, using a cleaning solution prescribed by the manufacturer.

Fans and fan blades must also be checked and cleaned regularly to achieve optimum cooling. Lights must be checked and replaced when necessary, and light covers must always be clean and free of cracks.

Door runners and door hinges must be oiled and set regularly to ensure that they open and close smoothly. Also check and replace door seals when necessary.

The area around the compressors and condensers must be well ventilated to keep the compressors cool, and must be kept clean. Drains and drainage pipes should be checked and cleaned on a regular basis, and kept free of blockages.

**Regulations and Inspections**

Cold stores that are used to store and cool down fruit must adhere to specific regulations.

The regulation pertaining specifically to food storage is R918 of the South African Standards and Requirements for the Display, Storage and Temperature of Food, published by the Department of Health. To ensure food safety, these regulations must be strictly adhered to when building and using your cold store.

In most packhouses a food safety system such as HACCP will be used. Make sure that the necessary monitoring and recordkeeping documentation is in place for the cold store. Check that regulations governing the use of lights and drain covers are adhered to. A food safety system might also require that storage areas and areas where forklift are allowed to drive, are demarcated on the floor.
In terms of environmental safety, ensure that the type of compressor and the gas used by the compressor bring about as little as possible damage to the environment and that the compressors and other electrical equipment are as energy-efficient as possible.

Before you are allowed to use your cold store for the cooling and storage of export citrus, the PPECB will inspect the cold store and approve it for use if all the inspection criteria are met.

The PPECB also performs yearly inspections to ensure that the cold stores still complies with the requirements for effective cooling and food safety.

**Conclusion**

It is important to know the basics of cooling and what you should look for when inspecting a cold store.

If you have decided to have your own cold store built, always use a reputable company with a good track record for the design and construction of the store – remember that a cold store is a long term investment.

The accuracy of cooling is essential as it adds value to your product by extending its shelf-life.

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**active learning**

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 44.1 – Group Discussion**

In your group, list and discuss the different requirements for holding rooms and pre-cooling chambers. Make keynotes on the discussion and your conclusions in your workbook.

**Activity 44.2 – Case Study**

A farmer decides to build a new pre-cooling chamber on his premises to accommodate the expected growth over the next few seasons. The farmer plant to use the cold room for storing lemons for non-sensitive export markets, and the farm is in the Letsitele area. The dimension of the room will be 4m x 20m x 20m.

Use a BTU calculator to determine the size of the compressor he will need to cool fruit to the required holding temperature of 5°C.
Activity 44.1 – Group Discussion

In your group, list and discuss the different requirements for holding rooms and pre-cooling chambers. Make keynotes on the discussion and your conclusions below.

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<thead>
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<th>Details</th>
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<td>Humidity</td>
<td>Controlled</td>
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<td>Ventilation</td>
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<td>Lighting</td>
<td>Minimal</td>
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<tr>
<td>Space</td>
<td>Adequate</td>
</tr>
</tbody>
</table>

Keynotes:
- Requirement 1
- Requirement 2
- Requirement 3

Conclusion:
- Summary of discussed requirements
- Final thoughts on design
Activity 44.2 – Case Study

Consider the case study below and answer the question based on it.

A farmer decides to build a new pre-cooling chamber on his premises to accommodate the expected growth over the next few seasons. The farmer plans to use the cold room for storing lemons for non-sensitive export markets, and the farm is in the Letsitele area. The dimension of the room will be 4m x 20m x 20m.

Use a BTU calculator to determine the size of the compressor he will need to cool fruit to the required holding temperature of 5°C.
Module 45
Container Loading

Presenter: Chris Laing

Introduction

Over the past few years, the volume of citrus fruit exported by container has shown huge growth. The cost saving to the producer by minimising port handling and storage fees has made this way of exporting the preferred method. The citrus industry expects this trend towards container shipping to continue.

There has also been a move towards container loading inland, at packhouses, and not at the harbour facilities. This means that regulations concerning the loading of containers are becoming more and more critical to the citrus industry.

Reference

For more information on the growth of container shipping in South Africa, please look at Module 38 – Export Shipping Overview.

Container Loading Procedures

Container Approval

PPECB will start of by inspecting the depot where the containers are being washed and prepared for use.

We will arrive at the depot and physically ensure that the container has been washed, is dry, has no foreign taints inside and contains no foreign objects. We will ensure that the container is running like it should.

After these checks we will apply a yellow PPECB seal to the container door to show that it was inspected, and also a yellow PTI PPECB sticker will be placed on the container to indicate that these checks were all done. These two checks are both valid for 60 days.
**Cold Store**

The container will arrive at a cold store. The cold store itself is inspected by PPECB annually to ensure that it conforms to the PPECB act.

Before loading the PPECB will again ensure that the container is as booked by the clients. We will make sure that the set points and the vent setting is as per booking. We will ensure that the container inside and outside is in the correct condition for loading.

We will then also monitor all temperatures of fruit that has to be loaded in the cold store itself to ensure that it applies to the protocol within the specific tolerances.

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**The Q67 Form**

The Q67 form stipulates the temperature settings and other protocols that must be followed when the fruit is in transit.

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**Container Loading**

While loading the container the PPECB will ensure that no damaged pallets, damaged cartons or damaged fruit is loaded. While the fruit is being loaded into the container, the PPECB will also check that the fruit is loaded in such a way that the airflow inside the container is not affected.

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**Container Sealing**

After loading, the container will be sealed and will be trucked to the terminal, where PPECB will ensure that the container is plugged in, running at the preferred set point that the client wanted, and that the vent settings are as it should be.
Container Carrying

Before the container is loaded aboard the vessel, the PPECB will compile the carrying instructions, with the lines manifest, which will be handed to the captain of the vessel to ensure that he knows exactly how every single container has to be handled for the entire voyage.

The vessels also report all container temperatures daily to the PPECB. We scrutinise and manage those temperatures and place them on the PPECB website for every client to monitor.

Conclusion

The cost advantages of exporting fruit by container is considerable, as containers can be used to ship fruit at a stable temperature or even be set to follow a cold sterilisation protocol.

It is important though to note that, to maximise the cost saving of containerisation, fruit should be stacked in a high-cube formation on pallets. If standard pallets are loaded into containers, some pallets have to be broken up and re-packed before being loaded into the container. In most cases, this means that a few loose cartons end up in the container and these are likely to become damaged.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

**Activity 45.1 – Research Report**

Write a 1-page report on the advantages and disadvantages of exporting citrus in containers.

**Activity 45.2 – Internet Research**

Get hold of the export and logistics information for the last citrus season from the CGA website. Lists how many containers of citrus were exported from each harbour in South Africa in this season. Now compare these figures with the projections that were made in module 35, and discuss the deviations.

(Annual CGA logistics report – CGA website)
Activity 45.1 – Research Report

Write a 1-page report on the advantages and disadvantages of exporting citrus in containers.
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Get hold of the export and logistics information for the last citrus season from the CGA website. Lists how many containers of citrus were exported from each harbour in South Africa in this season. Now compare these figures with the projections that were made in module 35, and discuss the deviations.

(Annual CGA logistics report – CGA website)
Module 46
Vessel Loading

Presenter: Bernard Henning

Introduction

Before any ship can be loaded with export citrus it has to be inspected and approved by the PPECB. Some vessels will be inspected and approved by the countries of origin as well.

The PPECB will also check and ensure that cooling facilities on these vessels are adequate and in good working order.

There are two types of Refrigeration Ships or Reefer ships that are used for exporting citrus. Firstly the normal Reefer ship that is used to export citrus to non-sensitive markets and secondly, “steri” ships that transports fruit to sensitive markets. In this module we will look at the general procedures the PPECB follows to inspect these vessels and then also at the specific procedure followed for inspecting “steri” ships.

In terms of the PPECB Act 9 of 1983, all vessels carrying perishable products for export control must be inspected by PPECB. Firstly, the forwarder must send a F01, a service request, to PPECB and from there on the process will start.

Vessel Inspection

We visit the vessel, and a discussion is held with the chief officer or the captain. We will discuss the specific cargo that was previously carried by the vessel.
Vessel Certification

All vessels must have a valid certificate. The certificate is valid for a three year period. The list of vessels that is certified to be used for fresh produce exports is provided by the USDA website.

Part of the requirement is that temperature logs must be kept and also service certificates for their printers. The vessel must have a certificate that has been valid for a six month period before arrival in any port of South Africa.

On board they must have a minimum of two printers and also a memory back-up system. According to the requirement, they must also have a new printer cartridge, they must have at least two spare air sensors, and they must have five spare pulp sensors.

That is part of the requirement before we will continue with the whole survey process.

Deck Inspections

After we have completed the technical check, we proceed to the deck self in a vessel to do specific survey. The PPECB inspectors are accompanied by a senior officer who will follow the whole process.

Deck Plan

Firstly we verify the common decks according to the deck plan. We also check for the independent decks, to make sure that the deck plan is correct according to the vessel layout.

Temperature Check

While we are in the decks we will take the temperature readings. The vessel temperature must be -1°C within a tolerance of one degree.
Deck Cleanliness

Firstly we check that there is no taint in decks. We check all the pallet boards and the side boards to make sure that they are not damaged. We check for dirt and make sure there is no decay, any signs of rodent activity or anything lying around in the decks.

Gratings

We also look underneath the gratings to make sure everything is clean and neat.

On the deck side itself, the gratings must be able to carry at least five tons, the weight of a fork-truck with a pallet. The vessel has to provide information that the gratings can maintain that.

Cooling Facilities

We check that all the independent decks and the common decks – common decks are two decks that work with one cooling system – have their cooling facilities in place.

Lights

While we are in the decks we will also look at the lighting, to make sure all lights are working properly. There must be sufficient light and no light covers must be broken.

Hatches and Railings

Between the hatches we check on the rails to make sure that there is no dirt. There must be nothing at all. On the rails we look for glass, dirt and debris. If there is any it must be cleaned before we can commence with the loading process.
Q10 Form

All this information is noted on the Q10 forms, which is also completed to identify any problems with the vessel. If there is a problem it is noted in the remarks column. That information is then discussed with the chief officer and the captain to make sure that they rectify the problem.

Calibration

After we have completed the deck survey, we proceed with the calibration of the vessel. The tolerance for the calibration for USA is ±0.3°C and for Japan it is ±0.2°C. We work within those tolerances. Any sensor that deviates from that tolerance must be replaced or be rectified.

We make two consecutive printouts of the temperature reading to ensure that all temperatures are within the protocol.

A deviation of -0.1°C will be allowed from the first printout to the second printout. If there is a problem we can make a third printout, but the second and the last printout must correspond. Time intervals allowed between the first and the second printout is a minimum of one minute and a maximum of five minutes.

After we have completed the calibration the charts are stamped and signed, indicating when calibration commenced and completed.

Inspecting Steri Ships

When inspecting steri ships the PPECB will also carry out the following checks.
### Pre-Cooling

In our inspection, there is a pre-cooling requirement. The requirement is a technical requirement. The vessel must pre-cool its hold for a specific period of 48 hours, at \( +\)0.5°C, of which the last 24 hours it must be within the temperature specifications temperature.

From thereon we will scrutinise the temperature logs. The logs must provide us with the delivery air temperature, which we call the DAT, and also the return air temperature, which is the RAT. We also look at the CO₂ gas concentrations.

All logs must be checked, for pre-cooling time, exactly when the process started and when the process ended, to make sure that the 48 hours was completed.

### Importer Requirements

Looking at the shipping line, if you ship to Japan, their vessels must also be approved for a three year period, but it is a little different from the USDA. The USDA will inspect their own vessels, whereas Japan, PPCEB will do the inspection.

They send us a form called a Q58, which is a technical document with all specific requirements. Using that document, we will evaluate the vessel. Basically what will happen is, when a vessel arrive in port we will do the final check. After that the vessel will be placed on the approved list for a three year period.

In the case of Iran, the vessels must also be surveyed by the PPECB. They also have to send in the Q58 technical form. The only difference between our Iranian vessels and our Japanese vessels is that they don’t need a USDA approved certificate.

If they can provide us with an approved certificate, obviously we will do the calibrations as a normal process. But if they do not have one, all the sensors must also be identified. It can take quite a while to complete the process. When approved all vessels will be placed on the approve list for a three year period.

For Japan, we must perform a 24 hour empty deck test. Every censor are suspended from the ceiling and placed into a fruit in the deck. For a 24 hour period, the fruit must be cooled to -0.6°C.
After the 24 hour period, which might be more or less 28 hours later, we will scrutinise the logs to make sure that all sensors was down to -0.6°C. A double check will be done by a second PPCEB assessor, to make sure that we did not miss any deviations. Everything is logged on the Q114 form.

**Product Inspection**

After the vessel has been inspected and approved for use we will locate product in the cold stores. We proceed to the cold store to make sure that the product is on the correct temperature for loading. We verify the product against the loading document which we receive from the cold store side.

A product allocation is done that will indicate exactly which rooms must be used to approve the cargo. Everything will be documented on the Q01 form which is our cold store loading document.

**Quay Side**

From the cold store we proceed to the quay side operation. The fruit must now be moved over the quay side to the vessel.

**Lifts**

On the quay side we only allow two lifts on the ground and one lift in the air per hatch. That is the process we follow to minimise the temperature risk of product moving from the cold store to the vessel.

**Climate**

We do not load in rainy conditions. Inclement weather will also force us to stop the loading process. But if the weather is good, we will proceed with the loading.
Quay Side Product Check

On the quay side we do a double check of the pallets. We will physically check for the USDA pass stickers, we will also look for the Japanese pass stickers.

We will take a temperature reading to make sure that the product temperature is still within the tolerance. We do not allow a temperature increase of more than 1°C. Any damaged cartons or any damaged pallets are removed from the quay side and are rectified.

Pallets that are moving across to the vessel must be in a good condition. We also check the pallet bases for fungal growth or any bark. The pallet bases must also adhere to the ISP15 requirements.

Q114 Form

Onboard the vessel, while we are loading, we record all temperatures on the Q114 form. The whole process is documented to make sure that the correct steps are followed.

Onboard Product Inspection

Onboard the vessels again we check for broken pallets. We check that walking boards are used when people walk on top of the pallets and we also check that airbags are placed in between pallets where there are any gaps. We check for fan obstructions, fans must be unobstructed. There must be a proper airflow through the product and back to your fans.

Deck Covering

Next we check that part of the decks is covered with plastic sheets where pallets are not placed in the decks itself. The plastic sheeting must be properly secured. On the upper decks railings must be in place for safety sake.
Loading Checks for Steri Ships

In addition the PPECB do the following check while steri ships are loaded.

The temperature tolerances that we allow for fruit being exported to Japan and Iran is +1°C during the loading process. Fruit must be below 0°C or colder before we can commence the cold treatment onboard the Japan vessels.

For the USA, -0.6°C is the commence temperature. So all temperatures must be down to -0.6°C or colder before we commence the cold treatment.

Double Checking

All temperature guidelines in place when exporting food must be double checked afterwards by a second person to make sure that the temperature is within the tolerances.

When we place the stamps on a chart that indicate a deck opening and a deck closing, it must also be double checked. This is done to ensure that we use the right time, and that the temperatures are within the protocol.

The printer paper must be stamped and signed by the PPECB inspector, and it must also be stamped and signed by the chief officer, to confirm that the information is correct on the charts. The vessel will only be permitted to sail when all deck temperatures are down to the correct protocol temperature.

In the case of exports going to Japan, the Department of Agriculture, Forestry and Fisheries, and the MAF officer must also sign the charts. Their signature must be next to the PPECB stamp to confirm that cold treatment has commenced.

MAF officer

The MAF officer is an official from the Japanese Ministry of Agriculture and Fisheries.
Departure Documentation and Reporting

All the information will be then documented. The vessel will also be provided with a daily report which must be send every morning at 8 o’clock to the PPECB with all temperature readings recorded. The PPECB will manage this information to make sure that the set protocols are adhered to.

Just before the vessel sails the PPECB will issue the vessel with a temperature letter and a temperature instruction. This instruction will indicate to the captain exactly what procedure he must follow. During the sailing he will report back to PPECB on a daily basis.

On the Q106 form the captain will stamp and sign that he has received all the information and is familiar with the temperature instructions and that he knows exactly what he must do.

The Q07 is our sealing document, which PPECB use to indicate that all hatches were sealed by the PPECB.

In the case of vessels heading to Japan the inspectors will be present when we seal the hatches and they will also document that specific seal numbers. The seal numbers is very important on arrival in the port of destination, because on the other side the authority will check and make sure that the seals were not broken and replaced during the journey.

The temperature instruction is issued to the master of the vessel. Copies are given to the Japanese inspector as well as the American inspector, and then there will also be a copy onboard the vessel for the officer in charge at the port of destination.

Conclusion

Another important document that must accompany any shipment of fruit is the Phytosanitary Certificate that is issued by the Department of Agriculture, Forestry and Fisheries. Inspections by the PPECB ensure that the vessels used are able to transport export citrus safely and in hygienic conditions to overseas markets.

The inspections also ascertain that the temperature protocols for the product are adhered to and strictly followed.
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<th>active learning</th>
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Activity 46.1 – Worksheet

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Activity 46.2 – Internet Research

Do research on the PPECB website for the relevant information, and describe in your own words the method and temperature protocols for exporting fruit to Japan.
**Introduction**

Over the course of this series we have discussed in detail all the steps involved in preparing citrus fruit for export, up to where the fruit is loaded onto a vessel heading for the overseas market.

In review, Malcolm Dodd looks at the fundamental importance of the cold chain in maintaining the value of your fruit.

**The Cold Chain**

The cold chain is fundamental to the success of the export of citrus from South Africa to all the markets overseas. The reason for this is that citrus fruit is still alive once it has been picked off the tree and to keep it alive for as long as possible and in as good condition as possible we have to keep it cold.

So the important thing with the cold chain is to get the fruit cold and maintain the fruit at that temperature.

In the citrus industry in some circumstances fruit are picked and packed and it does not get chilled until it gets to the port and gets put on a vessel. That is fine because the fruit can withstand that treatment.

However what is important to understand is that once the fruit have been chilled you have to keep it cold. The reason for this is that if you take it out of the cold store and let it stand outside and it warms up, the fruit then will start to respire faster and its rate of deterioration increases.

Now the definition of a cold chain is: the movement of citrus fruit from packhouse to marketplace through various storage and transport mediums at the optimum temperature and relative humidity without any interruptions or break in the cold chain.
So the people who have influence on this are the cold store manager, who has to remove the fruit from the cold store to make it ready for when a container is being loaded, the forklift driver who moves that fruit, and then also the person who is in charge of having the fruit inspected and then loaded into the container.

What happens sometimes is that a message is sent that a container has arrived. So the cold store manager will issue instructions for those twenty pallets of fruit to be moved out of the cold store and into a waiting area, and then an inspector comes along and there is a delay there. So fruit is standing outside the cold room waiting all the time before it is loaded into the container.

It is important that the cold store manager, the forklift operator and the person who is supervising the loading of the container to communicate with each other and ensure that the movement of the fruit from the cold store into the container goes as quickly as possible so the fruit does not pick up temperature.

All these steps and processes for whoever is involved in the cold chain need to be observed, and often people do not appreciate the impact that delaying loading a shipping container can have on the quality of the fruit. Therefore it is important for them to move this fruit into the shipping container as soon as possible.

Once the fruit is in that shipping container there is nothing that anybody can do about it because it is under the control of the shipping line. They deliver it to the port in the international market and from then on the cold chain must be maintained as well. It becomes increasingly important because the fruit is getting older at that point in time.
It might seem that one is placing a lot of emphasis over maintaining this cold chain. It is necessary to place a lot of emphasis on it for the simple reason that it is so important.

If the fruit is cold and allowed to warm up, it then ripens up somewhat during that warming period and you never get it back to the same level of ripeness as it was before the cold chain was interrupted.

Conclusion

The grower can spend a lot of money on growing the best quality fruit and packing and preparing it for the export market, but all of this effort and cost can come to nought if every person involved in the value chain does not fully appreciate the importance of maintaining the cold chain.

Remember that a chain is only as strong as its weakest link.

Active Learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 47.1 – Staff Training

Develop a short training session aimed at new, low-level packhouse workers to explain to them why it is important to maintain the cold chain, and how this should be done.

Activity 47.2 – Research Report

Research the differences between the cold chain for export citrus and the cold chain for exporting deciduous fruit. Write a 1-page report on the subject.
Activity 47.1 – Staff Training

Develop a short training session aimed at new, low-level packhouse workers to explain to them why it is important to maintain the cold chain, and how this should be done.

Summarise the content of the training session below, and include details on the form of presentation that you would use during the training session.
Activity 47.2 – Research Report

Research the differences between the cold chain for export citrus and the cold chain for exporting deciduous fruit. Write a 1-page report on the subject.
Module 48
Safety and Quality Management
Presenter: Gert Kotze

Introduction

In this module we look at safety and quality management in the packhouse. To ensure a safe and good quality product, most packhouses employ a safety and quality control system. The preferred system for food safety and quality management in South African packhouses is HACCP. The HACCP system is an internationally recognised method of managing food production, and HACCP compliance and certification is required by most overseas markets.

HACCP Principles

HACCP is a systematic, preventive approach to food safety and quality that addresses physical, chemical, and biological hazards as a means of protecting food safety and quality.

HACCP is used in the food industry and identifies potential food safety hazards at specific points in specific processes, known as critical control points (CCPs), so that key actions can be taken to reduce or eliminate these dangers.

The system is used at all stages of food production and preparation, including packing and distribution. The HACCP system is based on seven principles.

Principle 1 – Hazard Analysis

The first principle is to do a hazard analysis.

Packhouses determine food safety hazards and identify the measures the packhouse can apply to prevent or control hazards. A food safety hazard is any biological, chemical, or physical property of the packhouse that can cause food to be unsafe for human consumption.
**Principle 2 – Critical Control Points**

Principle two is the identification of critical control points.

A critical control point (CCP) is a point, step, or procedure in the process where control can be applied and as a result, a food safety hazard can be prevented, eliminated, or reduced to an acceptable level.

**Principle 3 – Critical Limits**

The third principle is establishing critical limits for each critical control point.

A critical limit is the maximum or minimum value for the physical, biological, or chemical hazard at that control point. If that hazard falls within the critical limits, the food safety hazard should be at an acceptable level.

**Principle 4 – Monitoring**

Establishing the requirements for monitoring critical control points is principle four.

Monitoring is necessary to ensure that the process is under control at each critical control point. Each monitoring procedure and its frequency should be listed in the HACCP plan.

**Reference**

An example of monitoring is regular titration. For more information on this process, please look at Module 21 – Titration.

**Principle 5 – Corrective Actions**

Principle five is to establish corrective actions.

These are actions to be taken when monitoring indicates a deviation from an established critical limit. Corrective actions are intended to ensure that no product that might be dangerous when consumed enters the commercial chain.


**Principle 6 - Recordkeeping**

Principle six is about establishing recordkeeping procedures.

HACCP regulations require that all packhouses maintain certain documents, including its hazard analysis and written HACCP plan, and records documenting the monitoring of critical control points, critical limits, verification activities, and the corrective actions taken when deviations occur.

**Principle 7 – Validation**

The last principle, number seven, is about establishing procedures for validating the working of the HACCP system.

Validation ensures that the packhouses do what they were designed to do – that is, they are successful in packing a safe product. Packhouses are required to validate their own HACCP plans before they can be accredited and certified.

**HACCP Implementation**

We must maintain HACCP standards throughout the packhouse process. HACCP standards include fruit safety, staff health and safety, and the packhouse environment must be safe, clean and neat.

We will now look at a few examples of the practical implementation of HACCP principles in a packhouse.

**Example – Chemical Use**

The first two examples concern the use of chemicals during production and in the packhouse.

To ensure food safety, we monitor the spraying records of producers, to check that they correspond with recommendations we sent to them for the plant protection products that may be used for particular markets. In the packhouse, daily samples are taken of chemicals used in the packhouse, and sent away for analysis to verify compliance with standards.
Example – Personal Hygiene

The next two examples look at the personal hygiene of workers in the packhouse environment.

When handling fruit, all packhouse workers, and particularly sorters and packers, must wear protective clothing, and specifically gloves, because long nails can damage fruit.

If anyone is injured in the packhouse – accidents do happen – the person must report the injury to the supervisor immediately. The area where the injury occurred is evaluated and thoroughly cleaned. Work in the packhouse is stopped and the injured person is treated before he is allowed to return to work.

Example – Building Maintenance

In the next example, we look at an example of how building maintenance is controlled through HACCP.

We have a glass policy in the packhouse. Every window is numbered, and if windows break, records are kept of it. The area is inspected for broken glass, because staff can be exposed, and there is a great danger that fruit can pick up glass splinters. The part of the HACCP standard is strictly applied.

Quality Control and Monitoring

This example is about quality control and monitoring.

Sometimes fruit is damaged on a line. The quality controller takes samples every hour from packing trays and lines. The samples are inspected to ensure that the size spread is correct, fruit are being handled properly, and there are no injuries to the fruit. This feedback goes to the packhouse manager who signs it off.

Retention Samples

Retention samples are usually taken by retaining one carton of each batch of fruit packed in the packhouse. These cartons must be regularly inspected to monitor the development of postharvest diseases, and kept for at least three weeks at ambient temperature.
Recordkeeping

Our last example looks at recordkeeping and the importance of traceability.

An important point is connected to traceability of the fruit. Each producer’s fruit is packed and despatched individually. This means that when that fruit reaches the market and there is a problem, it can be traced back to producers, farms and orchards. Feedback can then be given to them, informing them of the problem.

Conclusion

Strict application of the HACCP system will not only ensure food safety, but by the proper management of critical control point food quality will also be guaranteed.

HACCP is a management tool that, if used properly, will open new markets for the producer and ensure a safe and quality product every time.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 48.1 – Staff Discussion

Hold a group discussion with your workers in the packhouse about why it is important not to wear jewellery when working with fresh fruit. Prepare a short presentation to lead the discussion and attach a copy of the presentation to you workbook. Make keynotes on the conclusions reached during the discussion.

Activity 48.2 – Research Report

Make a list of the critical control points, critical limits and monitoring activities in your packhouse. Make recommendations for how monitoring and the management of CCPs can be improved in your packhouse.
Activity 48.1 – Staff Discussion

Hold a group discussion with your workers in the packhouse about why it is important not to wear jewellery when working with fresh fruit. Prepare a short presentation to lead the discussion and attach a copy of the presentation to your workbook (insert copy here). Make keynotes on the conclusions reached during the discussion.
Activity 48.2 – Research Report

Make a list of the critical control points, critical limits and monitoring activities in your packhouse. Make recommendations for how monitoring and the management of CCPs can be improved in your packhouse.
Module 49
Commercial Accreditation Systems

Presenter: Paul Hardman

Introduction

For a grower to export citrus, he has to first of all comply with the export standard for that variety and specific export market. These standards are set by the Department of Agriculture, Fisheries and Forestry. In most cases, the grower then also have to comply with the requirements of one or more commercial accreditation schemes, which set standards for food safety and quality, and – in many cases – the management of the production and packing process. These standards assist the grower and packhouse in developing and implementing sound management practices.

Accreditation Systems

British Retail Consortium (BRC)

The first that one we looking at is BRC, British Retail Consortium. In 1998 the retailers in the UK got together and put forward a proposal on food safety systems – a technical document which they could use in all packhouses that they source food from, being packing facilities within the UK as well as all their packing facilities outside of the UK. To a large extent South African packhouses have adopted the BRC standard which is now in its fifth version.

It covers a number of aspects relating to senior management. It insists on a food safety and a quality management plan to ensure that products coming out of that facility are of a consistent and safe quality. It looks at site standards, in other words various aspects of what happens in the packhouse and what pieces of equipment are required to facilitate that process, not only do they look at the product itself, but they look at the process the product goes through.

They follow and track fruit through the facility to see that each aspect does not pose any risk to that fruit.
Finally there is an element within BRC that ensures that there is ongoing training and that the people actually working on the system knows what they are doing and are informed and aware of the implications if they do not perform their duties.

**International Standards**

**Organisation (ISO)**

Next we will be looking at the ISO system. The International Standard Organisation came to a point and where they were approached and asked to provide an international system that would be independent of retailers, growers and essentially being a third party, they were in a position to put a food safety system together.

It is not a certification system as such, but a voluntary approach to managing food safety and quality within the packhouse. There are no audits that are done on the system, but if growers are doing the internal audits and actually following the process, they should have evidence to demonstrate to their trading partners that they have a food safety system in place that can deliver good quality and safe fruit.

**GLOBALGAP**

In terms of what happens on the farm, there are a number of good agricultural practice certification schemes. GLOBALGAP is the most popular widely recognised around the world. In fact, that popularity is only likely to increase now that the Global Food Safety Initiative has recognised GLOBALGAP as the audit scheme that they would prefer growers to adopt.

**Integrated Crop Management Assessment System (ICMAS)**

The final scheme we will be talking about is known as ICMAS, the Integrated Crop Management Assessment System. This tool was designed primarily to assist growers in their process of certification, and it is quite valuable where a grower are implementing a range of schemes and trying to get certification with a number of different bodies.
What the system essentially does is to break down the requirements within those schemes to their simplest form, asking yes/no type questions around each control point and, depending on what answer the grower gives, it qualifies him to be certified at a particular level.

Certification Scheme Focus Areas

Recordkeeping

Recordkeeping is a fundamental part of all schemes and the onus and responsibility falls to the grower to keep good records on every aspect of the farm, particularly when it comes to food safety and the use of plant protection products like pesticides. Those are particularly important areas for recordkeeping where you need thorough records.

Environmental Management

Most of the certification schemes places responsibility on the grower in terms of managing the site and the environment in which he is producing the crop. He needs to make sure that he is not doing any long term or short term damage to his particular site.

Worker Health and Safety

The next common focus that you will find in certification schemes is the need to ensure worker health and safety. There are particular control points that will ensure workers working in the facilities and on the farms are protected during the work they do.

Waste Management

There is also an element of waste management and pollution control that we commonly find in all certification schemes.
Traceability

Probably the critical one is traceability. It is absolutely critical that growers have good traceability systems throughout their processes and that is often linked to the recordkeeping.

For more information on traceability, please look at Module 50 – Traceability.

Plant Protection Products

Another key aspect of the schemes is the use and the demonstration that the use of plant protection products is done in a responsible way and in accordance of the requirements of the South African law as well as the requirements of the retailers.

Internal Auditing

Finally, the last aspect that is a common thread throughout these certification schemes is the need to do self-checking and self-auditing.

This is a requirement to ensure that all systems and processes are operating as needed. This is often verified through either spot-checks by external auditors, as well as through full auditing that will be done by a certification body.

Mostly certification bodies would provide a training service as well to help the grower prepare for an audit.
Certification Process

The typical process that a grower follows once he has decided to get certified is to firstly find out what specific accreditations his target buyer might be looking for.

Then he needs to familiarise himself with the requirements for accreditation and apply these on his farm. Once prepared he will do an internal audit and then finally a certification body will hold an external audit.

Within a year of certification, the certification body will audit the farm again, this time unannounced just to make sure that the initial process is still running.

Other Schemes

Apart from the general, commercial accreditation schemes discussed above, there are also a number of private commercial standards that specific importers and buyers have developed, such as Tesco’s Nature’s Choice and Marks and Spencer’s Field to Fork.

For more information on these schemes, please contact your export agent or the relevant buyer.

active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 49.1 – Self Assessment

Do research on the internet and find the criteria that a packhouse must comply with to obtain ISO accreditation. Use these criteria to perform a self-audit.

In your workbook, list the criteria, rate the current compliance of your packhouse, and list the actions that the packhouse will have to take to become compliant.

Activity 49.2 – Research Report

Compile a 1-page report indicating what recordkeeping practices are used in your specific area of responsibility to ensure food quality and safety.
Activity 49.1 – Self Assessment

Do research on the internet and find the criteria that a packhouse must comply with to obtain ISO accreditation. Use these criteria to perform a self-audit.

List the criteria below, rate the current compliance of your packhouse, and list the actions that the packhouse will have to take to become compliant.

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Activity 49.2 – Research Report

Compile a 1-page report indicating what recordkeeping practices are used in your specific area of responsibility to ensure food quality and safety.
Module 50
Traceability

Presenter: Paul Hardman

Introduction

Traceability is the ability to trace any product back to its original source. In terms of fruit production and export, traceability is the ability to trace back a specific carton of fruit, from the market place, through the entire process to the orchard in which the fruit was grown.

Traceability has become a requirement from an official point of view. Each and every carton of citrus exported should be traceable back down to the farm level or the packhouse level. There is a requirement for one step up, one step down traceability, which is basically the ability to see where fruit went to and where it has come from.

Managing Risk

Traceability is critical to the operating of the farm for a number of reasons, but essentially all these reasons tend to boil down to the ability to manage risk. If you have an excellent traceability system your ability to manage your risk is so much greater.

Managing Food Safety Risk

Just looking at a couple of those risks, the first is food safety risk. When fruit is exported overseas and is found to be contaminated or not fit for human consumption anymore, it is quite critical that that fruit can be identified, isolated and, if necessary, recalled. The only way you can do that is if you got good information about what has happened to that product.
Managing Business Risk

In that same respect there is an element of business risk that is associated with exporting fruit, if anything should happen to your fruit. Obviously if it becomes contaminated you would need to destroy that fruit and it would be a loss of income.

Traceability systems can help prevent your brand and your product being implicated where you can demonstrate that your fruit went to a different market or was never part of that setup. So it is a requirement that you can demonstrate that the product that was implicated is not your product or if it is, be able to identify and destroy the product, if necessary.

Managing Product Quality

The final risk and it is perhaps a little less obvious when it comes to traceability and the need to manage risk is product quality management. Traceability is really the process of knowing what is happening to fruit all along the chain. Where the deviations from set norms or set quality parameters occur, you can pick that up and the system is able to feed that back through to the owner.

It becomes a very useful tool in managing quality problems. We are a long way from our markets in South Africa and if growers are able to identify quality problems early, it certainly helps in reducing the claims on the quality problems that are observed overseas. In addition to that, it will help correct the source of the problem, whether that will be in the packhouse or in the orchard.

Conclusion

There are numerous reasons why traceability is important. Underlying all of them is the need to manage one or more business risks. From the buyer’s point of view, looking across the supply chain, a complete traceability system allows him to identify the origins of a product through a process of queries and communication. From the seller’s point of view, it allows him to follow the path taken by his produce as it makes its way from the farm gate to the final buyer.
active learning

Watch the DVD clips, read through the learning material and do workplace research to gather the knowledge and information to complete the assignments below.

Activity 50.1 – Flowchart

Draw a flowchart explaining how a valencia bought in a supermarket in London can be traced back to where and when the fruit was packed, the person that packed it, and the orchard where it was produced.

Activity 50.2 – Case Study

A carton of marsh grapefruit arrives in Japan. When the carton is opened, it is found that the fruit are infected with Diplodia SER. The fruit is traced back to you, but none of your retention samples or any other test show any sign of infection, while your neighbour, whose fruit is packed at the same packhouse, have problems with Diplodia. How will you be able to prove that the infected fruit does not belong to you?
Activity 50.1 – Flowchart

Draw a flowchart explaining how a valencia bought in a supermarket in London can be traced back to where and when the fruit was packed, the person that packed it, and the orchard where it was produced.
Activity 50.2 – Case Study

Consider the case study below and answer the question based on it.

A carton of marsh grapefruit arrives in Japan. When the carton is opened, it is found that the fruit are infected with Diplodia SER. The fruit is traced back to you, but none of your retention samples or any other test show any sign of infection, while your neighbour, whose fruit is packed at the same packhouse, have problems with Diplodia. How will you be able to prove that the infected fruit does not belong to you?