

## **Final Report**

# **Australian Citrus Quality Standards – Stage 3**

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Citrus Australia Ltd

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CT15013

**Project:**

Australian Citrus Quality Standards – Stage 3

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## Summary

The Australian citrus industry is in a buoyant phase. Demand to the north of Australia through the Asian trade channel has had a positive effect on grower returns. Strong export demand has influenced domestic fresh fruit and domestic juice markets. In 2018, exports of citrus exceeded 250 000 tonnes valued at A\$453M. Globally, the Australian industry is regarded as the highest cost producer, primarily due to labour costs. The industry relies on its reputation as a producer of high quality, flavoursome and safe produce to maintain its foothold in premium markets around the world. Australia produces 715 000 tonnes of citrus per annum (5 year average). Approximately one third of the volume is sold on the Australian domestic market for fresh consumption. The Australian domestic market is therefore industry's largest market.

The objective of project CT15013 (Australian Citrus Quality Standards – Stage 3) was to improve the eating quality of citrus fruit in order to develop trust with Australian consumers. Citrus industry leaders hold the view that reliably delivering fruit of consistent quality to consumers will increase purchase frequency and purchase weight of oranges and mandarins. To achieve this objective, the project defined six areas of activity that included:

- testing and reporting maturity levels of fruit for sale in Australian wholesale markets
- developing and implementing a maximum granulation standard for Imperial mandarins
- engaging and strengthening linkages with the national supply-chain
- developing a Standard Operating Procedure for commencing harvest
- conducting pre-harvest field testing and communicating results to industry participants
- collaborating with the research community to improve the quality of Australian citrus.

Throughout the life of the project, there has been incremental progress and a cultural change within the industry, with a greater level of awareness of consumer expectations and effort to deliver upon those expectations.

One of the major supermarket chains is of the firm view that strong sales, repeat purchases and category growth are directly linked to the development and implementation of the Australian Citrus Quality Standards. This assertion is based upon a robust analysis of scan data and loyalty programs. The major retailers have adopted the Australian Citrus Quality Standards as their criteria for market entry but not all have enforced the standards with the same level of rigor.

The pre and post-harvest fruit testing and reporting components of the project provided a valuable tool to inform sourcing and marketing decisions. Given the long history of accurate testing and reporting using skilled technical personnel, industry participants generally accepted the tests results and did not question the integrity of the program. In the three years of the project, 83 per cent of fruit tested either achieved or exceeded the Australian Citrus Quality Standard.

Citrus Australia investigated the best practice for harvest, and modified the methodology for fruit testing. It is common practice within citrus industries globally to extract and combine the juice from several fruit into a single receptacle and measure sugar and acid content from that combined sample. This method provides no indication of the experimental error within orchards. Moreover, there was strong potential for poor quality fruit within the sample to be disguised by the other fruit in the sample. Similarly, a single piece of high quality fruit could disguise the presence of a large number of poor quality fruit. Accordingly, the in-field and market testing protocols were modified in the second year of the project and testing was conducted on individual fruit within samples to provide industry with a better understanding of the variability within orchards and commercial consignments.

Citrus Australia also questioned whether a ten-fruit sample adequately represents an entire block or an orchard and the location within an orchard from where a sample is taken. After analysis of the various parameters, Citrus Australia determined a sample of 30 fruit to be more appropriate than a ten-fruit sample. The need for individual fruit sampling and a greater number of fruit in a sample creates new challenges for industry and underlies the need for rapid advancement in non-destructive, in-field testing technology.

A granulation standard was developed for Imperial mandarins and had widespread support from industry, particularly the Queensland sector. This was a first for the industry which had previously no standardised method of measuring and reporting granulation levels. The incidence of granulation detected increased during the project, due to a combination of weather events which caused higher than usual levels of granulation during the 2018 season. The granulation standard provided market testing agents and retailers with a uniform procedure to accurately detect, grade and report granulation and a quantifiable measure to report back to suppliers.

Linkages between the supply-chain and the research community were further developed over the length of the project and representatives from both communities provided contributions towards the project. Citrus Australia's industry forums were platforms for the supply-chain and researchers to network and communicate findings. Communication was delivered via these forums as well as through online and print media (e.g. Citrus Australia website, Australian Citrus News and Citrus eNews).

The project team developed a Standard Operating Procedure (SOP) for harvest as a tool for growers to reliably measure fruit maturity with a view to predict the most appropriate time to harvest fruit that achieves consumer expectations and prevents immature fruit from being consigned to market. The SOP was developed in consultation with Citrus Australia's Domestic Leadership Group and incorporates industry best practice and existing procedures in California and New Zealand. The SOP was released as a guideline on the Citrus Australia website. The SOP will be entirely voluntary as enforcement will be challenging without market place incentives or punitive measures at retail.

## Keywords

Australian Citrus Quality Standards (ACQS), citrus, orange, mandarin, Brix-acid, BrimA, citrus maturity, Imperial granulation, Imperial dryness.

## Introduction

Citrus fruits are non-climacteric - they do not develop sugars after harvest so fruit must be harvested when the internal maturity reaches levels that are satisfactory to consumers. The visual appearance of fruit (size, colour etc.) is largely unrelated to the internal characteristics. Market pressures drive some growers to harvest fruit as soon as it is visually ready (size/colour). The early harvest of fruit means that fruit that does not meet consumer expectations in relation to eating quality is consigned to market.

The Australian Citrus Strategic R&D Plan (2012-2017) listed four key objectives. Objective 2 was to:

*‘Ensure the price of Australian citrus is maximised by improving our reputation as a reliable supplier of high quality citrus, capitalising on aspects of taste, colour, freshness and food safety’.*

Project CT15013 aimed at addressing this objective and builds upon the successes of previous projects aimed at improving and maintaining the eating characteristics of oranges and mandarins (CT13022, CT12013). Ultimately, consistent and sustained quality would influence consumer confidence and increase consumption on the Australian domestic market through higher purchase weight and frequency. Improved quality at the domestic level would have obvious flow-on effects in building Australia’s reputation in export markets.

Previous investments in this area were primarily aimed at demonstrating to industry that unacceptable fruit was being consigned to market and negatively impacting consumer purchasing behaviour. The keystone to the success of the previous quality standards projects was the ‘in-market testing’ conducted to demonstrate that fruit outside the acceptable range was being consigned to market. At that stage in the industry’s development, large parts of the sector failed to acknowledge this important shortcoming or the impact it was having on consumer purchasing behaviour. Across the supply chain, the responsibility was passed to other parties. Common messages included *“the grower picks too early”* or *“the marketers and retailers are demanding my fruit”*. Independent testing laid rest to the myths and exposed the high number of poor quality fruit consignments when the first project commenced.

In the course of the earlier projects, the appropriateness of the maturity parameters commonly used by industry (Brix, acid, Brix acid ratio and juice percentage) were questioned. Research in the United States had shown that consumer’s preferences could be more closely aligned to the BrimA maturity index (Jordan *et al.* 2001). The Californian industry had adopted a new standard based on BrimA, a significant change for the world’s largest fresh citrus exporter (California Standard, circa 2012).

In consultation with the University of California and the United States Department of Agriculture, Citrus Australia designed a sensory evaluation study to understand consumer preferences. The study confirmed that the BrimA maturity index was a more reliable indicator of consumer preference than the Brix:acid ratio, Brix alone, acid or juice content. Further work was then undertaken with Delytics New Zealand to further develop models to predict consumer behaviour based on the BrimA maturity index. The citrus industry agreed to adopt the BrimA index as the industry’s maturity standard.

Granulation (or internal dryness) is a physiological disorder that affects some citrus varieties, particularly Imperial mandarins. Fruit may suffer granulation to varying degrees. Project CT15013 was also aimed at determining acceptable limits in relation to granulation, based on consumer sensory evaluation studies. In collaboration with the University of Queensland, the project team conducted a sensory evaluation trial to determine acceptable and unacceptable levels of granulation in Imperial mandarins. Subsequent to the study, a maximum granulation standard was developed and adopted by the industry.

## Methodology

Project CT15013 had six components.

1. Maintain current ACQS market testing and reporting program.
2. Develop and implement a maximum granulation standard for Imperial mandarins.
3. Supply-chain engagement.
4. Develop standard operating procedure for start of harvest.
5. Communicate pre-harvest field testing and reporting.
6. Research collaboration.

Here we outline the methodology behind each of the six components.

### 1. Maintain current ACQS market testing and reporting program

This component was designed to provide transparent reporting of fruit maturity at the marketplace. Contractors were engaged to sample, test and report the quality of oranges and mandarins in the domestic marketplace to Citrus Australia. Citrus Australia collated the results and reported to those within industry that had a vested interest in improving fruit quality. Industry used the report to make harvest and marketing decisions to supply the best tasting fruit for their customers.

Testing contractors were appointed in each of the capital city wholesale markets in Adelaide, Brisbane, Melbourne, Perth and Sydney. Contractors were trained and assessed to conduct testing according to the testing procedures developed by Citrus Australia under previous iterations of the project. Auditing of contractors took place throughout the life of the project to ensure that consistent test procedures were being applied across all testing sites.

Contractors visited the fresh produce market weekly and selected samples of new in season oranges and mandarins. A sample consisted of ten fruit and the details of the sample were recorded, including:

- grower
- packer
- marketer
- brand
- variety
- class
- defects
- diameter of each fruit.

Each fruit was dissected and the juice was extracted using a citrus reamer. Sugar content was approximated by determining Total Soluble Solids (TSS). The refractive index of the juice was measured using a sugar refractometer (0 – 30 per cent range). The sugar refractometer is calibrated in such a way that it directly provides readings on total soluble solids (TSS) in degrees Brix ( $^{\circ}$ Brix).

Titrateable acidity was measured by titration against a sodium hydroxide solution with a phenolphthalein indicator. For each test, the BrimA maturity index was calculated according to the calculation proposed by Jordan *et al.* (2001). The calculation is:

$$\text{BrimA maturity index} = (^{\circ}\text{Brix} - (4 \times \text{acid})) \times 16.5$$

Research in the USA and Australia provides evidence that the BrimA maturity index is a more reliable indicator of consumer acceptability than the Brix:acid ratio that was previously adopted by industry.

Test reports with detailed results were distributed to industry on a weekly basis. Results were assigned a 'traffic light' colour coding. Where a test result achieved or exceeded the minimum specification, a green coding was applied. A cautionary orange coding applied to fruit that only marginally did not meet the minimum specification and where the minimum specification was not achieved, a red coding was applied.



Details on the weekly report included:

- date of test
- test number
- sample market (Adelaide, Brisbane, Melbourne, Perth or Sydney)
- grower or packer
- market agent
- variety
- grade
- diameter of the fruit
- state the sample originated from
- number of granulated fruit in sample (Imperial mandarins only)
- Brix level
- BrimA maturity index.

During the first year of project CT15013, the juice from ten fruit was aggregated into a single sample and measurements (Brix and acid) were taken and a single result was generated. This was standard practice under previous iterations of the project and considered best practice at the time. The project team challenged this practice as there was strong potential for the result to be skewed (in either direction) by a single piece of fruit. In 2017, the program moved towards testing the juice from each individual fruit in the sample. While this was a more labour intensive process for the testing contractors, it provided a measurement on the sampling error within orchards. The average of the BrimA maturity index for the ten fruit was reported to industry to maintain the reporting methodology and allow comparison across the previous years of reporting. Where a 'cautionary' result or 'did not meet specification' result were reported, the data for each individual fruit were provided to the supplying grower to explain the result in more depth. Sampling, testing and reporting continued along the same lines through the third year of the project.

## 2. Develop and implement a maximum granulation standard for Imperial mandarins

The dry or 'granulated' texture of Imperial mandarins is an undesirable eating quality. This project aimed to take the initial steps towards addressing this defect as it had become a market failure not addressed by individual businesses and affecting confidence in the sector to deliver quality produce to market. Granulation is most common in the Imperial mandarin variety and a common consumer and category management concern. If fruit is affected (granulated) consumer re-purchase behaviour is adversely affected. Imperial mandarins become granulated during the early stages of development and non-destructive detection can only be achieved with sophisticated grading technology that is still in development. At the time of writing, Australian packing-houses are not equipped with such machinery. This project component aimed to identify what level of granulation was acceptable to the consumer and then created a granulation standard and testing procedure for identification. This in turn could inform future engineering solutions to the granulation issue.

In collaboration with the University of Queensland, a study was designed to evaluate and demonstrate the performance of a specialist sensory panel trained for QDA® (quantitative descriptive analysis). The objective of the trained panel was to develop a language that describes the sensory properties of Imperial mandarins using descriptive sensory analysis. The panel was selected from university volunteers (staff and students) and trained according to ISO standard 8586-1. The trained panellists evaluated mandarins with and without granulation and categorised the fruits based on different levels of granulation, juiciness, and sweetness. The physical and chemical properties such as texture, juiciness, pH, Brix, acidity and colour of the mandarins were evaluated. A scale was developed to describe the granulation.

Continuing that work, a consumer evaluation study was conducted to determine granulation acceptability levels among consumers. The trained panel found that some of the important sensory attributes that could play a significant role in consumer acceptability were sweetness, sourness, mandarin flavour, juiciness and chewiness. The objectives of the consumer study were to determine the preference of 150 test subjects between mandarins exhibiting three levels of granulation; 35 per cent, 45 per cent and 55 per cent for the following mandarin sensory attributes – mandarin flavour, sweetness, sourness, juiciness and chewiness. Each fruit was evaluated for its colour, Brix, acidity and weight of the granulated mandarins (35, 45 and 55% granulation). Responses were provided on a categorical hedonic (9 point) scale. Participants were presented the three samples of mandarin in a balanced random order. Data were subject to a One-Way Analysis of Variance (ANOVA).

The Queensland Regional Advisory Committee and the Domestic Leadership Group were consulted and both groups were given the opportunity to provide input and subsequently review the standard throughout its development. The major retailers were also consulted throughout the process.

### 3. Supply-chain engagement

The project team held the view that project priorities and objectives should be informed by supply-chain participants. Accordingly, the team put in place mechanisms for the two-way exchange on project priorities. Project CT15013 built upon the legacy of previous projects and at the commencement of the project, the project team had already established networks of growers, packers, researchers, regulators, agronomists, retailers, wholesalers and other members of the value-chain. However, as the citrus industry has continued to evolve, industry participants have changed and renewed effort has been required to maintain existing relationships and cultivate new ones.

The Domestic Leadership Group was re-established at the commencement of the project. Membership of the group was made up of a mix of vertically integrated citrus businesses. A representative from Hort Innovation also attended each meeting. We estimate that the businesses represented on the committee supply over 80 per cent of the citrus fruit on the Australian domestic market. The group's terms of reference were to:

- identify domestic marketing priorities and suitable resource options
- assist with implementation and communication
- provide regular and timely feedback on domestic marketing issues
- provide advice to the Citrus Australia Board on national citrus R&D and marketing levy programs managed by Horticulture Innovation Australia
- monitoring and evaluating project activities against key performance targets.

Face-to-face meetings of the Domestic Leadership Group were held twice annually, typically in March (to coincide with the start of the Queensland mandarin harvest) and October (to coincide with the end of the season). Minutes were recorded and distributed after each meeting. The Domestic Leadership Group was also utilised as a sounding board to inform decisions by the project team as issues arose. For instance, granulation in Imperial mandarins became a greater than expected issue with retailers, mid-way through the project. The group also provided a substantial amount of input into the Standard Operating Procedure for start of harvest.

Regional Advisory Committees were established in each region (Murray Valley, Riverina, Central Burnett, South Australia and Western Australia) at the commencement of the project and meetings were held at least twice annually. Gaining enthusiasm and momentum with the committee in the Riverina was however a challenge for the first part of the project but progress was certainly made towards the latter part. The Terms of Reference of the Regional Advisory Committees were to:

- provide information and advice to Citrus Australia on regional priorities and to ensure that local issues are actively considered within the national context
- ensure that Citrus Australia diligently collates national information on crop estimates, weekly market dispatches and planting statistics
- identify, prioritise and implement industry development projects such as extension and the provision of industry information
- maintain a local or regional focus on research and development priorities.

The Queensland Regional Advisory Committee provided a large amount of input into both the granulation standard for Imperial mandarins and the Standard Operating procedure for start of harvest.

The Regional Advisory Committees provided a strong vehicle for informing regional forums, in-field demonstrations, workshops and other activities. Regional forums were held in each region annually (typically in June), and twice annually in Queensland, providing the project team with an opportunity to deliver presentations on a range of contemporary issues. The forum agendas were developed in consultation with the Regional Advisory Committee in the relevant region. The forums were generally coupled with practical demonstrations in orchards or in packing-houses. Fruit quality and the Australian Citrus Quality Standards were a strong focus of the practical demonstrations and presentations, particularly in Queensland where there is a large number of hectares dedicated to Imperial mandarins. Further, Queensland is the earliest production region to access the Australian domestic market and therefore required the most attention.

At the regional forums, citrus researchers were also invited to present findings, extend R&D outcomes and demonstrate to growers how their levies were being invested. Dr John Golding (citrus post-harvest researcher, New South Wales Department of Primary Industries) was a regular presenter and also accompanied the team on face-to-face industry visits. Members of the supply chain were also invited to present, with a view to improving knowledge transfer across regions. For example, 'quality focussed' growers, packers and marketers from the southern regions were a strong feature at Queensland forums. While this project (CT15013) was focussed on quality, the regional forums provided additional benefit by utilising the opportunity for the two-way exchange of information on:

- market access
- exports
- post-harvest
- national plantings
- crop forecasts
- agrichemicals
- food safety
- R&D findings
- export promotions
- labour and welfare.

Special purpose forums were also held each year. The Market Outlook Forum was held in March 2016 and March 2018. The Citrus Technical Forum was held in March 2017. These events attracted supply-chain members from across Australia and international speakers were invited to participate and delivered the keynote address at each event. Both settings provided opportunity for the team to present the findings from CT15013.

Recognising that discomfort exists for some participants in a group setting, the project team visited growers, packers, marketers and distributors regularly throughout each season to provide the opportunity for more specific feedback and input on domestic supply-chain issues. The timing of the mid-season visits usually coincided with the Regional Forums (to minimise travel costs). Fruit quality was a strong focus of those discussions. The team also made a firm commitment to visit each packing-house at the end of each season to provide further opportunity for face-to-face engagement. There were obvious efficiencies to be gained by combining activities of project CT15102 (Citrus Market Development and Innovation) including agrichemicals, export registration, market access and export marketing. Supply-chain representatives and researchers were regularly invited to accompany the team on the visits. Dr John Golding was always keen to capitalise on the opportunity to meet with growers and packers in the regions.

Each season, the project team visited the wholesale markets in each capital city to meet with testing contractors and to speak with wholesalers on issues related to quality. Testing contractors were also trained and proficiency tested regularly throughout the life of the project to ensure that test procedures were being adhered to. These visits were timed to coincide with the peak of the citrus supply in June or July.

The project team cultivated and maintained strong working relationships with the Quality Assurance and purchasing teams with the major retailers. As noted previously, the retailers provided strong contributions towards the development and implementation of the standards. Face to face visits with the major retailers took place at least twice annually. There was a substantial amount of engagement with the retailers at the earlier stages of the project in an effort to develop the Standard Operating Procedure for start of harvest.

#### 4. Develop Standard Operating Procedure for start of harvest

The appearance, eating quality and shelf-life of citrus fruit is to be of a high standard if it is to satisfy consumer expectations. As citrus fruits are non-climacteric, these attributes do not improve after harvest and the packing-house can do little to rectify poor harvest decisions. It is therefore imperative that measures be put in place to ensure that unacceptable fruit is not harvested to begin with. Development of a standard operating procedure (SOP) to initiate harvest was included as a project objective.

The SOP was designed to achieve ACQS limits as well as rind colour requirements. In citrus, the internal sugars do not develop after harvest but the rind colour can be manipulated by application of ethylene gas (referred to as de-greening) when a certain percentage of the rind has experienced colour break from green to orange. The temptation for growers and marketers is therefore to harvest early and attempt to manipulate the rind colour through de-greening in order to capitalise on early opportunities in the market. Poor application of this technology can result in off flavours and the exacerbation of post-harvest rots. Throughout project CT15013, the subject of de-greening practice was raised and workshops were held in Queensland to address issues such as appropriate ventilation, temperature and length of treatment. Expertise from the research community as well as the commercial sector was utilised and data were provided to explain the physiology of fruit colour change and the triggers (largely diurnal temperature variation i.e. the variation between a high temperature and a low temperature that occurs during the same day) that naturally begin the process.

The SOP was intended to be used by growers as a method to assess their crop through representative samples to make informed decisions on when to harvest (i.e. when internal quality is acceptable to consumers and when rind colour is conducive to de-greening).

The content for the start of harvest Standard Operating Procedure (SOP) was determined in year-one of the project in consultation with growers, packers, marketers and retailers. Advice was also provided through our international networks in the United States and New Zealand where maturity standards are mandated.

As the Queensland growing regions are the earliest regions to commence harvest, there was a strong emphasis on working with the Queensland Regional Advisory Committee and the Queensland Citrus Exporters Group in developing the draft standard. Citrus Australia's Domestic Leadership Group provided a large amount of input during the drafting phase of the SOP. The major retailers were also engaged throughout the process with a view to making the SOP a condition of entry into the Australian retail market. Appropriate levels of sampling and testing prior to harvest were determined by engaging a biometrician. Ultimately, the aim was to develop a sampling regime that at least 90 per cent of the fruit in an orchard achieves consumer expectation at the 95 per cent confidence level.

#### 5. Pre-harvest field testing and reporting

Pre-harvest testing and reporting was conducted each season to share region specific maturity levels (as close as possible to harvest) and provide objective evidence to support (or dispel) some of the industry anecdotes and theories around harvest timing.

Citrus growers, packers and marketers have traditionally relied upon historical data to predict maturity at harvest but testing the season's crop provides a more accurate indication of maturity as there can be substantial differences between seasons and within regions. As with many agricultural industries, citrus growers can experience 'early' or 'late' seasons. Where maturity testing has taken place, growers have typically based their predictions on a sample of ten fruit (or less) from an entire orchard.

Pre-harvest testing and reporting was undertaken in each growing region by sampling fruit from orchards, and testing according to standard procedures. To demonstrate the range of maturity (sampling error) in the population, 30 fruit were randomly selected from each location and maturity levels were assessed according to the ACQS market testing procedures (detailed under item 1). Using Citrus Australia's grower network, the project team arranged orchard visits across a number of growing regions, sampling varieties that were close to being harvested, from different rootstocks, orchard locations and soil types to help highlight the variables that contribute to maturity.

Results were communicated to industry participants via email, through our Regional Advisory Committees, and at pre-season meetings in each region (Attachment 1, pre-harvest industry report 2018)

## **6. Research collaboration**

One of the objectives of project CT15013 was to foster an environment for research collaboration, national extension, and industry adoption of R&D outcomes.

Throughout the life of this project, the project leaders cultivated strong working relationships and built a community of practice within the post-harvest research community. The research community were regular attendees at our regional forums and special interest forums where they were invited to deliver presentations on R&D findings. The biennial Citrus Technical Forum was held in March 2017 and planned again for March 2019. The program for the technical forum is specifically designed to bring Australian and overseas researchers together at a single venue.

## Outputs

Here we report the outputs that align with the seven key project objectives.

Activity	Output
<b>January – June 2016</b>	
Domestic Leadership Group	Domestic Leadership established with members of the supply-chain, Citrus Australia and Hort Innovation.
Market testing contractors	<p>Market testing contractors appointed in each of the major wholesale markets:</p> <ul style="list-style-type: none"> <li>• 2 contractors Brisbane (Oz market consultants)</li> <li>• 1 contractor Sydney (Freshcare)</li> <li>• 2 contractors Melbourne (Rudge produce)</li> <li>• 1 contractor Adelaide (APAL agricultural)</li> <li>• 2 contractors Perth (Total Quality Assurance)</li> </ul>
Visual guide for granulation assessment	<ul style="list-style-type: none"> <li>• Imperial mandarin granulation visual guide</li> <li>• Imperial granulation standard (including guide for sampling)</li> <li>• Discussion paper on sampling to detect granulation in Imperial mandarins, May 2016.</li> </ul>
Pre-season field testing in Queensland	<ul style="list-style-type: none"> <li>• Fruit tested from 6 orchards across the Central Burnett</li> <li>• 120 individual fruit tests</li> <li>• 12 grower reports</li> <li>• Presentation to Queensland growers, N. Hancock 1 March 2016.</li> </ul>
2016 Market Outlook Forum	<ul style="list-style-type: none"> <li>• Report on market outlook forum March 2016</li> </ul>
Regional forums and variety days	<ul style="list-style-type: none"> <li>• SA Regional Forum, 24 May 2016 <ul style="list-style-type: none"> <li>- Presentation – Australian Citrus Quality Standards N. Hancock</li> </ul> </li> <li>• Murray Valley Regional Forum, 20 June 2016 <ul style="list-style-type: none"> <li>- Presentation – Australian Citrus Quality Standards N. Hancock</li> </ul> </li> <li>• Riverina Regional Forum, 23 June 2016 <ul style="list-style-type: none"> <li>- Presentation – Australian Citrus Quality Standards N. Hancock</li> </ul> </li> <li>• Variety and rootstock workshop, Yanco 23 June 2016</li> <li>• Qld Regional Forum, 1 March 2016 <ul style="list-style-type: none"> <li>- Presentation – Australian Citrus Quality Standards N. Hancock.</li> </ul> </li> <li>• Variety and Rootstock Field day, Bundaberg Research Station, 16 June 2016</li> <li>• Murray Valley Variety and Rootstock workshop, Mildura, 20 June 2016.</li> </ul>
Variety Leadership Group	<ul style="list-style-type: none"> <li>• Meeting minutes 25 June 2016</li> </ul>
Domestic Leadership Group	<ul style="list-style-type: none"> <li>• Minutes of meeting 15 March 2016</li> <li>• Review of Standard Operating Procedure for start of harvest</li> </ul>

Train contractors to assess granulation	<ul style="list-style-type: none"> <li>• 2 contactors Brisbane (Oz market consultants)</li> <li>• 1 contractor Sydney (Freshcare)</li> <li>• 2 contactors Melbourne (Rudge produce)</li> <li>• 1 contractor Adelaide (APAL agricultural)</li> <li>• 2 contactors Perth (Total Quality Assurance)</li> </ul>
Liaison with R&D community	<ul style="list-style-type: none"> <li>• Presentation by Mark Skewes (SARDI) - Managing deficit irrigation in grape vines and how that can be applied to citrus.</li> <li>• Presentation by Dr Kerry Walsh, University of Central Queensland - Hand held maturity equipment for non-destructive testing of mango maturity and its application in citrus</li> <li>• Presentation by Dr Roberto Martinez, (NSW DPI) - Citrus consumer preference and maturity variability in citrus orchards.</li> <li>• Presentation by Dr John Golding (NSW DPI) – Effects of ethylene on fruit quality.</li> <li>• Packing house visits in Murray Valley and Riverland with Dr John Golding.</li> </ul>
Maturity testing in capital city wholesale markets	<ul style="list-style-type: none"> <li>• ACQS report 1, 24 Mar 16</li> <li>• ACQS report 2, 1 Apr 16</li> <li>• ACQS report 3, 7 Apr 16</li> <li>• ACQS report 4, 15 Apr 16</li> <li>• ACQS report 5, 29 Apr 16</li> <li>• ACQS report 6, 6 May 16</li> <li>• ACQS report 8, 13 May 16</li> <li>• ACQS report 9, 20 May 16</li> <li>• ACQS report 10, 27 May 16</li> <li>• ACQS report 11, 3 June 16</li> <li>• ACQS report 12, 10 June 16</li> <li>• ACQS report 13, 17 June 16</li> </ul>
Standard Operating Procedure for start of harvest	<ul style="list-style-type: none"> <li>• Standard Operating Procedure for start of harvest (draft 1).</li> </ul>
Media and communications	<p><i>"Better taste to boost consumption"</i>, Australian Citrus News, 2016 Summer edition.</p> <p><i>"Consumers accept 35% granulation"</i>, Australian Citrus News, 2016 Summer edition.</p>
Auditing of maturity testing contractors	<ul style="list-style-type: none"> <li>• 2 contactors Brisbane (Oz market consultants)</li> <li>• 1 contractor Sydney (Freshcare)</li> <li>• 2 contactors Melbourne (Rudge produce)</li> </ul>
Citrus Australia Regional advisory committee meetings	<ul style="list-style-type: none"> <li>• Citrus Australia South Australia Regional Advisory Committee meeting. <ul style="list-style-type: none"> <li>- Meeting minutes 22 Feb 2016</li> </ul> </li> <li>• Queensland Regional Advisory Committee meeting <ul style="list-style-type: none"> <li>- Meeting minutes 2 March 2016</li> </ul> </li> <li>• Queensland Regional Advisory Committee meeting 31 May 2016 <ul style="list-style-type: none"> <li>- Meeting minutes 31 May 2016</li> <li>- Report on quality standards project progress, N Hancock.</li> </ul> </li> </ul>

Develop network of field test sites in the Riverland with Citrus Australia South Australia Region	11 sites identified <ul style="list-style-type: none"> <li>• Lyrup (3 sites)</li> <li>• Ramco (3 sites)</li> <li>• Sunland (1 site)</li> <li>• Taylorville (4 sites)</li> </ul>
<b>July – December 2016</b>	
Maturity testing in capital city wholesale markets	<ul style="list-style-type: none"> <li>• ACQS report 14, 1 Jul 16</li> <li>• ACQS report 15, 15 Jul 16</li> <li>• ACQS report 16, 22 Jul 16</li> <li>• ACQS report 17, 29 Jul 16</li> <li>• ACQS report 18, 5 Aug 16</li> <li>• ACQS report 19, 12 Aug 16</li> <li>• ACQS report 20, 19 Aug 16</li> <li>• ACQS report 21, 26 Aug 16</li> <li>• ACQS report 22, 9 Sep 16</li> <li>• 7 410 individual fruit trusted</li> <li>• 741 grower reports generated</li> </ul>
Auditing of maturity testing contractors	<ul style="list-style-type: none"> <li>• 1 contractor Adelaide (APAL agricultural)</li> <li>• 2 contractors Perth (Total Quality Assurance)</li> </ul>
Domestic Leadership Group	<ul style="list-style-type: none"> <li>• Meeting minutes 16 Oct 16</li> </ul>
Riverina Regional Advisory Committee	<ul style="list-style-type: none"> <li>• Meeting minutes 24 Nov 16</li> </ul>
Variety Leadership Group	<ul style="list-style-type: none"> <li>• Meeting Minutes 6 Dec 16</li> </ul>



Activity	Output
<b>January – June 2017</b>	
Queensland Regional Forum 22 February 2017	Formal presentations: <ul style="list-style-type: none"> <li>• Harmonised Australian Retailer Produce Scheme (D Daniels)</li> <li>• Crop Quality and Forecast (N Hancock)</li> <li>• Australian Citrus Quality Standards – (N Hancock)</li> <li>• Packing house hygiene and postharvest quality, Dr John Golding.</li> <li>• Packing-house de-greening workshop, Mundubbera.</li> </ul>
2017 Citrus Technical Forum, 1-2 March 2017	<ul style="list-style-type: none"> <li>• Report on Technical forum</li> <li>• Post-harvest quality workshop</li> </ul>
Riverina Regional Forum 11 May 2017	Presentations: <ul style="list-style-type: none"> <li>• Crop Quality and Forecast (N Hancock)</li> <li>• Australian Citrus Quality Standards – (N Hancock)</li> </ul>
Variety Leadership Group	Meeting minutes 14 June 2017
Domestic Leadership Group	Meeting minutes 2 May 2017
Other events	Woolworths quality roadshow, Mildura 25 May 2017
Market testing contractors	Agreements with market testing contractors renewed in each of the major wholesale markets: <ul style="list-style-type: none"> <li>• 2 contractors Brisbane (Oz market consultants)</li> <li>• 1 contractors Sydney (Freshcare)</li> <li>• 2 contractors Melbourne (Rudge produce)</li> <li>• 1 contractor Adelaide (APAL agricultural)</li> <li>• 2 contractors Perth (Total Quality Assurance)</li> </ul>
Maturity testing in capital city wholesale markets	<ul style="list-style-type: none"> <li>• ACQS report 1, 5 May 2017</li> <li>• ACQS report 2, 12 May 2017</li> <li>• ACQS report 3, 19 May 2017</li> <li>• ACQS report 4, 26 May 2017</li> <li>• ACQS report 5, 2 June 2017</li> <li>• ACQS report 6, 16 June 2017</li> <li>• ACQS report 7, 23 June 2017</li> <li>• ACQS report 8, 29 June 2017</li> </ul>
Regional forums	<ul style="list-style-type: none"> <li>• Murray Valley Regional Forum 10 May 2017               <ul style="list-style-type: none"> <li>- Presentation – Australian Citrus Quality Standards (N Hancock)</li> </ul> </li> <li>• South Australia Regional Forum 11 May               <ul style="list-style-type: none"> <li>- Presentation – Australian Citrus Quality Standards (N Hancock)</li> </ul> </li> </ul>
Domestic Leadership Group	Meeting minutes 2 May 2017

July – December 2017	
Maturity testing in capital city wholesale markets	<ul style="list-style-type: none"> <li>• ACQS report 9, 14 July 2017</li> <li>• ACQS report 10, 21 July 2017</li> <li>• ACQS report 11, 28 July 2017</li> <li>• ACQS report 12, 4 Aug 2017</li> <li>• ACQS report 13, 11 Aug 2017</li> <li>• ACQS report 14, 22 Aug 2017</li> <li>• ACQS report 15, 25 Aug 2017</li> <li>• ACQS report 16, 1 Sep 2017</li> <li>• ACQS report 17, 8 Sep 2017</li> <li>• ACQS report 18, 15 Sep 2017</li> <li>• ACQS report 19, 23 Sep 2017</li> <li>• ACQS report 20, 20 Oct 2017</li> <li>• ACQS report 21, 27 Oct 2017</li> <li>• ACQS report 22, 3 Nov 2017</li> </ul> <ul style="list-style-type: none"> <li>• 4122 fruit tested</li> <li>• 414 grower reports generated</li> </ul>
Forums and events	<ul style="list-style-type: none"> <li>• Citrus Gall Wasp workshop, Loxton 7 September <ul style="list-style-type: none"> <li>- Presentation – Harmonised Australian Retail Produce Scheme (D Daniels)</li> </ul> </li> <li>• Queensland Regional forum 28 November 2017 <ul style="list-style-type: none"> <li>- Presentation - Australian Citrus Quality Standards (M. Milner)</li> <li>- Discussion on Standard Operating Procedure</li> </ul> </li> </ul>
Queensland Regional Advisory Committee	<ul style="list-style-type: none"> <li>• Presentation - Australian Citrus Quality Standards (M. Milner)</li> <li>• Discussion on Standard Operating Procedure Meeting minutes 29 October 2017</li> <li>• Meeting minutes 27 November 2017</li> </ul>
Domestic Leadership Group	<ul style="list-style-type: none"> <li>• Meeting minutes 17 October 2017</li> <li>• Presentation - Australian Citrus Quality Standards (M. Milner)</li> </ul>
Murray Valley Regional Advisory Committee	<ul style="list-style-type: none"> <li>• Meeting minutes 26 July 17</li> <li>• Meeting minutes 3 October 2017</li> </ul>

Activity	Output
<b>January – June 2018</b>	
Pre-season quality field testing	<ul style="list-style-type: none"> <li>• Sampling and testing from 16 orchards in Gingin, Gayndah and Mundubbera (March 2018)</li> <li>• Sampling and testing from 11 orchards in South Australia (March 2018)</li> <li>• Sampling and testing from 10 orchards in Murray Valley (April 2018)</li> <li>• Report to industry on Queensland pre-season testing 26 March 2018.</li> <li>• Report to industry on Riverland pre-season testing 29 March 2018.</li> <li>• Report to industry on Murray Valley pre-season testing 10 April 2018.</li> </ul>
Market testing contractors	<p>Agreements with market testing contractors renewed in each of the major wholesale markets:</p> <ul style="list-style-type: none"> <li>• 2 contractors Brisbane (Oz market consultants)</li> <li>• 1 contractors Sydney (Freshcare)</li> <li>• 2 contractors Melbourne (Rudge produce)</li> <li>• 1 contractor Adelaide (APAL agricultural)</li> <li>• 2 contractors Perth (Total Quality Assurance)</li> </ul>
Queensland Regional Advisory Committee	<ul style="list-style-type: none"> <li>• Meeting minutes 16 Jan 2018</li> <li>• Meeting minutes 6 Mar 2018</li> <li>• Meeting minutes 19 April 2018</li> <li>• Discussion on Standard Operating Procedure for start of harvest</li> </ul>
Variety Leadership Group	<ul style="list-style-type: none"> <li>• Meeting minutes 18 Jun 2018</li> </ul>
South Australia Regional Advisory Committee	<ul style="list-style-type: none"> <li>• Meeting minutes 15 January 2018</li> </ul>
Freshcare training sessions	<ul style="list-style-type: none"> <li>• 10 sessions across tristate region.</li> <li>• 167 growers/packers trained to Freshcare Food Safety &amp; Quality Edition 4 Code of Practice.</li> </ul>
Maturity testing in capital city wholesale markets	<ul style="list-style-type: none"> <li>• ACQS report 1, 23 Mar 18</li> <li>• ACQS report 2, 29 Mar 18</li> <li>• ACQS report 3, 6 Apr 18</li> <li>• ACQS report 4, 13 Apr 18</li> <li>• ACQS report 5, 20 Apr 18</li> <li>• ACQS report 6, 27 Apr 18</li> <li>• ACQS report 7, 4 Apr 18</li> <li>• ACQS report 8, 11 May 18</li> <li>• ACQS report 9, 18 May 18</li> <li>• ACQS report 10, 25 May 18</li> <li>• ACQS report 11, 1 Jun 18</li> <li>• ACQS report 12, 8 Jun 18</li> <li>• ACQS report 13, 15 Jun 18</li> <li>• ACQS report 14, 22 Jun 18</li> </ul>
Media and communications	<p><i>“New quality testing approach”</i> Australian Citrus News, 2018 Summer edition.</p>

Regional Forums and workshops	<ul style="list-style-type: none"> <li>Queensland Regional Forum 1 March 2018 <ul style="list-style-type: none"> <li>Presentation - Australian Citrus Quality Standards (M. Milner)</li> <li>Discussion on Standard Operating Procedure</li> </ul> </li> <li>Riverina Regional Forum 1 May 2018</li> <li>Murray Valley Regional Forum 15 May <ul style="list-style-type: none"> <li>Presentation – Aus. Citrus Quality Standards (M. Milner)</li> </ul> </li> </ul>
Citrus Market Outlook Forum, 16 Mar 2018	<ul style="list-style-type: none"> <li>Presentation - Australian Citrus Quality Standards (M. Milner)</li> </ul>
Murray Valley Regional Advisory Committee	<ul style="list-style-type: none"> <li>Meeting minutes 15 May 2018</li> </ul>
Riverina Regional Advisory Committee	<ul style="list-style-type: none"> <li>Meeting minutes 23 March 2018</li> <li>Meeting minutes 17 April 2018</li> <li>Meeting minutes 19 June 2018</li> </ul>
Standard Operating Procedure for start of harvest	<ul style="list-style-type: none"> <li>Standard Operating Procedure for start of harvest (draft 2).</li> </ul>
<b>July – December 2018</b>	
Regional Forums and workshops	<ul style="list-style-type: none"> <li>Afourer mandarin pruning and quality workshop, Red Cliffs 23 July</li> <li>Food safety forum, Barmera <ul style="list-style-type: none"> <li>Presentation: Allergen management, Georgina Christensen</li> <li>Presentation: Drivers for Food Safety &amp; Quality Compliance, Clare Hamilton Bate</li> <li>Presentation: Intro to Food Safety, N. Hancock</li> <li>Presentation: Microbiological Pathogens on Citrus Fruit- Understanding The Risks, SP Singh</li> <li>Presentations on HARPS, Tristen Kitchener</li> </ul> </li> <li>Queensland Regional Forum 11 October 2018</li> <li>Western Australia Regional Forum, 18 Oct 2018.</li> </ul>
Maturity testing in capital city wholesale markets	<ul style="list-style-type: none"> <li>ACQS report 15, 2 Jul 18</li> <li>ACQS report 16, 6 Jul 18</li> <li>ACQS report 17, 13 Jul 18</li> <li>ACQS report 18, 23 Jul 18</li> <li>ACQS report 19, 27 Jul 18</li> <li>ACQS report 20, 6 Aug 18</li> <li>ACQS report 21, 10 Aug 18</li> <li>ACQS report 22, 20 Aug 18</li> <li>ACQS report 23, 24 Aug 18</li> <li>ACQS report 24, 3 Sep 18</li> <li>ACQS report 25, 19 Oct 18</li> <li>ACQS report 26, 26 Oct 18</li> <li>ACQS report 27, 5 Nov 18</li> <li>ACQS report 28, 9 Nov 18</li> <li>ACQS report 29, 16 Nov 18</li> <li>5 140 individual fruit tested in 2018</li> <li>514 individual grower reports on maturity</li> </ul>

Freshcare Training	<ul style="list-style-type: none"> <li>• 11 training sessions across tristate region.</li> <li>• 39 growers/packers trained to Freshcare Food Safety &amp; Quality Edition 4 Code of Practice.</li> </ul>
Murray Valley Regional Advisory Committee	<ul style="list-style-type: none"> <li>• Meeting minutes 11 Sep 2018</li> <li>• Meeting minutes 31 Oct 2018</li> </ul>
Queensland Regional Advisory Committee	<ul style="list-style-type: none"> <li>• Meeting minutes 18 Sep 2018</li> <li>• Discussion on Standard Operating Procedure</li> <li>• Meeting minutes 11 October 2018</li> </ul>
Variety Leadership Group	<ul style="list-style-type: none"> <li>• Meeting minutes 8 October 2018</li> </ul>
Domestic Leadership Group	<ul style="list-style-type: none"> <li>• Meeting minutes 29 October 2018</li> </ul>

### 1. Develop and maintain a national quality standard

National quality standards were developed in previous iterations of the project. Until that point, no such national standards existed. The Australian Citrus Quality Standards (ACQS) have been maintained and updated as the understanding of consumer preferences has improved. The Standards, together with instructional manuals, calculators and a number of other resources are available for download at:

<https://www.citrusaustralia.com.au/growers-industry/citrus-quality-and-maturity>

Items maintained and updated include:

- Australian Citrus Quality Standards Manual
- 2015 Australian Citrus Quality Standards
- Australian Citrus Quality Standards – Calculating citrus fruit maturity guide [here](#)
- Australian Citrus Quality Standards – Calculations Spread Sheet [here](#)
- Citrus Maturity Testing Equipment List [here](#)
- Australian Citrus Quality Standards Guide (video)
- Trade definition of ‘seedlessness’
- Citrus Quality Calculator iPhone app
- Citrus Quality Calculator Android app.

The standards were reviewed by the Domestic Market Leadership Group each year. In 2017, juice content was removed as a maturity indicator as it was shown to have poor correlation with consumer acceptability. A maximum granulation standard was added as a result of the sensory evaluation study conducted with the University of Queensland (discussed in item 3).

## 2. Maintain current ACQS market testing and reporting program

Maturity testing took place throughout each season in the major wholesale markets and reports were provided to industry participants each week (Attachment 2).

Key statistics are as follows:

	2016	2017	2018
<b>Total fruit tested</b>	7 410	4 122	5 140
<b>Weekly reports</b>	21	22	29
<b>Tests reported</b>	741	414	514
<b>Varieties tested</b>	37	42	38
<b>Oranges that achieved minimum standard</b>	98%	83%	93%
<b>Mandarins that achieved minimum standard</b>	96%	84%	96%
<b>Granulated Imperial mandarin samples</b>	NA	6	29

Variation of aggregated versus individual results

	2016	2017		2018	
	Aggregated test results	Aggregated test results	Individual test results	Aggregated test results	Individual test results
Pass results	706 (95%)	348 = (84%)	3 337 = (81%)	450 = (93%)	4 365 = (90%)
Caution results	13 = (2%)	34 = (8%)	249 = (6%)	11 = (2%)	194 = (4%)
Did not meet specification	22 = (3%)	32 = (8%)	536 = (13%)	23 = (5%)	277 = 6%
Total	741	414	4 122	485*	4 850*

\*In 2018 there was a total of 514 tests, 29 were granulated samples which left 485 tests for internal maturity

\*\* Total tests 5 140 minus 290 granulated samples

As indicated previously, a decision was made in 2017 to move towards taking measurements from each fruit in the ten-fruit sample to demonstrate the variation that exists between fruit from the same orchard. Comparison between results in 2016, 2017 and 2018 indicate that pass results declined as a result of the change to the testing regime. This suggests that there were a substantial number of tests in previous years that were deemed to have achieved the minimum standard that in fact had not.

## 3. Develop and implement a maximum granulation standard for Imperial mandarins

The sensory evaluation study by the University of Queensland concluded that mandarins granulated at the 35 per cent and 45 per cent levels are acceptable to consumers. However, granulation at the 55 per cent level or greater is considered unacceptable. Accordingly, a visual guide was developed that shows the entire spectrum of granulation with acceptable limits and rated granulation on a scale of one to seven. Providing a maximum level (for pass or failure) simplified decision making for assessors and removed the opportunity for minor defects to be recorded which in practice can accumulate and cause an unnecessary rejection at a distribution centre. The guide and standard was endorsed by the Domestic Leadership Group and approved by the Citrus Australia Board as the maximum granulation standard. The visual assessment guide and granulation standard are provided as attachments to this report.

#### 4. Supply-chain engagement

There was a high level of direct engagement with growers, packers and marketers through Citrus Australia's Regional Advisory Committees, Variety Leadership Group, Domestic Leadership Group, Export Market Committee, and regional forums. Regional Advisory Committee meetings were held twice each year and minutes were recorded. The Domestic Leadership Group, Export Market Committee and Variety Leadership Group held two face-to-face meetings each year to coincide with start and end of the season. The Domestic Leadership Group provided a large amount of input into the development of standards and the review of existing standards. The group also informed project priorities which were recorded in the minutes of each meeting.

Regional forums provided an opportunity for the project team to engage with supply chain members (chiefly growers and packers) through formal presentations on the Australian Citrus Quality Standards and market testing results. The regional forums were held annually in each region and twice annually in Queensland. Pre-season (in-field) testing was also conducted to coincide with the regional forums so that results could be presented with a view to informing harvesting decisions. Invariably, researchers, marketers and other industry experts were invited to attend the forums to provide presentations on issues related to quality and market requirements. Our special interest forums (Market Outlook and Technical Forums) provided similar opportunities (on a greater scale) for the team to provide formal presentations to supply chain members on citrus quality.

The project team met at least twice annually with the retail and quality teams from each of the major retailers. Training in quality, maturity (including maturity assessment) was provided to quality assurance staff. The category manager from one of the major retailers attended and presented at Citrus Australia's Market Outlook forum in 2018 and authored an article on the Australian Citrus Quality Standards in the Autumn 2018 edition of Australian Citrus News. In 2017, the project team assisted one of the major retailers to conduct regional 'meet the grower' roadshows in which suppliers were provided an opportunity for the retailers and growers to better understand each other's requirements.

In 2017, the project team participated and contributed to 'Would I buy it?' panels with a major retailer. Findings from those panels have informed the retailer's citrus product specifications which include a hybridised version of the Australian Citrus Quality Standards. The project team contributed to the development of the product specifications.

#### 5. Develop standard operating procedure for start of harvest

The Standard Operating Procedure for start of harvest was finalised in 2018 and made available on Citrus Australia's website (Attachment 5). However, there has been limited uptake of the SOP by the supply-chain. In the absence of mandatory requirements by retailers, it has been difficult to affect a cultural change within the community of citrus growers.

#### 6. Communicate pre-harvest field testing and reporting

Pre-harvest testing was conducted in Queensland, Murray Valley and South Australia's Riverland. Sampling sites were provided through the Regional Advisory Committee in the respective region. Growers whose orchards had been sampled were provided with individual fruit testing results.

Aggregated data formed the basis of presentations at Citrus Australia's regional and special interest forums. Formal reports were also provided to industry.

Throughout the process, there was a large amount of face-to-face engagement with growers and packers. Additional benefit was derived through these visits by providing opportunity to provide training on maturity testing procedures.

## 7. Research collaboration

Project activities have been influenced by the R&D community and there has been a large amount of input into the project by researchers in Australia and overseas. There were a large number of contributors to the project who provided input and their contributions are as follows:

Professor Kerry Walsh, University of Central Queensland	Progress of various hand held/ non-destructive Brix and acid reading equipment and the determination of the appropriate number of fruit to sample for Imperial mandarin granulation assessment. Collaboration on accuracy of hand held acid meters G-won and Atago units.
Dr Phul Subedi, University of Central Queensland	Inline (packing) granulation detection developed by MAF Roda. Collaboration using experimental equipment to trial granulation detection on the packing line using various light frequencies.
Mark Loeffen, Delytics New Zealand	Analysis of Australian and Californian navel orange and Australian Afourer mandarin data and consumer trends of preferring balanced flavoured fruit. Collaboration on appropriate sample size and importance of individual fruit sampling. The development of new technology in New Zealand to read Brix and Acid using Fourier transform infrared spectroscopy (FTIR).
Dr Bob Jordan, Delytics New Zealand	Improvements to the BrimA concept, understanding its current limitations.
Mark Skewes, South Australian Research and Development Institute	Deficit irrigation techniques in grape vines and possible citrus applications.
Dr Roberto Martinez, New South Wales Department of Primary Industries	Citrus maturity variation in citrus orchards.
Dr John Golding, New South Wales Department of Primary Industries	Effects of poor de-greening practices on fruit quality and packing shed hygiene.
Graeme Sanderson, New South Wales Department of Primary Industries	Maturity testing in evaluation variety evaluation blocks; comparisons of titration method and hand held acid meters.
Dr Andrew Macnish, Queensland Department of Agriculture and Fisheries	Flavour profile of stored and transported fruits.
Terry Rudge, Rudge Produce Systems	Testing alternative acid meters, improvement of protocols.
Dr Mary Lu Arpaia, University of California	Citrus maturity standards in California, post-harvest treatment of citrus, consumer studies, developing surveys for consumer preference studies.
Dr David Obenland, United States Department of Agriculture, Agricultural Research Service	Citrus maturity standards in California, post-harvest treatment of citrus, consumer studies, developing surveys for consumer preference studies.
Dr Sangeeta Prakash, University of Queensland	Collaboration on determining consumer preference on levels of granulation in Imperial mandarins.



The postharvest research team from the New South Wales Department of Primary Industries (NSW DPI) have been strong attendees and presenters at Citrus Australia's regional forums and special interest forums. Similarly, the two NSW DPI Industry Development Officers in the Murray Valley and Riverina have provided strong contributions to Citrus Australia's Regional Advisory Committees and have assisted in the coordination of the biannual meetings, workshops, field presentations and regional forums. Citrus post-harvest researcher Dr John Golding has participated in many regional forums and has accompanied the project team on regional packing house visits to better understand post-harvest practices and quality issues.

In Queensland, post-harvest researchers from the Queensland Government Department of Agriculture and Fisheries (QDAF) have provided an equal contribution to the Queensland Regional Advisory Committee and the Queensland Citrus Exporters Group. The Queensland postharvest research team has demonstrated a strong commitment to improving citrus quality. QDAF remains active in citrus variety and rootstock breeding and evaluation. A strong focus of that work is quality, in particular resolving some of the quality issues associated with Imperial mandarins.

## Outcomes

At the commencement of the project, we set some ambitious goals that included:

- an informed supply chain with an ability to assess fruit maturity
- an informed supply chain that is aware of maturity levels in the market place
- uniform maturity standards adopted by the retail sector
- a high level of compliance against the standards
- adoption of on farm practices to improve quality
- a quality culture maintained in the citrus industry
- reduced levels of granulated fruit being consigned to market
- reduced levels of immature fruit consigned to market
- increased collaboration in citrus quality research and development.

In the longer term, our objectives were to increase consumer demand and increase grower profitability. Project CT15013 has made a significant contribution towards the industry realising these goals and the citrus industry today is in a stronger position than ever before. The industry is currently enjoying a buoyant phase with growers achieving better returns than any time in recent memory. While much of the success is being fuelled by the export trade to Asia, the success would not be possible without quality products to offer. More than one-third of the annual citrus crop is sold on the Australian domestic market, making it the most important market. By consistently producing high quality fruit that achieves consumer expectations, the Australian citrus industry has proven itself to be a genuine global contender and competitive against even the most efficient citrus producers in the world.

Through the project activities of CT15013, the supply chain has gained a higher level of awareness of consumer expectations and a willingness to improve cultural practices to satisfy consumer demands. Through our engagement with growers, packers and retailers, there is a greater technical ability to conduct product testing, coupled with a genuine effort to only supply mature fruit to market.

In previous projects, Citrus Australia initiated, developed and maintained national maturity standards that were adopted by the supply chain. In doing so, Citrus Australia broke down the 'state-by-state' approach to citrus maturity standards and removed the opportunity for indifference. The supply chain now has a single set of standards to work to, levelling the national playing field and offering opportunity to differentiate through improved quality. Continual revision and development of the standards over time has moved them from an arbitrary set of figures, ratios and percentages to parameters that are truly reflective of the consumer's preference and predictive of their intention to purchase.

Packers, marketers and retail businesses adopted the standards and tested fruit on arrival at packing-houses, market floors, and distribution centres. The project team had lengthy discussions with marketers and has an extensive network of growers from which to draw feedback. As well as providing empirical evidence, testing contractors in the wholesale markets provided an effective conduit between the project team and marketers to provide feedback on the impact of the standards. There is strong anecdotal evidence that the age-old rhetoric between growers and marketers is being eroded. Previously, growers would assign blame to marketers that they had been pressured to harvest early and *vice versa* - marketers would blame growers for pressure to market immature fruit in an effort to capitalise on higher prices early in season. Discussion with growers and marketers indicates that there is a strong awareness of the Australian Citrus Quality Standards and a high level of understanding on how the standards were developed (through consumer sensory evaluation studies). In other words, there is now greater awareness of "what consumers want". Furthermore, there is a higher level of awareness that consumer repurchase behaviour is heavily influenced by early season maturity levels and that the practice of consigning immature fruit to market adversely impacts on sales throughout the entire season. Moreover, there appears to be a higher level of understanding of what this practice does to the long-term reputation of the Australian citrus category.

Through national market testing, Citrus Australia has provided a feedback loop to industry to gauge their businesses performance. Market pressure, early in the season (when prices can be high for fruit regardless of its quality) has been a difficult force to overcome. The transparency of third party testing focuses attention back on to the consumer. Retailers have the opportunity to reward early producers who meet consumer requirements and the onus is on the supply chain to show it can be achieved. Customer demand results in sales of product but this cannot be achieved if consumers don't enjoy the fruit. The market testing program has demonstrated continual improvement of fruit eating quality (as measured by the BrimA maturity index) in the wholesale market testing results as evidenced in the percentage of samples meeting or exceeding specification increasing year on year.

In particular, one national retail business explicitly stated in a face-to-face meeting in January 2018 that quality standards were having a definite impact on customer behaviour and repeat purchases, which was verified by examining their data from loyalty programs and scan data. The retailer repeated the message at the 2018 Citrus Australia Market Outlook Forum and in an article in the Australian Citrus News (Autumn 2018). The business has refocused its fruit purchasing model to put consumer satisfaction ahead of being ‘first to market’.

Granulation is a vexing issue for the industry, primarily affecting Imperial mandarins, but other citrus varieties can also be affected. Granulation or ‘dryness’ as it is commonly known, is a physiological issue which causes the juice in the fruit to become gel like. Research has not been able to isolate a single cause although stresses such as crop load, available moisture and physical impediments such as benching (at the union with the rootstock) are thought to be contributing factors. Visual external symptoms can be difficult or unreliable and no solution has been found for grading the fruit during packing-house processes. Often, whole blocks are rendered unmarketable which places pressure on businesses to ignore the issue in favour of consigning fruit to market. For obvious reasons, awareness of granulation in orchards (before the fruit is harvested) is preferable before marketing decisions can be made. Sampling and testing fruit through visual examination is the only known reliable method.

When the visual granulation guide was developed, it became apparent that the sample sizes taken by growers to assess granulation in orchards were insufficient and would only detect a catastrophic failure. The 2016 season was particularly problematic with a large number of rejections at the retail level due to granulation. Although rejections were occurring, growers were still asserting that the fruit had been tested prior to harvest. A biometrician was engaged to determine the appropriate sample size for detecting granulation if it were present at levels that are unacceptable to retailers and consumers. However, practicality is often in conflict with statistics. A sample of thirty fruit sample was found to be a happy compromise between grower and biometrician. After lengthy technical discussions with the Queensland sector (through the Queensland Regional Advisory Committee), a 30-unit sample became the industry standard which provides 95 per cent confidence that granulation at a ten per cent (ten fruit in one hundred) would be detected. Subsequently, the standard including a guide to sampling was also developed (Attachment 4). The 30-fruit sample for granulation assent has now become common practice.

Feedback from consumers and retailers, as well as growers had elevated granulation to a high priority. Mistrust in the Imperial variety by retailers had become so significant that without the intervention of the project team and the introduction of a maximum granulation standard, the Imperial mandarin may have been relegated to history. Despite its popularity with consumers, retailers were not prepared to risk the ongoing and seemingly increasing issue of granulation. Coupled with poor outturn quality from the de-greening process, granulation was most certainly affecting their business reputation. The granulation standard has extended the product lifespan for Imperial mandarins. However, more will need to be done on farm and in packing-houses to address this issue if the variety is to continue any level of retail success.

Growers have developed a greater awareness of the granulation issue and the limits to consumer acceptability. A number of growers have accepted the facts and have transitioned to other more productive varieties. At the time of writing, there is no other tested variety anywhere in the world which matures as early as the Imperial mandarin but a number of varieties are showing promise.

The 2018 season saw many growers discussing rather than arguing results with the project team. In years of high levels of granulation, it is particularly important for industry to minimise the impact of dry fruit on the market. Granulation is difficult to grade out using current technology and there has been no advancement in non-destructive field or inline packing testing or grading technology. National sampling and reporting provides transparency to this issue.

The team cultivated and maintained strong working relationships with members of the entire supply chain from grower through to retailer. Through our Domestic Leadership Group, issues related to quality were prioritised and progressed by the project team. The Domestic Leadership Group provided a conduit for the two-way flow of information between suppliers (growers, packers and marketers) and buyers (wholesale, retail and consumers). We consider this as a major strength of the project and we have witnessed a shift in culture within the industry towards an attitude of ‘*growing to market requirements*’. While this would seem fundamental in any business model, it has not always been the case. The project has provided suppliers with objective evidence on precisely what the market requirements are and whether or not the requirements are being achieved. As a result, cultural practices have changed, some hard decisions on varietal mix have been made, and orchards are being re-developed.

Throughout the life of the project, the team earned the trust and confidence of the supply base and buyers. In doing so, growers, packers and marketers became willing to share information on crop expectations (volume and quality) each season. In turn, this information has been relayed to buyers (retail and wholesale) which provided greater ability for category management and forward planning. Retailers have developed a high level of trust in the project team and have utilised the relationship to better understand supply and quality issues. On several occasions, retailers required independent advice on quality issues and the team negotiated outcomes that were mutually agreeable to the retailers and suppliers. For example, a practical on-arrival testing regime was developed to assess fruit at distribution centres for the presence of granulation in Imperial mandarins. The 2016 season was seen as particularly problematic, with a large amount of business uncertainty due to product rejections by the retailers. Initially, retailers were rejecting fruit on the basis of a ten-unit sample of fruit. The project team had lengthy technical exchanges with the retailers and successfully demonstrated that detection of granulation in a ten-unit sample warranted further testing, not an immediate rejection. As a result, rejections were reduced to very low levels. This was seen as a major step forward for the industry, particularly in years when granulation is present at a high (but irregular) levels due to climatic factors.

Engagement with the retail sector has been strong and there is a deep level of mutual respect between Citrus Australia and the four major retailers. With a high rate of employee attrition within the retail sector, it remains a constant challenge to maintain working relationships with continual 're-education' of the quality and purchasing teams. Irrespective of the high turnover, we have managed to maintain currency and ensure that the dialogue between the project team and the retailers has continued to be productive.

As a consequence of the engagement with retailers and the success of the Australian Citrus Quality Standards, the national citrus category manager from one of the major retailers delivered a presentation at Citrus Australia's 2018 Market Outlook forum in Sydney. This is considered a major departure from traditional engagement by the retailers who have historically adopted a more conservative approach and kept their supply base at 'arm's length'. A number of other representatives from the retail sector have also attended workshops and forums to exchange views on the expectations in the Australian domestic market. In 2016, one of the major retailers made a strategic decision to engage more closely with its supply base. This acknowledged that the supply base had been neglected and that this was impacting on the fresh produce side of the business.

The Domestic Leadership Group has been invited to engage with retail teams in a range of formats. A single national focal point for quality has provided industry with opportunities to advance citrus, setting it apart from other commodities. Through CT15013, Citrus Australia has provided a reliable open point of engagement for the retail sector through its professional staff and strategic outlook.

In developing the standard operating procedure for start of harvest, the project team sought to address a common issue for early harvest – poor out-turn quality as a result of de-greening (gassing with ethylene) process. Using resources from Australian and international post-harvest specialists, the best management practice for assessing fruit that would be ready for de-greening was included in the SOP. This proved to be contentious as some growers claim the recommended 25 per cent colour break is not the only method for achieving a satisfactory outturn. Disappointingly, growers making that claim would not share the source of their information (or their evidence) and would not support the SOP with the best management practice for de-greening.

There has been lengthy technical exchange between the project team and retailers on the SOP. While initially enthusiastic, retailers later indicated reluctance to mandate such a standard as part of their supply requirements. Similarly, discussions at regional forums and through our regional advisory committees initially indicated strong support for the development of the SOP. The Queensland sector was particularly supportive given the declining returns for Imperial mandarins as a result of poor quality fruit being consigned to market. However, despite the show of strong support, the project team was unable to gain traction and there has been poor uptake of the standard by growers. The voluntary nature of the SOP, lack of incentive from the retail sector and conflicting views on some elements meant that it was not embedded as an industry SOP. A SOP for start of harvest ('Pass to Pick' concept) has been in development for a number of years and was explored in previous iterations of this project (CT12004). Achieving industry consensus has represented a major challenge. Prior to this reporting period, we held extensive consultation with growers, packers, marketers and retailers to develop the standard. The greatest challenge has been to find a compromise between achieving statistically valid results (with large sample numbers) and developing a sampling regime that is practically achievable. The level of testing required to provide statistically significant results remains a challenge for growers, given the time required to perform tests.

While Brix testing is rapid and simple (using a sugar refractometer), measurement of acid content (by titration against a hydroxide base) remains a slow and inefficient process. Instrumentation to perform rapid acid measurement remains elusive. Despite the poor uptake of the SOP, the project team does not view this activity as a failure. Technology is advancing fast and several providers are claiming to have rapid acid assessment instruments in the advanced stages of development to. If such technology is brought market, the SOP will provide a strong foundation for supplying mature fruit to market.

A focus on pre-harvest testing has opened dialogue between growers and packers. Harvest can be calibrated to the results and has encouraged more self-testing among industry participants. In South Australia, the packing sector requested that the project team provide a check of packing-house procedures as part of the pre-testing done in the region.

Repeating the testing at the same orchards and blocks is providing the Gayndah-Mundubbera region with a catalogue of data to refer to at a later date. Growers in that region are very supportive of the testing and have actively been involved in setting the timing of the testing and providing various sites. In Western Australia, a program has been developed by local growers using local levies to provide pre harvest testing of fruit through a private firm. All this adds to the evidence of a changing culture towards fruit maturity and acceptable harvest practices.

Collaboration with the citrus research community has resulted in Citrus Australia developing a network of key contacts with researchers in a range of areas in citrus research and development both nationally and abroad.

The research and development contacts contributed in the development of the ACQS procedure and reporting, the maximum granulation standard and visual guide for Imperial mandarins and the start of harvest SOP. It also was fundamental when preparing national and regional events to satisfy industries appetite for new developments. Citrus Australia has generated many quality related research concepts and contributed to the development of projects, participated in expert panels and has a seat on research steering committees because of its interest and commitment to improved quality.

## Monitoring and evaluation

### Key Evaluation Questions

#### Effectiveness

##### 1. *To what extent have the industry funds achieved their objectives in delivering benefits to growers?*

At the outset of CT15013, our chief objective was to improve the profitability of the Australian citrus sector. The industry is currently enjoying greater profitability than any time in recent history. While it is difficult to draw a direct link between that success and CT15013, the success would not have been possible without quality product offerings. On that basis, we consider that this project has made a valid contribution to the industry's position to remain profitable and competitive. Despite a substantial increase in plantings and production over the last three years (and potential for over-supply in the domestic market), demand for citrus in domestic and overseas markets appears to be insatiable.

The domestic market is the largest market for Australian citrus growers. Investment in CT15013 and previous iterations of the Australian Citrus Quality Standards has addressed a market failure at the heart of the industry. In an environment of ever increasing competition for consumers of fruit and snack foods, the citrus industry must remain relevant. Consistently good quality is important in maintaining consumers, increasing frequency of purchase and weight of purchase. Individual businesses cannot address this issue on their own; improvement required intervention.

Growers were consulted and included in decisions throughout the delivery of the CT15013 project. Despite the obvious challenges in working with a range of competing businesses across the supply chain, the objectives of the project have been met. Many positive outcomes have been achieved and opportunities identified for further R&D. Non-destructive technology to rapidly assessment of acid content of fruit remains a key priority with several providers heavily focussed in this area.

The uptake by industry and the major retailers of the ACQS standards and Imperial granulation standard positively influenced growers by unifying standards which they could adhere to.

#### Relevance

##### 2. *How relevant are Hort Innovation projects to the needs of intended beneficiaries including targeted growers, advisors and industry stakeholders?*

CT15013 and its preceding projects have generated activity across the supply chain and within the research community. The projects have upskilled the industry along the supply chain, with new protocols and procedures developed, new parameters to work to and training provided to assist with adoption.

Consumers have benefited and this has been reported by a third-party retailer with evidence provided through loyalty programs, scan data and sales increases when eating quality was prioritised over 'first to market' practices.

#### **Appropriateness***How well have intended beneficiaries including targeted growers, advisors and industry stakeholders been engaged in the process?*

Growers, advisors and industry stakeholders were engaged in the process at the meetings and events coordinated and attended by the project officer and Citrus Australia. The performance and future endeavours were presented and discussed at regional meetings and with the Domestic Market Committee to ensure the outcomes remained on target and beneficial to industry.

A database was maintained and used to inform stakeholders of research outcomes. Meetings of R&D personnel developed new R&D ideas and fed in to the concept funnel maintained by Hort Innovation. Evidence of the focus on quality and consumer preference is seen in new R&D projects that include quality or have it as a focus for example the use of deficit irrigation to improve Brix levels (CT17000).

3. *To what extent were engagement processes appropriate to the target audience/s of RD&E including targeted growers, advisors and industry stakeholders?*

The engagement of growers, advisors and industry stakeholders was professional, strategic and timely. Consultation with regional committees and domestic leadership groups meant project information was specifically tailored to the intended audience.

Project information was presented at regional and national forums as well as published articles in the Australian Citrus News magazine and Citrus eNews. Presentations used formatted PowerPoint presentations ensuring content was clear and visible to the audience and articles were written on behalf of the project officer by a journalist.

### **Efficiency**

4. *What efforts did the projects make to improve efficiency?*

Where possible, activities of CT15013 were done in conjunction with project CT15012 (Citrus Market Development and Innovation). This included coordinating travel to regional forums and leadership group meetings. Travel was arranged in a way to maximise opportunities to visit wholesale markets and retailers.

Collaboration with international researchers improved the efficiency of survey and research design. Through using Citrus Australia's network of packing-houses, it was possible to capitalise on their grower meetings to deliver information or training.

### **Mid-term review**

In November 2017, RMCG conducted a mid-term evaluation of the Quality Standards (CT15013) and Citrus Market Development (CT15012) project. The review found that the CT15013 project built on the legacy of the previous investments (e.g. CT13022, CT12013) to continue to provide benefits to growers and the industry. RMCG reported there had been a focus on market requirements, systems to ensure quality meets these requirements, and coordinated implementation across the industry. RMCG concluded that activities delivered through CT15013 resulted in a fundamental change in the industry, with focus on internal fruit quality, objective measurement and feedback, market development and systems.

The report made the following recommendations:

1. Continue to maintain current and pre-harvest market testing and reporting program under the Australian Citrus Quality Standard.
2. Finalise and prioritise the coordinated implementation of the maximum granulation standard for imperial mandarin and Standard Operating Procedure for harvesting fruit.
3. Further investigate and develop in-field testing and methods that are non-destructive, quicker and prior to fruit being picked to assist with Australian Citrus Quality Standard, maximum granulation standard for mandarin and standard operating procedure e.g. near infra-red technology developed overseas for other commodities in the US, Europe and New Zealand.
4. Refine how non-compliance with the Australian Citrus Quality Standard is publicly reported (e.g. not listing agent) and who has access (e.g. limiting retailer access).

In response to these recommendations, we report that:

- recommendation 1 was continued through to the completion of the project and its continuation is a recommendation of this report
- recommendation 2 remains unresolved. While the SOP for start of harvest has been developed and finalised, adoption by industry has been poor
- recommendation 3 was investigated. While it is quick and efficient, the technology being used in New Zealand is lab-based and expensive (\$30 000 per unit). New Zealand being a smaller industry and smaller country, it is easier to send fruit for sampling at a central lab. It is a recommendation of this report that new technology is investigated through the Hort Innovation processes
- recommendation 4 was raised at the Domestic Leadership Group. That group argued that transparency of the reporting was integral to its success and voted against altering the format of the report.



## Recommendations

1. Maintain a national quality standard.
2. Engage with the retail sector.
3. Continue to test and report citrus maturity in the market, however refine the scope to address early season fruit.
4. Test and report pre-season maturity across growing regions.
5. R&D concepts be developed that investigate non-destructive maturity testing for Brix and acid levels.
6. R&D concepts be developed that investigate causes of granulation of Imperial and methods to manage it on farm.
7. R&D concepts be developed that investigate non-destructive detection of granulation of mandarins.
8. That industry transition to individual testing of fruit maturity as technology improves.
9. That industry transitions to a sample size of 30 pieces of fruit per sample as technology improves.

## References

Jordan R, Seelye R, McGlone A (2001) A sensory-based alternative to Brix/acid ratio. *Journal of Food Technology* 55 (6), 36–44.

## **Intellectual property, commercialisation and confidentiality**

No project IP, project outputs, commercialisation or confidentiality issues to report.

## Acknowledgements

Citrus Australia acknowledges growers who generously provided their time to contribute to committees and leadership groups that provided advice and guidance to the CT15013 project. Additionally, to those growers who provided data, fruit and their time in various testing and sampling activities, we are grateful for your participation and kindness.

## Appendices

Attachment 1: Copy of the pre-harvest industry report from 2018

Attachment 2: Weekly maturity testing report

Attachment 3: Visual assessment for Imperial mandarin granulation

Attachment 4: Imperial granulation standard (including guide for sampling)

Attachment 5: Standard Operating Procedure for start of harvest

26 March 2018

## 2018 Queensland Pre-Season Testing Report

Samples taken: 19 & 20 March 2018

Samples tested: 21 & 22 March 2018

Variety	Rootstock	Soil Type	Topography	Location	Min Size (mm)	Max Size (mm)	Av. Size (mm)	Min Brix	Max Brix	Av. Brix	Min Acid	Max Acid	Av. Acid	Min BRIMA	Max BRIMA	Av. BRIMA
Imperial	Cleo	Heavy Loam	Flat ground	Gayndah	52	67	58	9.8	10.7	10.3	0.7	1.2	1.0	90	106	103
Imperial	Cleo	Sandy Loam	Flat ground	Gayndah	57	70	63	8.8	10.3	9.5	0.6	0.8	0.7	103	127	112
Imperial	Troyer	Granite	Hill (top)	Gayndah	51	69	62	8.4	10.1	9.4	0.5	0.8	0.6	99	129	115
Imperial	Troyer	Granite	Hill (top)	Gayndah	57	72	65	8.9	10.5	9.8	0.5	1.0	0.7	102	134	115
Imperial	Troyer	Sandy Loam	Flat ground	Gayndah	59	75	65	8.5	11.1	9.8	0.5	0.9	0.6	99	140	121
Imperial	Troyer	Granite	Hill (top)	Gayndah	54	71	60	9.5	11.3	10.4	0.5	1.0	0.7	107	143	126
Imperial	Cleo	Sandy Loam	Flat ground	Gin Gin	No data	No data	No data	7.0	9.6	8.7	0.5	0.8	0.7	88	119	99
Imperial	Benton	Loam	Hill (top)	Gin Gin	56	76	65	7.6	9.7	8.8	0.4	0.9	0.7	89	114	99
Imperial	Troyer	Loam	Hill (top)	Gin Gin	56	70	63	8.5	9.9	9.2	0.6	1.1	0.8	78	116	101
Imperial	Troyer	Sandy Loam	Flat ground	Gin Gin	50	72	60	8.5	9.7	9.1	0.6	0.9	0.7	95	118	106
Imperial	Cleo	Red Loam	Flat ground	Mundubbera	50	68	59	7.9	9.3	8.8	0.5	0.8	0.7	90	117	101
Imperial	Troyer	Sandy Loam	Flat ground	Mundubbera	57	73	65	8.8	10.2	9.3	0.6	0.8	0.7	97	122	106
Imperial	Troyer	Sandy Loam	Flat ground	Mundubbera	52	70	61	9.8	10.9	10.3	0.7	1.4	1.0	73	131	106
Imperial	Cleo	Sandy Loam	Flat ground	Mundubbera	54	71	61	8.7	11.0	9.7	0.6	1.0	0.8	88	129	111
Goldup	Sweet Orange	Sandy Loam	Flat ground	Mundubbera	56	71	62	8.9	10.4	9.6	0.6	0.8	0.7	99	125	114
Imperial	Troyer	Sandy Loam	Flat ground	Mundubbera	59	71	65	9.2	10.7	9.9	0.6	0.8	0.7	100	133	119

# Australian Citrus Quality Standards Report to 25 May 2018



## Imperial Mandarin

Market	Test Number	Grower	Marketer	Variety	Size in mm	Grade	Origin State	Date Tested	# Fruit with severe granulation	Brix	ACS / BrimA
Brisbane	BRIS081	Benyenda Citrus	Armstrong Bros	Imperial	67	1	Qld	22-May-18	1	13.06	163
Brisbane	BRIS082	K&M Roth	Murray Bros	Imperial	65	1	Qld	22-May-18	0	12.87	157
Brisbane	BRIS083	Margram Farms	Murray Bros	Imperial	60	1	Qld	22-May-18	1	12.00	149
Melbourne	MELB056	Luscious Citrus	Glow Fresh	Imperial	59	1	Qld	21-May-18	0	12.13	153
Perth	PER005	Zappia M & N	Empiro	Imperial	53	1	WA	24-May-18	0	12.63	154
Perth	PER006	Novak N & J	Quality Produce International	Imperial	70	1	WA	24-May-18	0	11.58	136
Sydney	SYD021	GJ & JA Zahl P/L	Fresh Express	Imperial	68	1	Qld	21-May-18	1	9.62	123
Sydney	SYD023	Central Fruit Packers	Profruit	Imperial	60	1	Qld	21-May-18	1	10.89	139
Sydney	SYD025	Margram Farms	J.W. Kirkwood	Imperial	60	1	Qld	23-May-18	0	11.57	149
Sydney	SYD027	2.P.H Farms	Valley Fresh	Imperial	55	1	Qld	24-May-18	0	13.71	157

## Other Mandarin

Market	Test Number	Grower	Marketer	Variety	Size in mm	Grade	Origin State	Date Tested	Brix	ACS / BrimA
Melbourne	MELB057	Gayndah Packers	Freshmax	Daisy	70	1	Qld	21-May-18	12.62	149
Melbourne	MELB062	Doron Talmi	Freshmax	Dekopon (Sumo)	68	2	Vic	23-May-18	12.82	147
Perth	PER007	Mann KT & SL	Fresh Choice	Clementine	58	1	WA	24-May-18	12.47	152
Perth	PER008	Bogdanich Farms	Mercer Mooney	Clementine	67	1	WA	24-May-18	12.65	159

## Early Navel

Market	Test Number	Grower	Marketer	Variety	Size in mm	Grade	Origin State	Date Tested	Brix	ACS / BrimA
Brisbane	BRIS078	Auburnvale Citrus	Ireland 53	Early Navel	80	2	Qld	21-May-18	11.51	133
Brisbane	BRIS079	Mildura Fruit Company	Armstrong Bros	Early Navel	90	1	Vic	21-May-18	11.30	115
Brisbane	BRIS080	Spencer Ranch	Carter & Spencer	Early Navel	85	2	Qld	21-May-18	9.94	122
Brisbane	BRIS087	Sunwest	Nutrano	Early Navel	80	1	Vic	22-May-18	11.47	112
Melbourne	MELB059	Jumaluk Fruit Packers	C & S Ponte	Early Navel	86	2	SA	23-May-18	10.81	107
Melbourne	MELB060	Rinaland Investments	Barkers	Early Navel	92	2	NSW	23-May-18	10.70	101
Melbourne	MELB061	Mario's Packhouse	AMV Fresh	Early Navel	79	2	NSW	23-May-18	11.29	111
Perth	PER004	Agrifresh	Mercer Mooney	Newhall	94	1	WA	24-May-18	11.69	132
Sydney	SYD022	Clear Lake Citrus	Quality Farm Produce	Navelina	68	1	NSW	21-May-18	10.78	108
Sydney	SYD024	Nippy's Waikerie Produce	Golden Fruit Supply	Navelina	75	1	SA	23-May-18	11.62	123
Sydney	SYD026	Sim Fresh Pty Ltd	Apollo Fruit Supply	M7 Navel	70	1	NSW	23-May-18	11.44	121

## Imperial Granulation Assessment

Market	Test Number	Grower	Marketer	Variety	Size in mm	Grade	Origin State	Date Tested	# Fruit with severe granulation	Granulated Fruit Juice %	Comments
Brisbane	BRIS084	Bayntun & Co	JH Leavy & Co	Imperial	85	1	Qld	22-May-18	3 out of 10	7%, 15%, 18%	All other fruit in sample >33% juice
Brisbane	BRIS085	D & H Smith	Murray Bros	Imperial	48	1	Qld	22-May-18	3 out of 10	9%, 9%, 20%	All other fruit in sample >33% juice
Brisbane	BRIS086	Boyne View Citrus	Viva Produce	Imperial	75	1	Qld	22-May-18	6 out of 10	5%, 7%, 8%, 8%, 10%, 13%	All other fruit in sample >33% juice
Melbourne	MELB058	Boyne View Citrus	VB Sculli	Imperial	66	1	Qld	21-May-18	3 out of 10	10%, 12%, 11%	All other fruit in sample >33% juice

# Imperial mandarin granulation chart



Granulation tolerance:

0% acceptance: 1, 2

20% acceptance: 3, 4

100% acceptance: 5, 6, 7



## Imperial mandarin granulation

The maximum granulation standard for Imperial mandarin:

*A maximum of 3 fruit with severe (more than 55% ) granulation per fruit in a 30 piece sample, where:*

- sample 30 pieces of fruit per consignment. Sampling is the cutting of the fruit through the equator and assessing the fruit for the presence of granulation.
- a maximum of 3 fruit in 30 pieces may have severe granulation (greater than 55% granulation).
- when the sample has more than 3 fruit visually assessed to be severe -
  - ⇒ confirm the fruit is severely granulated by conducting a juice percentage test
  - ⇒ fruit with severe granulation and less than 25% juice are confirmed severely granulated



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Above: Example image of severely granulated fruit .

# PASS TO PICK

## HARVEST CLEARANCE PROGRAM



### INTRODUCTION

Customer purchase satisfaction is forefront to the success of reoccurring sales. What determines satisfaction? Exceeding customer expectation.

The modern customer is savvy, categorises the supermarket visit as a chore, must navigate the influences of layout, pricing, marketing and promotional advertisements and can complete their shop without interaction.

When a decision is made to purchase citrus the selection by the customer is predominantly visual which is managed by retail specifications.

The category can be let down when the external and or internal quality does not meet their expectation which has the potential to damage the category as a whole, the reputation of mature fruit and future fruit sales.

The following Pass to Pick – Harvest Clearance Program has been created to assist with the decision and timing of harvest to ensure fruit of acceptable external colour and internal quality reaches the customer.

The Pass to Pick – Harvest Clearance program is also structured to allow more of your fruit to be picked, packed and sold and it will assist in reducing the amount of immature fruit being offered for sale lowering the risk of rejection at the retail distribution centre.

Studies have found that when a customer has had a positive experience from purchasing fresh produce they are likely to re-purchase within a # to # week timeframe, on the other hand if the experience is negative the purchase time can be # weeks.

### CITRUS MATURITY FACTORS

Citrus maturity has two components external maturity (the colour of the rind) and internal maturity (the eating quality of the flesh), both factors are influenced by climatic conditions, soil type, rootstock variety, irrigation techniques, nutrition and terroir.

The external and internal maturity can (and often does) develop at different rates. Whilst warm growing conditions encourage the development of internal sugars it can also delay the rind colouring. The rind colouring of maturing fruit on the tree is a precursor to attaining acceptable colour that can be achieved by using a de-greening facility.

#### Recommendation of Minimum Acceptable Limits:

##### Rind colour:

- **≥ 90%** of fruit should exceed the minimum standard of:
  - 25% (a quarter) of the surface must have achieved colour break (before de-greening).

##### BrimA/Australian Citrus Quality Standard:

- **≥ 75%** of fruit should exceed the minimum standard of:
  - Mandarin 110
  - Orange 90

**Both external colour and BrimA minimums must be met to = Pass**

# PASS TO PICK ORCHARD SAMPLING PROTOCOL

It is recommended that growers and packers are both involved in the assessment of external colour development and the selection of samples for testing. A third party or packer could be used to conduct the internal maturity testing and reporting.

## MATURITY SAMPLE AREA (MSA)

The number of trees and fruit in a block or across an orchard must all be considered for the MSA. If there is a known variation within an MSA (such as a different rootstock, soil type or topography), it is recommended that a proportional amount of the fruit from that area be included in the sample; alternatively a separate MSA should be used for this block/area.

### Recommendation:

- Assess your property and divide into MSA's.
- Limit the maximum size of a MSA to 5 hectares.

**The more MSA's and samples taken the greater the accuracy.**

## TREE VARIABILITY

Various studies show that there is considerable variability of fruit maturity within a single tree and even greater across an orchard. Fruit on the outer canopy and higher parts of the tree tend to have higher brix and external colour development than fruit found on lower limbs and inside the tree.

### Recommendation:

- A minimum of 6 trees are to be sampled within the MSA.
- Trees should be representative of the MSA, do not sample from row ends or sick trees.
- For sampling purposes the tree canopy should be assessed and divided into upper and lower and outside and inside sectors.
- For strip picking sample 1-2 fruit per sector per tree
- For select picking sample 1-2 fruit per sector per tree that meet the specification i.e. a specified minimum size.

## FRUIT SAMPLE AMOUNT:

Due to the maturity variability between fruit on a tree and across an orchard, and taking into consideration consumer consumption habits the testing regime recommended is for individual fruit to be tested.


### Recommendation:

Test a minimum of 30 fruit individually per MSA.

Fruit samples should be representative of the MSA, do not sample fruit with splits, rots or punctures.

SAMPLE SIZE

A minimum of 30 fruit individually must be tested per maturity sample area (MSA) from a minimum of 6 trees. An MSA is a maximum size of 5ha.



# PASS TO PICK MSA SAMPLE ASSESSMENT

## EXTERNAL ASSESSMENT

### Procedure:

- Visually assess the external colour of the fruit sample.
- Record the colour % of each fruit.

### Recommendation:

- Minimum acceptable colour break is 25% (a quarter) of the surface must have achieved colour break.
- A minimum of 90% of the fruit sample must have 25% colour break.

## INTERNAL ASSESSMENT

### Procedure:

- Obtain a juice sample of each individual fruit - squeezing by hand is acceptable.
- Measure the Brix of the fruit - digital or optical refractometer.
- Measure the acid of fruit - titration.
- Calculate the BrimA/ACS of fruit -  $\text{BrimA} = (\text{Brix} - (4 \times \text{acid}) \times 16.5)$
- Record all individual results.

### Recommendation:

- $\geq 75\%$  of fruit should exceed the minimum standard of:
  - Mandarin 110
  - Orange 90

**Both external colour and BrimA minimums must be met to = Pass**

*Note: Resources are available on the Citrus Australia website for calculating the BrimA <https://www.citrusaustralia.com.au/>*

# ADDITIONAL ASSESSMENTS

## PACKING SHED ASSESSMENT

Once an MSA has achieved the minimum results above the packing shed should conduct an assessments of the fruit by selecting fruit at random from bins either prior to delivery or on delivery of the first load. If the grower is responsible for de-greening their fruit the packer should inspect the fruit prior to de-greening process commences.

## PASS TO PICK HARVEST CLEARANCE

A MSA has achieved clearance when both the external and internal assessments have passed two consecutive tests and a subsequent packing shed assessment confirms the result.

Test results should be recorded and submitted to the packing shed and or wholesale and retail buyers.

A standardised form for external and internal maturity reporting will be provided by Citrus Australia on request.

## RETAIL AUDIT

On receipt of a consignment retail distribution staff or their representative will assess the consignment as required, this may include a paper audit and/or physical assessment.