Citrus Packhouse

Module 6:
Sorting and Grading

Learner Guide

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Introduction

Fruit is marketed and exported from South Africa in two formats. By far the largest volume of fruit is exported in cartons and is meant for fresh consumption. The second format is when processing fruit is exported in bulk bins to overseas juice factories.

Fruit that is meant for fresh consumption is exported in cartons. All the fruit in every carton is the same type and cultivar, as well as the same grade and size, within very narrow tolerances. This means that the contents of each packed carton of export citrus is homogenous. This information about fruit in each carton is printed on a label that is attached to the outside of the carton. Cartons are in turn stacked and secured on pallets, with all the cartons on a pallet containing fruit of the same type, cultivar, grade and size.

The grade of the fruit is also referred to as the fruit class, and is determined by the quality of the fruit. Very strict parameters, set by regulations and export markets, determine the qualities fruit must have to belong to a certain grade. The higher the grade, the higher the return for the grower.

Up to this point in the packing process, when the fruit has been cleaned and treated, all the fruit that came from the orchard has stayed together through the packing process, with the exception of clearly damaged and decayed fruit that was removed during pre-sorting. It is now time to group them, like with like, in preparation for packing.

The terms sorting and grading are sometimes used interchangeably, but in packhouses they are generally used for two distinct actions, which is how we will use these terms in this module. Sorting is the action of separating out fruit that is not fit for export, and directing this fruit to the local market line, processing fruit bins, or waste fruit bins. This is done by hand. Grading is the action of separating fruit that has passed through sorting into different grades, or classes. During grading, some fruit may still be directed to processing, local market, or waste, but this should be minimal. This is almost always done by automated grading systems. Sizing is the action of separating fruit of a particular grade into size categories, also called counts. Automated grading systems size the fruit at the same time as grading them.

Fruit Quality Factors

If you have some experience in fruit production or packing, you can probably look at two fruit and form an opinion about which one is better quality, especially if you can also cut open and taste the fruit. But how do you do that? What factors are you taking into account? And, more importantly, how does the citrus industry objectively codify fruit quality? After all, a fruit of a particular type, cultivar, grade and size that is produced and packed in the Limpopo province should be very similar to another fruit of that type, cultivar, grade and size that is produced and packed 2,000km away in the Eastern Cape.

To make this possible, firstly we need to know what to measure, then we need to develop a standard protocol for measuring, and lastly we need to agree on the standards for each of these factors for different classes of fruit. Fruit quality factors have been defined to tell us what to measure, and we divide these factors into external and internal fruit quality factors.

External Fruit Quality Factors

External fruit quality factors describe the appearance of the fruit, and mostly have no real impact on the taste or eating quality. Fruit with poor external quality, however, is less desirable, and will fetch a lower price from the consumer.

External quality factors use the Colour Prints for Blemish and Appearance Standards as a measuring tool. The Colour Prints are issued by CRI and contain a set of graded colour prints for each external quality factor for each citrus type and variety. From these the standards for fruit of particular grades are defined. They are used at sorting stations to assist sorters with distinguishing between fruit that meets the minimum export standard and fruit that does not. They are also used in control rooms for automated grading systems, to manage the settings that differentiate between grades of fruit.

Standards are set for a range of external quality factors, which we will look at in turn. We will use the Colour Prints to illustrate the graded standards for each factor. Some external quality factors only apply to particular fruit types, and in some cases separate standards are set for different types. It is, however, important that you are aware of all the external quality factors that are regulated and that you should be paying attention to.

Fruit colour is a very noticeable external quality factor, and the Colour Prints contain sets for each citrus type and many cultivars.

Another external quality factor is damage caused by pests and diseases. This includes damage from insects such as thrips, red scale, rust mite, bollworm, mealybug, and leaf hopper. Pest insects also causes the growth of sooty mould, which is also considered pest damage. Disease damage of significance is caused by citrus black spot and alternaria brown spot. Wind scars, hail damage and frost damage are external quality factors caused by the weather, although frost damage is likely to cause more internal than external damage to fruit. Chemical burns, stem-end browning and oleocellosis are other damage factors that are regulated.

Standards are set for fruit malformations such as sheep nose, high shoulders, flat fruit and protruding navels, as well as skin defects such as rough texture, ribbing, ridging, rind pitting, and peteca.

Internal Fruit Quality Factors

Internal fruit quality factors determine the taste and eating quality of the fruit. There is a separate measurement for each internal fruit quality factor.

Juice content is measured by selecting a sample of fruit, weighing the fruit, extracting all the juice, separating the juice from the pulp, and weighing the fruit rinds and pulp. The juice percentage is then calculated based on these two weight measurements.

Degrees Brix is a measurement of the sugar content of the fruit. It is expressed as °Bx, with one degree Brix meaning one gram of sucrose per hundred grams. Brix is measured with the help of a refractometer.

The percentage acid content of the fruit is determined by titration. A sample of 20ml juice is placed in an Erlenmeyer flask and five drops of phenolphthalein indicator are added. A sodium hydroxide solution is then titrated into the flask, using a burette with precise measurements, until the juice in the flask turns pink, which is when the acid is neutralised. Initially it may be difficult to see the point at which the colour changes, but near the end-point the juice mix slowly lightens in colour, almost becoming clear before going very light green. A few extra drops of the sodium hydroxide will make the solution turn and stay pink. If you go past this point and the solution changes from pink to a deep purple or orange, you have added too much sodium hydroxide and you will need to empty the flask and begin again. Overzealous swirling often leads to passing the end-point. The volume of sodium hydroxide solution that was necessary to neutralise the juice is used to calculate the percentage acid content of the fruit.

The degrees Brix:acid ratio determines the tastiness of the fruit – if the ratio is too low, the fruit will be very sour, and if the ratio is too high, the fruit will taste bland. The ratio is calculated by dividing the degrees Brix, which is the sugar percentage of the fruit, by the acid percentage.

Seediness and granulation are another two internal quality factors that are regulated, as is internal fruit colour for pigmented grapefruit. Standards are also set for over-ripeness, which can also be considered as an internal quality factor.

Export Standards

The Standards and Requirements Regarding Control of the Export of Citrus Fruit document is published every year by the Department of Agriculture, Land Reform and Rural Development, or DALRRD, and empowered by the Agriculture Product Standards Act of 1990. This document sets out the minimum standards for the quality of export citrus fruit, and the requirements for the packing, marking and labelling of the fruit. The Standards and Requirements document describes in great detail the minimum requirements of the colour, blemishes, shape, skin texture and other characteristics of each fruit type that can be exported as different grades, or classes, as they are called in the document. This is the minimum standard that all export fruit must comply with, and the standard PPECB will apply when inspecting fruit.

The Standards and Requirements also set out detailed procedures for measuring internal quality factors, and address aspects for food safety compliance that might apply to citrus specifically, that are not covered in general food safety law, such as labelling that indicates postharvest treatments.

On top of the minimum standard, export markets and specific clients, such as overseas supermarket groups, may set their own standards and requirements to meet the specific demands of their customers. These standards and requirements are negotiated between the export agent on behalf of the grower and packhouse, and the overseas client. Often, they are already agreed upon at the start of the season, and clients are not generally tolerant of deviations from the agreed standards. PPECB does not inspect according to these private standards.

The private standards are usually contained in a packing guide issued by export agents at the start of every season and sent to the producers and packhouses from where they source fruit. The packing guide contains all the information that the packhouse needs, including standards for packing material, place packing diagrams, palletising diagrams, and much more.

CRI's Colour Prints for Blemish and Appearance Standards are used in DALRRD's Standards and Requirements and in the exporters packing guidelines, to indicate the standards for different grades of export citrus.

Packhouses must be able to grade fruit according to the standards and meet the requirements of export markets and overseas clients. To achieve this, it is essential that sorting and grading practices are aligned with market standards, to the finest detail.

Sorting

In most packhouses there are two or three different sorting stations, although sometimes not all of the stations are manned, depending on the quality of the fruit that is running on the line at the time. Sorting teams at the different stations might be looking for different defects in different packhouses. For instance, on some packlines the pre-sorting team may

also be asked to remove outsized fruit or very green fruit, in addition to decayed and split fruit. But in the end, it is important that, between the sorting stations, all fruit not fit for export should be removed.

Sorting Stations

The first sorting station is pre-sorting, directly after the tip, either just before or after the fruit washing system. We discussed pre-sorting in detail in module 4. Pre-sorting teams aim to remove decayed and split fruit, but may also be tasked with removing fruit that has other kinds of defects. Keep in mind though, that if the pre-sorting station is before the washing system, it is not easy to see marks on the fruit clearly because the fruit may still be quite dirty. Pre-sorters must remove decayed and mouldy fruit, which can be recognised easily enough. If these green bombs are allowed to enter the washing system, they can contaminate the system and spread decay.

The second sorting station is either right before or right after the fungicide and wax treatments. In most packhouses, this is referred to as the main sorting station. Main sorting aims to remove fruit that has pest or disease damage, with special attention to false codling moth, fruit fly and black spot infestation symptoms, as well as other fruit that is clearly not fit for export. Colour prints are posted at main sorting stations to assist sorters with identifying the fruit that cannot be exported.

If there is a third, or final, sorting station, it will be right before the automated grading system, or after the system by the packing tables, for a final verification that the fruit that is going onto the packing tables meets the required standard.

Sorters

A good sorter has keen eyesight, is able to concentrate for long periods, knows which fruit goes where, and, above all, knows the export standard. Sorters must keep their nails short and their hands very clean. In some cases, sorters may be required to wear gloves. It is very important that sorters handle fruit with care and prevent any injuries to the fruit. Remember that small fruit injuries that you cannot see with the naked eye can become an infection point and lead to postharvest decay.

When they are recruited, sorters may be required to do a colour blindness test. The ability to see colour and blemishes on fruit is critical to performing this task.

Sorting Tables

Best practice is for sorting tables to be well-lit, preferably with neon lights right above the sorting area, and at a comfortable height, so that sorters do not have to lean forward or work with their hands held too high. They should be of a width that sorters can reach all the fruit on their line without bending forward, and have rollers that continuously rotate the fruit.

Sorting Practices

As the fruit passes by in front of you, look for fruit with defects and blemishes. This may include the following:

- Decayed fruit with green mould, blue mould or sour rot
- Split fruit
- Green fruit

- Fruit with false codling moth or fruit fly sting marks
- Fruit with citrus black spot
- Fruit with other pest damage, such as red scale, bollworm, thrips or mite
- Fruit with sooty mould
- Fruit with oleocellosis
- Fruit with wind damage
- Fruit with long stems or picking injuries

You will have different instructions of what to do if you find fruit with each of the defects. This will depend on the severity of the defect, and on the market standard you are using. For instance, if you find any fruit with symptoms of false codling moth, fruit fly or citrus black spot infestation, you must remove this fruit immediately and send it to the fruit waste bin. Such fruit cannot be sold fresh or sent to the juice factory. The same goes for decayed and split fruit. But certain markets may have tolerance for some wind damage, or some thrips damage, even if the fruit is exported as grade 2 fruit. It is always better to err on the side of the grower, meaning that you should rather let fruit through even when there is a small chance that the fruit can be exported. Only remove fruit that you are absolutely sure cannot be exported.

If you find fruit with picking mistakes, such as fruit with long stems or fruit with picking injuries, you should put the fruit aside and inform your line supervisor, so that they can give feedback to the picking teams. Clip the long stems and put the fruit back on the line, if it has no other defects. Remove fruit with picking injuries because they will decay.

Grading

Grading is now fully automated in most packhouses, although there are still a small number of packhouses where grading is done by hand.

Market standards and requirements have evolved over time, and retailers overseas use these standards to differentiate their offerings to the consumer from those of competitors. In addition, for the same grade of fruit, some export markets may have requirements that differ from the requirements of another export market in small but important details. For instance, because lemons are used in some markets almost exclusively in the hospitality industry, those markets want fruit that is identical to those required by other markets, except that they place value on how long the fruit is because longer fruit gives them more lemon slices per fruit. These markets are also willing to pay a premium for fruit that meets their particular expectations. If a packhouse is able to separate out fruit that meets these requirements, it can be of great benefit to the grower.

This means that a packhouse can no longer afford to only separate fruit into two or three grades. They need to be able to make fine distinctions between fruit, and to separate fruit into categories that meet very specific, and even niche, requirements, in order to optimise returns for the grower.

Manual grading is therefore no longer a viable option for most packhouses, because no human eye can make such fine distinctions at speed. Manual graders are also less consistent than automated grading systems, because they get tired or distracted, and lose concentration.

There is a wide range of automated grading systems. On all of them, fruit is first guided from the conveyor belt into individual cups that run in lines. The fruit runs in these lines

under a bank of cameras, one above each line, which takes a large number of photos of each fruit. These photos are analysed by a computerised system that has been programmed with the standards and tolerances for each size and grade category that is being packed. At the same time, the system measures the size of the fruit.

The system is also programmed with instructions of where to send the fruit in each category. Mostly this instruction will be to drop the fruit onto a line going to a packing table, where fruit of the same size and grade category gathers, ready to be packed by a packer or an automated packing machine. Alternatively, the system can also direct fruit to the local market line, or to the processing fruit line.

Fruit labelling banks can be integrated with the automated grading system, with an instruction to label fruit of particular categories programmed into the system. A number of labelling banks can be installed on a line, and the system will instruct the fruit labellers to apply the right labels to the right fruit.

In the control room, quality control officers can draw samples from the automated grading system. They simply enter the number of fruit in the sample and the category from which the sample must be taken into the system, and the fruit sample is automatically directed to the control room. The quality control officers then examine the fruit in the sample to make sure that the system is grading to the right standard and that the settings are not too strict or too lax.

Sizing

Citrus fruit size categories are more commonly referred to as counts. The count is simply the number of that particular fruit type of that particular size that can fit into an A15C telescopic carton, which is the most common carton that is used for export citrus, and is therefore used as the reference carton for counts. As an example, if a Valencia orange is count 64, it means that 64 Valencia oranges of that size will fit into an A15C carton. If a Valencia orange is count 105, it must be really small, because now 105 of those oranges can fit into an A15C carton.

These are the standard counts and sizes for oranges, soft citrus, grapefruit, and lemons and limes. The diameter measurements that are given here are the average measurements for fruit in that size category, and is used by automated grading systems to size the fruit.

The only mechanical sizers that are still common in packhouses are the pony sizers that can usually be found close to the pre-sorting station. These pony sizers remove fruit that is too small to be exported. Mechanical sizers are seldom used for the main sizing, except maybe on local market lines, or lines on which processing export fruit is sized.

Conclusion

We have now reached the point where fruit unsuitable for export has been removed, the remaining fruit has been cleaned, treated, and then sent through an automated grading system that separated the fruit into groups of the same grade, or class, and size. The fruit is now ready to be packed according to the requirements of the overseas buyer.