

Horticulture Innovation Australia

Final Report

Evaluating new citrus varieties 2013 - 2017

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CT12026

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Summary

HIA project CT12026: Evaluating new citrus varieties 2013-2017 is a continuance of the Australian Citrus Crop Improvement program. This long term program is an industry driven initiative to ensure Australia has access to a range of new citrus varieties introduced from overseas or selected as local mutations. To remain competitive on local and international export markets the Australian citrus industry must produce fruit styles which meet current and future consumer trends. Breeding programs in countries such as the USA, Spain, South Africa and Israel are developing citrus varieties which are seedless, easy to peel, sweet and with good eating qualities. A cooperative agreement was developed between New South Wales Department of Primary Industries (NSW DPI), Auscitrus, four variety managers and the citrus industry, through Horticulture Innovation Australia (HIA), to undertake rapid and independent evaluation of new citrus varieties for the benefit of Australian growers. Citrus Australia Ltd (CAL) formed a sub-committee called the Variety Leadership Group (VLG) to over-see variety crop improvement in Australia and give guidance on future variety importation priorities.

The core evaluation site is at the NSW DPI research station at Dareton in far south-west NSW. The majority of new citrus varieties to enter Australia or those selected as local natural mutations undergo a set evaluation program. The program involves nursery multiplication of budwood to supply graft sticks for top working the varieties to mature Valencia trees. This is the quickest way to establish trees and produce fruit for sequential testing to determine quality characteristics and the potential marketing period. Young trees are also 'forced' to produce fruit in a heated glasshouse to determine if the variety is true to type and then field established on a range of citrus rootstocks to assess any potential rootstock: scion incompatibility problems. Evaluation activities also include the collection of phenology data to understand the different growth phases of each variety and yield data at time of harvest. Farm walks are conducted to introduce the new varieties to citrus growers, along with comparative fruit displays, Citrus Australia Ltd (CAL) seminar and forum presentations. The Australian variety evaluation program is also presented to visiting overseas citrus groups and at international citrus congresses such as the International Society of Citriculture Congress in Brazil, September 2016.

During the term of the project, evaluation was completed on 28 varieties with trees cut back for future trial use. Evaluation will continue on 17 varieties during 2017. An additional 35 varieties entered the program since 2014 with approximately 20 to produce field fruit for evaluation in 2018. There are 4 varieties due for quarantine release in August 2017 and 12 new citrus varieties entered Post Entry Quarantine (PEQ) in February 2017. The program's relevance to industry and on-going success is confirmed by the majority of new citrus varieties being supplied to NSW DPI for independent horticultural evaluation. The project leader also received a service to industry award at the CAL Citrus Technical Forum in March 2017 which also supports the importance of crop improvement to the citrus industry.

Privately managed new citrus varieties now comprise 21% of Auscitrus budwood production which is their largest category. Overseas variety selection has been more targeted in recent years with importation across mandarin, navel orange, Valencia orange, grapefruit and lemon categories. Many of these varieties have been selected with some country of origin production record and a climatic suitability assessment for Australian growing conditions. So the choice of what to plant in Australia will still be made on best available local information but from a group of higher performing citrus varieties. The Citrus Australia Tree Census is now starting to show the change in Australia's varietal mix with varieties such as Afourer (Tang Gold), Gold Nugget, Orri, Nectar, Kirkwood Red navel orange and Eureka seedless lemon appearing in the statistics. This trend will continue into the future as citrus growers redevelop and establish new plantings to meet both local and export demand.

Keywords

citrus, new varieties, evaluation, crop improvement, plant breeder's rights

Introduction

The project CT12026 is a continuance of an evaluation program begun in 2004 to independently assess the performance and market potential of new citrus varieties grown under Australian conditions. The citrus crop improvement program was initially led by Auscitrus which is the citrus industry's national budwood and seed supply scheme. The increasing dominance of Plant Breeder's Rights (PBR) varieties entering the program saw the leadership role move to NSW Department of Primary Industries in 2009 to avoid any potential conflicts of interest with variety managers.

Variety improvement has been an on-going priority of the Australian citrus industry to diversify the citrus mix in order to meet both domestic and export demands. The increasing demand for low seeded or seedless citrus varieties requires the importation of new varieties to test under local climatic and cultural conditions. Other key fruit quality attributes that consumers are now seeking also include varieties that are easy to peel, sweet and have good visual appeal. Citrus Australia Ltd (CAL) highlighted this need for change at the National Citrus Conference in Mildura in November 2009 with the conference theme of 'Varieties, Commercialisation and Biosecurity'. In December 2009 a CAL National Citrus Variety Committee was formed to oversee and progress new citrus variety development in Australia. The Australian Citrus Strategic R & D Plan 2012-2017 has variety development highlighted in Objective 2: 'Increase Market Value' and as Key Strategy Area 2.2 'Product Development – developing new varieties and rootstocks in line with consumer preferences'.

Since 2005 there have been 79 new citrus varieties included in the evaluation program at NSW DPI Dareton Research Station. The majority of new varieties imported to Australia or found as local mutations are nominated to the industry supported, independent evaluation program. There are 4 new varieties from the University of California breeding program expected to be released in August 2017, 5 Japanese early Satsuma mandarins entered Australian Plant Quarantine in January 2017, along with 7 varieties from the Korean Citrus Breeding program. The evaluation program works with variety managers such as Variety Access (VA), Australian Nurseryman's Fruit Improvement Company (ANFIC), nuleaf IP and Advanced Production Methods (APM). Auscitrus is also a project partner through which high health status budwood is supplied to propagate the new varieties for both hothouse and field evaluation.

The objectives of the project are to:

1. Rapidly propagate high health status new citrus varieties for trueness to type assessment, provision of graft sticks for top working and establish seedling trees on a range of citrus rootstocks for future field evaluation.
2. Collect data on fruit quality, maturity period, tree habit and yield and incorporate this information into variety information sheets.
3. Provide fruit grown to commercial standard to variety managers for market testing.
4. Conduct approved farm walks, field days and fruit displays to showcase new varieties to industry, variety managers and marketers. Participate in Citrus Australia Ltd (CAL) seminars and forums and international citrus congresses to update and promote the Australian variety evaluation program. Contribute articles on the variety program to industry magazines.
5. Maintain relationships with variety managers to ensure the majority of PBR varieties and local citrus mutations are included in the independent evaluation program for the benefit of Australian citrus growers.

Methodology

The horticultural evaluation of new citrus varieties is aimed to produce fruit to a commercial standard in a short time frame and present this information to the citrus industry. Decisions to adopt or reject new varieties are often made on early results from trial plantings to gain commercial advantage. The aim of the evaluation program is to provide impartial data on tree performance and fruit quality. This data assists citrus growers to make informed decisions when redeveloping or changing their varietal mix.

The current program establishes 4–6 top worked field trees of each variety on mature Valencia with an under-stock of Trifoliata, Carrizo citrange or Cleopatra mandarin. Seven nursery propagated field trees of each variety are also planted on a range of rootstocks predominantly for fruit quality testing and early assessment of rootstock: scion compatibility. The rootstocks used include Troyer and Carrizo citranges, Trifoliata, Cleopatra mandarin, Swingle citrumelo, C35 citrange and several new rootstocks from the USA including C146 and C22.

Horticultural assessment is conducted under the following criteria:

Trueness to Type: Ten to fifteen buds of new citrus varieties are supplied to the program by Auscitrus to propagate seedling trees in a heated hot house and then use this 'bulked-up' plant material as graft wood for field top working onto mature Valencia trees. The seedling trees are also managed to produce early flowers in a hot house environment and set fruit with the use of Gibberellic Acid (GA) sprays. This allows a trueness to type assessment of fruit to determine if the variety has been correctly imported or if there has been possible mutation during the shoot tip grafting process in Plant Quarantine. A group of 18 imported varieties were propagated in September 2014 and produced fruit in the Dareton hot house in 2016. Two of these varieties were not true to type and are being reintroduced to Australia. This mistake happened at the country of origin and the error was also detected with new variety introductions to Spain.

Fruit Quality: Testing is done on a 10–14 day schedule over the likely maturity period of each variety. Sample size is 10 fruit per test and collected from the 4 quadrants of the tree and within the canopy. Testing is begun before the variety is mature and continues until the internal quality begins to deteriorate. The characteristics analysed include: Juice%, °Brix (sugar), %Acid, Brix to Acid ratio, BrimA, seed number, rind thickness, fruit diameter, fruit weight and palatability over the maturity period.

Maturity Period: Sequential fruit quality testing over several seasons is required to determine the potential marketing 'window' for each variety. Maturity period charts are updated as new varieties are added and additional data is collected.

Yield and Fruit Size: At the Dareton evaluation site fruit yields are collected from top worked trees and field planted seedling trees for a minimum of 4 seasons. Data collected includes fruit thinning rates, fruit number at harvest and tree yield. Fruit is also supplied to variety managers/marketers for commercial grading, packing and market testing.

Phenology: Phenology is the key growth phases of the crop through the yearly production cycle. The recording is based on the 'Key Phenology Stages of Citrus' developed by NSW DPI and CAL. The main stages are: Budbreak, Start of bloom, Full bloom, End of petal fall, End of fruit drop, Cell division/cell expansion, Colour change, Fruit maturity and Harvest. Accurate phenology data allows an understanding of the growth stages of each variety and assists in the timing of management activities to maximize tree and crop performance.

Tree Growth Rate: Selected field planted trees are trunk and canopy measured to compare tree growth rates over time. Trunk measurements are more reliable in determining tree growth rate as the canopy growth can be altered by the need to prune young trees and early crop load weighting down branches and modifying tree

height. Trunk circumference, tree height and spread measurements assist in the determination of cropping efficiency of a variety.

Variety specific management trials on varieties of commercial interest: The evaluation site at Dareton Research Station is usually the first site in Australia to produce fruit on top worked and seedling trees, so small trials can be implemented if production issues are reported from overseas experience or identified locally. During the term of this current project, work has continued on improving the fruitfulness of Orri mandarin with girdling, GA at flowering, pruning and branch manipulation to reduce vigour. Similar GA and branch girdling strategies have also been applied to Royal Honey Murcott (RHM) in 2016 to improve fruit set. The use of GA and 2-4,D (Stop Drop®) to improve rind condition and retain fruit on the trees has also been tested on Orri mandarin, Gold Nugget mandarin and Late Cara Cara navel. Hand thinning has also been conducted on some varieties such as Tang Gold to test the effects on alternate bearing and fruit size at harvest. Fruit thinning growth regulators such as Corasil® and Maxim® have been used to reduce crop load in previous projects and will be tested on selected new varieties as they come into bearing from 2018. The interest in pigmented citrus such as Tarocco Ippolito blood orange has been highlighted by grower visits to view field trees and cool stored fruit. Anthocyanin pigmentation within the fruit can be improved with short term cool storage at 5°C after harvest.

New variety presentation to industry: A major component of the project is to show the new varieties to industry and discuss their early performance in Australia. This is done at regional, state and national levels. Visiting international groups composed of growers, researchers and advisors are also escorted through the trial site or shown fruit displays. The majority of new varieties are now under PBR protection and variety management so any in-field viewing of the trial areas can only occur with prior approval and as manageable groups. Formal presentations and new variety fruit displays are conducted in association with CAL regional forums and a biennial Citrus Congress held in Mildura, Victoria. Other fruit display events and presentations have been conducted in Queensland, Western Australia, South Australia and the Riverina region of NSW.

Variety Information Sheets: Information sheets are developed on the new varieties and entered into a new NSW DPI template format. Sheets are initially held as a draft until sufficient data can be collected to confirm their characteristics and field performance. Information sheets on the majority of varieties evaluated to date will be placed on the NSW DPI internet site in July 2017.

Outputs

Summary of the varieties included in the evaluation program since 2004 and their current status.

Table 1. New varieties evaluated and recent inclusions in the program since 2014

Evaluate 2017

No	Variety	Evaluate 2017	Date budded in nursery	Variety manager & Status
1	Mer		9/2/04	ANFIC – Evaluation completed
2	Pomelit		9/2/04	ANFIC – Evaluation completed
3	Nectar		9/2/04	ANFIC – Evaluation completed
4	Nouvelle		9/2/04	ANFIC – Evaluation completed
5	Eureka SL		9/2/04	ANFIC
6	IRM1		3/3/04	QDPI – Evaluation completed
7	Cami		26/4/04	ANFIC – Evaluation completed
8	Tacle		26/4/04	ANFIC – Evaluation completed
9	C-1829		26/4/04	ANFIC – Evaluation completed
10	C-1867		26/4/04	ANFIC – Evaluation completed
11	C-2191 (Alkantara)		26/4/04	ANFIC – Evaluation completed
12	D-8811 (Mandalate)		26/4/04	ANFIC – Evaluation completed
13	Sidi Aissa		30/12/04	Auscitrus – Evaluation completed
14	Orogrande		30/12/04	Auscitrus – Evaluation completed
15	Primosole		23/11/04	Auscitrus – Evaluation completed
16	IRM-2		/1/05	QDPI – Evaluation completed
17	Orri		8/9/05	Variety Access (transfer 7/12/12)
18	Gold Nugget		8/9/05	nuleaf
19	Nour		7/9/05	Auscitrus – Evaluation completed
20	Jincheng Bei Bei 447		/12/06	Auscitrus – Evaluation completed
21	Bintangcheng No 2		"	Auscitrus – Evaluation completed
22	Shasta Gold (TDE 2)		"	nuleaf – Evaluation completed
23	Yosemite Gold (TDE 4)		"	nuleaf – Evaluation completed
24	Tahoe Gold (TDE 3)		"	nuleaf – Evaluation completed
25	Earlygold		"	ANFIC – Evaluation completed
26	Tarocco Rosso		22/8/07	Auscitrus – Evaluation completed
27	Tarocco Meli		22/8/07	Auscitrus – Evaluation completed
28	Tarocco Ippolito		15/8/08	Auscitrus
29	Winola mandarin		15/8/08	ANFIC – Evaluation completed
30	Bintangcheng Renbin#5		/11/08	Auscitrus – Evaluation completed
31	Etna mandarin		19/2/09	Auscitrus – Evaluation completed
32	Tang Gold mandarin		4/12/09	nuleaf
33	Palmer navel		20/8/10	Auscitrus – Evaluation completed
34	Dekopon		22/9/11	Variety Access
35	FJ Navel		22/9/11	Variety Access
36	M4 Brown Navel		15/9/11	Variety Access
37	CIT1519 mandarin		3/11/11	Variety Access (to transfer to ANFIC)
38	Turkey Valencia		3/11/11	Variety Access
39	Kirkwood Red Navel		3/11/11	Variety Access
40	Summerina mandarin		1/10/12	APM (Advanced Production Methods)
41	Hadass mandarin		31/10/12	Variety Access

42	Royal Honey Murcott		31/10/12	Variety Access
43	Mandared tangor		17/12/12	ANFIC
44	Alpha Valencia		30/9/14	Variety Access—wrong variety, re-import
45	Midnight Valencia 115-1717		30/9/14	Variety Access
46	Ruby Valencia		30/9/14	Variety Access
47	Witkrans navel orange		30/9/14	Variety Access
48	Star Ruby Grapefruit (early)		30/9/14	Variety Access
49	Star Ruby Grapefruit (late)		30/9/14	Variety Access
50	Jackson Grapefruit		30/9/14	Variety Access
51	ARC Nadorcott mandarin	Top worked	30/9/14	Variety Access
52	Sunsmooth navel orange	Top worked	15/10/14	APM
53	91-03-04 mandarin	Top worked	15/10/14	CSIRO
54	Weipe SL Valencia		23/12/14	Variety Access
55	McClean Valencia		23/12/14	Variety Access
56	Lavalle Valencia		23/12/14	Variety Access
57	Benny Valencia		23/12/14	Variety Access
58	Carninka navel orange		23/12/14	Variety Access—wrong variety, re-import
59	Rayno navel orange		23/12/14	Variety Access
60	Glen Ora navel orange		23/12/14	Variety Access
61	Kishu mandarin		23/12/14	Variety Access
62	USDA 88-2 mandarin		23/12/14	Variety Access
63	Variegated Pink Eureka lemon		23/12/14	Variety Access
64	Late Cara Cara navel orange	Top worked	2/4/15	Variety Access
65	1474 - mandarin		11/3/16	Variety Access
66	1614 - mandarin		11/3/16	Variety Access (to transfer to ANFIC)
67	1627 - mandarin		11/3/16	Variety Access
68	1848 - mandarin		11/3/16	Variety Access (to transfer to ANFIC)
69	Early Star Ruby Grapefruit		11/3/16	Variety Access
70	Late Star Ruby Grapefruit		11/3/16	Variety Access
71	AE CC No 1		18/11/16	APM
72	AC41114LS Afourer mandarin		19/12/16	Variety Access
73	HC Afourer mandarin		19/12/16	Variety Access
74	MJR11 mandarin		19/12/16	Variety Access
75	MJR12 mandarin		19/12/16	Variety Access
76	H2 seedless (SL Stella mandarin)		19/12/16	Variety Access
77	Italian lemon		19/12/16	Variety Access
78	Gusocora (G5) 1553 Valencia		19/12/16	Variety Access
79	Sudachi		19/12/16	Auscitrus

Note: Comments:

- Field evaluation will occur on 17 varieties during 2017 with evaluation finished on 28 varieties during the term of the current project.
- Second year assessment of Royal Honey Murcott (RHM) and Nadorcott SL mandarins in 2017.
- Third year assessment of CIT1519, Summerina, Hadass and Mandared mandarins in 2017.
- Fourth year assessment of Dekopon mandarin, Tang Gold mandarin, FJ, Brown and Kirkwood Red navels and Turkey Valencia in 2017.
- On-going, long term assessment will continue on Eureka SL lemon, Orri and Gold Nugget mandarins along with Tarocco Ippolito blood orange.

- Twenty new varieties entered the program between September and December 2014 with field fruit production to occur in 2018 from top worked trees.
- An additional 6 varieties entered the program in March 2016 with the nursery propagation of 2 grapefruit and 4 mandarin selections with a further 9 varieties nursery propagated in November and December 2016.
- There is an expected release of 4 varieties from Plant Quarantine in August 2017. These varieties are from the University of California citrus breeding program and are managed in Australia by nuleaf IP.
- Five public access early Japanese Satsuma mandarins and 7 varieties from the South Korean citrus breeding program entered Australian Plant Quarantine in February 2017. Auscitrus will manage the Japanese Satsuma mandarins and Variety Access will manage any new varieties introduced from Korea.

Trueness to type assessment

Two variety importation mistakes were found in 2016 when fruit was produced on potted trees budded in December 2014 in the Dareton hot house. The use of Gibberellic Acid (GA) sprays at 30ppm during the flowering period in September 2015 helped to set and retain fruit on these young trees. The variety introduced as Carninka navel proved to be a Valencia type and the Alpha Valencia flowered and fruited as a seeded mandarin, probably Orah mandarin.

The error occurred at the South African source and the same issue was reported by a variety manager in Spain. The Australian variety manager has begun the re-introduction process for both varieties as they were suggested to have commercial potential in Australia, particularly the late maturing Carninka navel orange.

Figure 1. Hot house fruit production for trueness to type assessment Benney Valencia (L) Jackson grapefruit (R)



Fruit Quality

The internal fruit quality attributes of: Juice%, °Brix, B:A ratio, BrimA, Average seed number, Average rind thickness Average fruit diameter and Average fruit weight are sequentially collected for several years on all varieties to determine their maturity period and likely market 'window' if adopted by the citrus industry. Other features of the fruit are also noted such as rind colour and texture, fruit shape, susceptibility to sunburn and likelihood of fruit splitting. Table 2 shows the internal fruit quality summary of several varieties cropping for the first time (RHM and Nadorcott SL mandarins), another for the second time (Mandared tangor). Tables 3, 4 and 5 present fruit quality data for varieties which have produced fruit for at least 3 seasons, including Tang Gold mandarin , Turkey Valencia orange and Kirkwood Red navel orange .

Date	Variety	Rootstock	Juice%	°Brix	Acid%	B:A ratio	BrimA	Av. Seed number	Av. Rind (mm)	Av. Fruit Diam. (mm)
6/05/16	RHM	Citrange	53	10.1	0.64	15.8	124	*	*	*
16/05/16			55	10.0	0.67	15.0	121	0.5	2.4	66
27/05/16			52	10.6	0.58	18.2	136	0.8	2.6	64
7/06/16			47	10.2	0.51	19.9	135	0.7	2.6	66
21/06/16			54	11.2	0.58	19.4	147	0.5	2.2	64
4/07/16			51	11.2	0.46	24.3	154	0.8	2.7	65
18/7/16			49	11.3	0.40	28.0	160	0.2	3.2	65
6/05/16	Nadorcott SL	Citrange	52	9.6	1.31	7.3	71	*	*	*
16/05/16			49	9.6	1.18	8.2	81	0.1	2.5	65
27/05/16			51	10.3	1.10	9.5	98	0.1	2.7	70
7/06/16			49	10.0	1.07	9.4	94	0.0	2.5	67
21/06/16			46	10.8	1.08	10.0	107	0.2	2.3	71
4/07/16			46	11.6	1.06	11.0	122	0.1	2.7	66
29/7/16			46	12.2	0.92	13.2	140	0.2	2.5	65
7/06/16	Mandared	Trifoliata	50	12.0	1.46	8.2	102	0.3	3.4	80
21/06/16			56	12.0	1.37	8.8	108	0.3	2.6	83
4/07/16			52	12.4	1.38	9.0	113	0.3	2.9	85
29/7/16			53	12.3	1.35	9.1	114	0.0	3.1	81
22/6/15			51	10.8	1.31	8.2	92	0.0	3.5	80
29/7/15			53	12.4	1.37	9.0	114	2.0	3.6	79
10/8/15			52	12.7	1.35	9.4	120	0.3	4.6	72
Minimum maturity standard - Mandarin			35				110			

Table 3. Fruit quality of Tang Gold mandarin top worked to Valencia orange at the Dareton Research Station evaluation site, 2014–2016

Date	Variety	Rootstock	Juice%	°Brix	Acid%	B:A ratio	BrimA	Av. Seed number	Av. Rind (mm)	Av. Fruit Diam. (mm)
6/05/16	Tang Gold	Citrange	52	10.1	1.27	7.9	83	*	*	*
16/05/16			53	10.1	1.41	7.2	74	0.0	2.6	64
27/05/16			51	10.6	1.18	9.0	97	0.0	2.5	66
7/06/16			46	10.5	1.13	9.3	99	0.0	2.8	69
21/06/16			50	11.1	1.10	10.1	110	0.0	2.3	68
4/07/16			50	11.9	1.14	10.4	121	0.0	2.7	64
18/07/16			44	11.6	0.84	13.8	136	0.1	3.1	70
29/07/16			46	11.6	0.82	14.2	137	0.0	2.4	67
11/08/16			49	12.6	0.91	13.9	148	*	*	*
18/05/15			51	10.9	1.00	10.8	114	*	*	*
29/05/15			46	10.5	1.16	9.1	97	*	*	*
11/06/15			47	11.1	1.16	9.6	107	*	*	*
22/06/15			49	10.7	1.25	8.6	94	*	*	*
6/07/15			46	12.7	1.08	11.7	138	*	*	*
17/07/15			47	11.7	0.83	14.1	138	*	*	*
29/07/15			51	12.6	0.73	17.3	160	*	*	*
10/08/15			43	13.1	0.95	13.8	154	0.3	3.8	64
20/08/15			41	13.1	0.86	15.2	159	*	*	*
1/09/15			41	13.2	0.86	15.4	161	*	*	*
12/05/14			51	9.4	1.34	6.8	63	*	*	*
23/05/14			50	10.0	1.16	8.6	89	*	*	*
3/06/14			46	10.1	9.30	9.3	95	*	*	*
12/06/14			47	10.0	1.07	9.4	94	*	*	*
26/06/14			54	10.4	1.12	9.3	98	*	*	*
14/07/14			51	11.6	1.06	11.0	122	*	*	*
13/08/14			50	12.0	0.96	12.5	135	*	*	*
1/09/14			54	12.3	0.97	12.6	139	*	*	*
17/09/14			53	13.5	0.78	17.3	171	*	*	*
Minimum maturity standard Mandarin			35				110			

Table 4. Fruit quality of Turkey Valencia orange top worked to Valencia orange at the Dareton Research Station evaluation site, 2014–2016

Date	Variety	Rootstock	Juice%	°Brix	Acid%	B:A ratio	BrimA	Av. Seed number	Av. Rind (mm)	Av. Fruit Diam. (mm)
7/06/16	Turkey	Citrange	46	10.3	1.34	7.7	81	*	*	*
21/06/16			47	11.2	1.28	8.8	100	*	*	*
4/07/16			50	11.0	1.17	9.4	104	*	*	*
18/07/16			48	10.8	1.13	9.5	103	*	*	*
29/07/16			47	11.2	1.08	10.4	113	*	*	*
11/08/16			49	11.6	1.04	11.1	123	*	*	*
29/08/16			48	11.5	0.97	11.9	126	*	*	*
12/9/16			58	12.5	0.92	13.6	145	*	*	*
22/9/16			50	12.4	0.88	14.1	147	*	*	*
13/10/16			47	12.4	0.77	16.1	154	*	*	*
31/10/16			43	12.0	0.76	15.9	148	*	*	*
17/07/15			51	10.4	2.01	5.2	39	1.3	5.4	79
29/07/15			52	10.7	1.18	9.1	99	3.1	5.4	78
10/08/15			52	11.2	1.13	9.9	110	2.4	5.2	75
20/08/15			49	10.5	1.02	10.3	106	2.0	4.8	78
1/09/15			44	10.4	0.97	10.7	107	*	*	*
11/09/15			48	10.2	1.01	10.1	102	*	*	*
23/05/14			48	8.9	1.44	6.2	52			
3/06/14			49	10.0	1.36	7.4	75	1.6	6.1	81
12/06/14			47	9.2	1.25	7.4	69	0.8	5.9	81
26/06/14			53	9.6	1.24	7.7	76	1.0	6.5	82
14/07/14			51	9.4	1.07	8.8	85	2.0	6.4	82
24/07/14			49	10.2	1.20	8.5	89	*	*	*
30/07/14			52	9.4	1.20	7.8	76	*	*	*
13/08/14			51	10.0	1.09	9.2	94	*	*	*
1/09/14			48	9.8	1.10	8.9	89	*	*	*
17/09/14			51	10.6	0.92	11.6	114	*	*	*
7/10/14			49	11.1	0.95	11.7	121	*	*	*
16/10/14			46	9.6	0.77	12.5	108	*	*	*
Minimum maturity standard Orange			38	9.0		9	90			

Table 5. Fruit quality of Kirkwood Red navel orange top worked to Valencia orange at the Dareton Research Station evaluation site, 2014–2016

Date	Variety	Rootstock	Juice%	°Brix	Acid%	B:A ratio	BrimA	Av. Seed number	Av. Rind (mm)	Av. Fruit Diam. (mm)
26/04/16	Kirkwood	Trifoliata	47	10.4	1.13	9.2	97	*	*	*
6/05/16			50	10.7	1.01	10.6	110	*	*	*
16/05/16			51	11.0	1.08	10.2	111	*	*	*
27/05/16			50	11.6	0.97	11.9	127	*	*	*
7/06/16			49	11.4	0.95	12.0	125	*	*	*
21/06/16			50	11.8	0.93	12.6	133	*	*	*
4/07/16			47	12.4	0.87	14.2	147	*	*	*
18/07/16			48	12.3	0.90	13.6	143	*	*	*
29/07/16			48	12.0	0.78	15.4	146	*	*	*
16/04/15			45	8.8	1.33	6.6	58	<i>2015 data below from citrange</i>		
11/06/15			50	10.4	1.00	10.4	105	0.0	6.4	86
22/06/15			49	11.0	1.02	10.7	114	0.2	6.4	84
6/07/15			47	11.2	0.93	12.0	123	0.1	6.6	82
17/07/15			49	11.3	0.91	12.4	126	*	*	*
29/07/15			48	11.5	0.87	13.2	132	0.1	6.2	83
1/09/15			47	12.1	0.85	14.3	144	*	*	*
23/05/14			50	9.0	1.15	7.8	72	*	*	*
3/06/14			51	9.7	0.90	10.7	100	0.0	6.1	82
12/06/14			56	10.2	1.01	10.1	102	0.0	4.6	79
26/06/14			56	10.4	0.93	11.2	110	0.0	5.3	83
14/07/14			53	11.1	0.91	12.2	123	0.0	4.7	78
30/07/14			51	11.2	0.93	12.1	124	*	*	*
4/08/14			51	10.7	0.83	12.9	122	*	*	*
13/08/14			52	11.6	0.88	13.2	134	*	*	*
1/09/14			56	11.7	0.80	14.6	140	*	*	*
Minimum maturity standard Orange			38	9.0		9	90			

Maturity Period

Table 6 shows the maturity period for a range of new varieties currently under assessment at the Dareton site. Two standard mandarin varieties are included for an early season and mid/late season comparison. Bintangcheng orange selections from China remain on the 2016 version as there has been some commercial interest from the processing juice sector. Sequential fruit quality testing and phenology data has been used to compile and then update the table each year. Comparative testing at regional evaluation sites in project CT10012: Evaluating new citrus varieties 2010–2013 showed the Riverland site at Renmark, SA to have similar maturity periods for a range of varieties as Dareton. The West Australian site at Gin Gin was also not dissimilar to Dareton results, while the Riverina region of central NSW was 2–3 weeks later in maturity. The Queensland site in the Central Burnett region was generally 3–4 weeks earlier, depending on variety.

Table 6.

Draft maturity periods for selected new varieties - Sunraysia.

2016 Variety	April Week				May Week				June Week				July Week				August Week				September Week				October Week				November Week							
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4				
FJ navel					■	■	■	■																												
Bintangcheng orange#2						■	■	■																												
RHM mandarin									■	■	■	■																								
<i>Imperial mandarin</i>													■	■	■	■					<i>Industry standard variety</i>															
Eureka SL lemon													■	■	■	■	■	■	■	■																
Bintangcheng orange#5									■	■	■	■	■	■	■	■																				
Brown navel													■	■	■	■																				
CIT1519 mandarin																	■	■	■	■																
Kirkwood Red navel													■	■	■	■	■	■	■	■																
Tang Gold mandarin																	■	■	■	■																
Nadorcott SL mandarin																	■	■	■	■																
Dekopon																	■	■	■	■																
Tarocco Ippolito																	■	■	■	■																
<i>Afourer mandarin</i>																	■	■	■	■	<i>Industry standard variety</i>															
Mandared tangor																	■	■	■	■																
Orri mandarin																	■	■	■	■	■	■	■	■												
Gold Nugget mandarin																	■	■	■	■	■	■	■	■												
Hadass mandarin																					■	■	■	■												
Turkey Valencia																					■	■	■	■	■	■	■	■								
Summerina mandarin																									■	■	■	■								

Yield and fruit size

Yield data summaries are included on the variety information sheets (see Appendix) as a general representation of the cropping potential of the new varieties. The results are presented on an average, individual tree basis with the majority of the data from trees top worked to Valencia orange. When the top working program began in 2005 each new variety was grafted to 12 Valencia trees. The Valencia rootstocks comprised 4 Trifoliata, 4 Carrizo citrange and 4 Cleopatra mandarin. Fruit quality testing confirmed that the rootstock had the dominant effect on fruit quality and cropping potential. The Valencia 'inter-stock' also proved compatible with all new varieties grafted since the initial top working program began in 1996. Top worked evaluation trees have been reduced to 4–6 trees per variety since October 2012. The reasons for this reduction were that many of the varieties under evaluation were not suited to Australian climatic and market conditions and attracted little commercial interest from the local industry. A smaller number of trees could provide an adequate volume of fruit for maturity testing, determination of the potential marketing period, demonstrate the characteristics of the tree and fruit to citrus growers and allow crop management activities to be tested on the new varieties.

Nursery grown seedling trees are also field planted on a range of rootstocks to assess any early incompatibility problems. Fruit produced from them are also included in the juice quality testing program. Seven trees are established on rootstocks such as citrange, swingle, trifoliata, Cleopatra mandarin and C35 citrange. Some recent nursery propagations have also included new rootstocks from the USA and include C22, C146 and US812.

The scale and turn-over of varieties in the rapid evaluation program does not suit long term replicated trial establishment. So data generated from harvests on top worked and field grown trees can only demonstrate a potential cropping pattern for the new varieties in the program.

Phenology

The phenology stages of a range of new varieties of commercial interest are presented in Table 7. The timing of each growth stage can vary between years depending on climatic conditions. A minimum of 3 years data has been used to compile the result for Gold Nugget, Kirkwood Red, Turkey and Eureka SL with one full year of observations collected on RHM.

Table 7. Key phenology stages for Royal Honey Murcott (RHM), Gold Nugget mandarin, Kirkwood Red navel orange. Turkey Valencia and Eureka SL (seedless) lemon.

RHM												
Site	July	August	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June
Sunraysia												
Budburst (BB)	1											
First Flower open (FF)	2											
50% Full flowering (Full)	3											
End Petal Fall (PF)	4											
End Fruit drop (FD)	5											
Cell expansion (CE)	6											
Colour change/break (CB)	7											
Maturity	8											
Harvest	9											

Gold Nugget												
Site	July	August	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June
Sunraysia												
<i>Sunraysia (harvest)</i>												
Budburst (BB)	1											
First Flower open (FF)	2											
50% Full flowering (Full)	3											
End Petal Fall (PF)	4											
End Fruit drop (FD)	5											
Cell expansion (CE)	6											
Colour change/break (CB)	7											
Maturity	8											
Harvest	9											

Kirkwood Red												
Site	July	August	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June
Sunraysia												
<i>Sunraysia (harvest)</i>												
Budburst (BB)	1											
First Flower open (FF)	2											
50% Full flowering (Full)	3											
End Petal Fall (PF)	4											
End Fruit drop (FD)	5											
Cell expansion (CE)	6											
Colour change/break (CB)	7											
Maturity	8											
Harvest	9											

Turkey Valencia												
Site	July	August	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June
Sunraysia												
<i>Sunraysia (harvest)</i>												
Budburst (BB)	1											
First Flower open (FF)	2											
50% Full flowering (Full)	3											
End Petal Fall (PF)	4											
End Fruit drop (FD)	5											
Cell expansion (CE)	6											
Colour change/break (CB)	7											
Maturity	8											
Harvest	9											

Eureka SL

Site	July	August	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June
Sunraysia												
<i>Sunraysia (harvest)</i>												
Budburst (BB)	1											
First Flower open (FF)	2											
50% Full flowering (Full)	3											
End Petal Fall (PF)	4											
End Fruit drop (FD)	5											
Cell expansion (CE)	6											
Colour change/break (CB)	7											
Maturity	8											
Harvest	9											

Tree Growth

Table 8 compares seedling tree circumference 12 centimetres above the rootstock: scion bud union and tree height of four new varieties field planted in November 2013 and measured each October, 2014–2016.

Table 8. Butt circumference (cm) and tree Height (m) 2014–2016

Variety	Rootstock	2014		2015		2016	
		Butt (cm)	Height (m)	Butt (cm)	Height (m)	Butt (cm)	Height (m)
Dekopon	C35 citrange	4.7	1.15	9.8	1.20	14.5	1.50
	C35 citrange	3.6	1.00	9.0	1.20	14.5	1.60
	cleopatra	3.5	1.10	5.0	1.10	5.5	1.00
	citrange	3.2	0.90	5.2	1.00	11.0	1.50
	citrange	2.8	0.90	3.3	0.80	5.6	0.80
	citrange	3.0	0.70	3.4	0.70	4.8	0.70
	citrange	2.8	0.90	3.8	0.70	8.5	1.20
RHM	US812	3.3	0.90	7.0	1.50	12.2	2.40
mandarin	C35 citrange	3.4	1.10	7.0	1.30	11.9	2.40
	cleopatra	1.9	0.60	3.1	0.70	7.0	1.60
	trifoliata	3.8	1.20	7.5	1.50	11.6	2.40
	swingle	3.3	1.00	7.8	1.40	12.4	2.70
	citrange	3.5	1.10	6.3	1.30	9.9	1.90
	citrange	3.3	0.90	6.9	1.10	11.0	1.60
Kirkwood	C35 citrange	4.5	0.80	8.3	1.10	13.5	1.70
Red navel	trifoliata (tanghe)	3.1	0.55	4.0	0.60	5.8	0.80
	trifoliata	3.0	1.00	4.0	0.90	7.7	0.90
	swingle	3.8	1.30	6.2	1.30	9.8	1.50
	citrange	3.0	1.10	4.1	1.10	7.0	1.20
	citrange	4.6	1.10	7.5	1.10	11.0	1.20
	citrange	3.5	1.10	9.5	1.20	16.8	1.80
Turkey	C35 citrange	4.7	1.10	9.7	1.30	14.6	1.90
Valencia	cleopatra	3.6	0.80	8.0	1.20	12.0	1.60
	trifoliata (tanghe)	3.4	0.80	8.0	1.00	12.1	1.60
	trifoliata	3.8	0.90	6.7	1.10	10.6	1.30
	swingle	3.6	0.80	6.5	1.00	10.2	1.40
	citrange	4.8	1.30	8.2	1.40	13.2	1.70
	citrange	4.4	1.20	10.0	1.30	15.7	1.80
	citrange	7.0	1.30	12.5	1.50	18.5	1.80
	citrange	5.1	1.20	7.1	1.30	12.8	1.40

Tree measurements in 2016 showed that Dekopon mandarin was the smallest of the 4 varieties with an average trunk circumference across all rootstocks of 9.2 cm and height of 1.19 m. Turkey Valencia had the largest average trunk circumference of 13.3 cm and average tree height of 1.61 m. The most upright of the 3 year old trees was RHM mandarin at 2.14 m and it also had the second largest trunk circumference. RHM has also shown high vigour as a top worked tree and has required branch girdling and a GA spray at petal fall to help 'set' fruit in 2016. This variety is grown commercially in Queensland and if adopted in southern citrus regions will require a management program to reduce tree vigour and its upright growth habit to improve fruit production.

Variety specific management

All evaluation trees receive standard nutrition programs either as field planted seedling trees or top worked trees. Nitrogen nutrition is applied to top worked trees 3 times per season in September, November and January via the under tree sprinkler system. Phosphate is applied every 2 years as a band along the edge of the tree canopy. Field planted trees are fertigated with a complete nutrient mix every 2 weeks from late August to March each year with the nutrient composition and amount varied according to phenological growth stage. Both plantings receive foliar zinc and manganese micronutrient sprays in late spring and early autumn each year as well as several supplementary foliar sprays of Calcium nitrate and Potassium nitrate. These nutrition programs have been adequate to maintain the health status of all varieties under evaluation and allow other management activities to be tested on trees grown to high industry standard.

The Orri mandarin variety has been in the program since 2006 and has proven to be one of the most difficult to manage under local growing conditions. The Australian variety manager is close to finalising a commercialisation agreement with the Israeli breeders of Or4 (Orri™) to allow commercial scale plantings in Australia. Orri has excellent flavor and appeals to most people who have tried the fruit. The variety can also be exported as demonstrated by fruit grown in Israel available for sale on the Australian market. Australian exporters see potential for Orri grown in Australia being popular on the Asian market due to its high °Brix (sugar) content and high eating quality.

The 2 main issues with Orri are the (i) high tree vigour which produces foliage at the expense of flowers and fruit as well as (ii) the inability to retain young fruitlets. Both problems are related and a range of management strategies have been undertaken to try and alleviate these production issues.

Gibberellic Acid (GA) first applied at 80-90% petal fall in 2010 at a rate of 30ppm, along with branch girdling in 2011 were some of the management strategies implemented (figure 4). The GA has been shown to increase fruitfulness and girdling traps nutrients above the shallow cut and is also reported to aid fruitlet retention. Both practices became part of the yearly management program for Orri at the evaluation site and mostly proved successful. Spanish visitors in May 2016 suggested splitting the GA application into 15ppm mid flowering and a second 15ppm 2 weeks later as they had more success with this timing of application. This was implemented in October 2016 along with branch girdling, but the excessive tree vigour of both top worked and field grown Orri trees suppressed any positive effect of this new management practice. Pruning practices on Orri have been aimed at improving light penetration into the tree and removing at least one large limb on the eastern side of the tree to allow easy access to the centre of the tree to girdle limbs. Pruning also stimulates tree regrowth and unless quickly removed or managed can lead to more vigour, shading and poor fruit set. The work involved in attempting to impose vigour reducing strategies on large trees has proven time consuming and of little interest to local citrus growers.

Orri is being planted as field trees and top worked to mature trees in Spain. Their strategy is to manage and reduce vigour from the time of tree planting and graft establishment. Branches are selected then bent or tied to below horizontal position to reduce vigour and improve fruitfulness (figures 2 and 3). When these branches start to produce fruit the weight of the crop helps to keep them in a horizontal position and the tree with an open centre. Selective pruning is then used to maintain tree form. These strategies are similar to what is practiced with stone fruit production but is relatively new to citrus.

These vigour reduction techniques were imposed on field planted and top worked trees of Orri at Dareton in April 2017 and will be assessed in combination with girdling and GA application in coming years (figures 5, 6 and 7). Limb manipulation will also be applied to any variety with an upright habit that is established at the Dareton evaluation site with the aim of improving early fruit set.

Figure 2. Spain. Clementine mandarin re-budded to Orri mandarin with 4 main branched tied



Figure 3. Spain. Orri top worked to Powell navel with branches tied down to a horizontal position



Figure 4. Australia. Five years of girdling wounds on Orri branches at Dareton evaluation site 2016.



Figure 5. Australia. Top worked Orri tree heavily pruned in April 2017 to remove upright growth and open the centre of the tree



Figure 6. Australia. One year old mandarin tree with branches tied to a horizontal position 2017



Figure 7. Australia. Orri field grown trees heavily pruned with branches bent and tied down 2017



New variety presentations to Industry

A major component of the project involves introduction of the new varieties to the citrus industry through approved farm walks, fruit displays, forum/seminar presentations and industry publications.

Industry presentations

2017

Citrus Australia Ltd (CAL) Regional Forums - 2017.

Presentation: 'New variety evaluation update and fruit display'.

10th May 2017: Mildura, Victoria

11th May 2017: Renmark, South Australia

12th May 2017: Mildura Fruit Company new variety farm walk, Dareton

Presentation: New variety and rootstock evaluation.

1st -2nd March 2017: Citrus Australia Ltd Technical Forum, Mildura. Victoria.

2016

Citrus Australia Ltd (CAL) Regional Forums - 2016.

Presentation: 'New variety evaluation update and fruit display'

24th May 2016: South Australian (Loxton)

20th June 2016: Sunraysia (Mildura)

23th June 2016: Riverina (Yanco Agricultural Institute)

Sunraysia Citrus Growers Annual General Meeting – Dareton Research Station,

29th November 2016: Farm walk and trial inspection and a stored fruit display

Presentations and discussions with other visitors to the Dareton evaluation site in 2016

Individual farmer visits: 11

Small group (3-5 people): 18

Larger group: 6

10th May 2016: Mildura Fruit Company and Spanish visitors (8)

12th May 2016: Biogold International and USA farmers (13)

28th June 2016: Chilean farmer and consultancy group (10)

16th August 2016: nuleaf sponsored Qld farmer group (11)

17th August 2016: NSW DPI Executive's research station visit (8)

29th November 2016: Sunraysia Citrus Growers AGM and farm walk (15)

2015

16-17th March 2015: Citrus Australia Technical Forum and Field Day, Mildura, Vic.

10th July 2015: Presentation: 'New varieties for the future' and coordinator for field session 'New Plantings',

South Australian grower group farm walk at Dareton evaluation site

22nd July 2015: New variety presentation at the West Australian cttgroups forum, Perth markets

27th July 2015: New varieties seminar, Yanco Agricultural Institute

29th July 2015: Argentine citrus farmers visit, Dareton. Farm walk and new variety presentation

6th August 2015: Nippy fruit juices grower group farm walk, Dareton

In addition a total of 53 citrus growers, marketers, variety managers and nurserymen also visited the Dareton evaluation site between the 21st January 2015 – 26th October 2015 to inspect and discuss new citrus varieties. It involved both individual, small group visits of 2 – 4 people and several larger groups. The largest group was 11 citrus growers from northern NSW, South Africa and Queensland on the 18/3/2015 and 9 from South Australia, Queensland and the USA on the 15th May 2015.

2014

27th May 2014: 'Variety Access' seminar and farm walk at Dareton evaluation site on to an audience of 26 citrus growers.

4th July 2014: 'Advanced Production Methods (APM)' farm walk at Dareton evaluation site to an audience of 20 citrus growers.

Between February and November 2014: 15 small group visits to the Dareton evaluation site by a total of 50 local and international growers along with horticultural professionals.

2013

May 2013: Citrus Australia Regional Forum and Variety Day 2013. Waikerie, SA 18th May, Dareton, NSW 20th May and Leeton, NSW 22nd May

5th June 2013: New citrus variety fruit displays. Gayndah and Mundubbera, Queensland

10th July 2013: New citrus variety fruit display and presentation. Bindoon, Western Australia

8th August 2013: 'New citrus variety seminar and farm walk for South Australian and Riverina citrus growers'. Dareton

24th September 2013: Mandalate mandarin seminar, Dareton. ANFIC

International citrus growers, marketers and scientists to visit the Dareton Research Station and discuss new varieties came from: Spain, USA, South Africa, Argentina, Chile, Thailand and China (fruit buyers), England (fruit buyers).

Industry Publication

'Varieties to meet export demand', Australian Citrus News – spring 2016, pp 4-9.

'World leaders in the citrus industry', Your Sunraysia magazine, Nov. 2016. pp 85-92.

Weekly Times Newspaper (25/8/15) 'Sweet new types juice up offerings'.

Citrus Connect, e Newsletter, NSW DPI (Oct. 15) 'Evaluation of new citrus varieties'.

Sanderson, G., Creek, A., Lacey, K. and Wallace, M. Evaluation program for new citrus varieties 2004-2012. Citrus Australia Regional Forum and Variety Day 2013 booklet. Citrus Australia Ltd.

Sanderson, G. Showcase of easy peeler varieties. Australian Citrus News - Vol.89, Sept. 2013. pp 14-15.

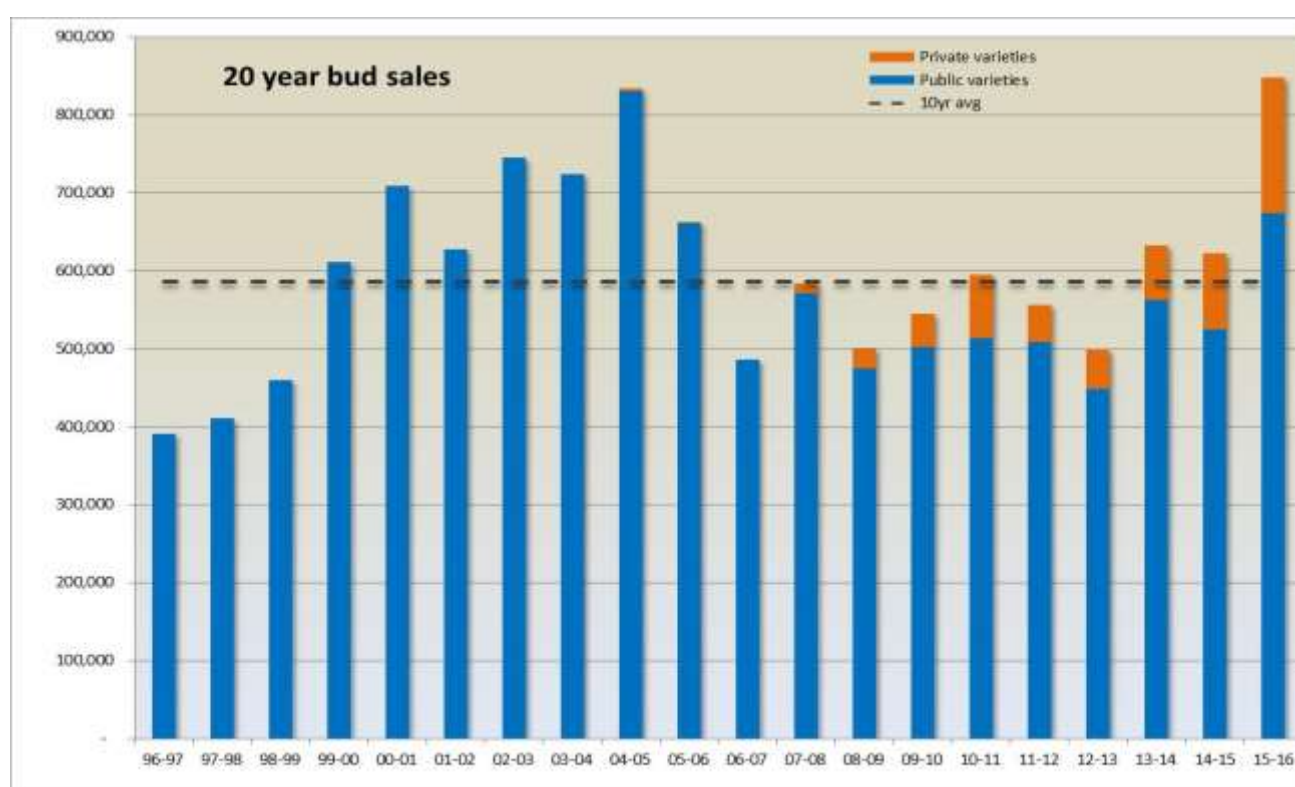
International Conference (non-refereed)

Graeme P Sanderson and Troy D Witte. *Evaluation of citrus varieties arising from natural mutation in Australia* (Poster). 13th International Citrus Congress, Brazil, 18–23rd Sept. 2016

Outcomes

Figure 8 demonstrates the expansion and adoption of new citrus varieties in Australia. The majority of new citrus varieties are now Plant Breeder's Rights (PBR) protected (private) and managed by local commercialisers. Auscitrus maintain high health status 'mother' trees of these new varieties and rapidly multiply budwood for distribution to approved nurseries for propagation and supply of trees to growers. There are contractual arrangements between commercialisers and growers who wish to plant these managed varieties. Royalty structures vary between varieties and variety managers and can relate to minimum area planted and the 'points' of royalty payment collection, such as at tree sale, on a planted hectare basis and a percent levy of the fruit sale returns. This new complexity in deciding what to plant is a decision the citrus farmer has to make with best available information. The new variety evaluation project provides rapid, independent information to assist growers in making the best commercial decisions to suit their future planning and citrus varietal mix.

Figure 8. Auscitrus budwood sales over a 20 year period 1996/97 – 2015/16



The Australian citrus industry is currently in an expansion phase with high demand for both budwood and rootstock seed from Auscitrus, along with tree orders at citrus propagation nurseries fully committed for several years. In the half year to 31st December 2016 private (new) varieties comprised 21% of total budwood sales/orders for Auscitrus which was at 847,068 buds. The 10 year average for budwood sales is expressed as a dashed line in Figure 8 and approximates to 586,000 buds pa. The combined new variety category is the highest in terms of budwood sales and highlights the expansion of managed and Plant Breeder's Rights (PBR) varieties in the Australian citrus industry. Varietal change has to occur in the Australian citrus industry to have fruit categories that meet current and future market demand. The international trend towards seedless citrus has seen a range of mandarin and orange varieties enter the program from overseas breeding programs. The 'convenience style' of citrus fruit which is low seeded/seedless, easy to peel and sweet is being met by additions to the program such as Gold Nugget, Summerina, Orri, Dekopon, RHM, Tang Gold and Nadorcott SL mandarins. The evaluation trial has the varieties established as nursery propagated and top worked trees which allow specific management practices to be tested and assessed. The trees also supply fruit for quality assessment and can be supplied to variety managers to

undertake market testing. Varieties which have been provided to variety managers for commercial display and market testing include Eureka SL lemon, Orri mandarin, Mandalate mandarin, Gold Nugget mandarin, C1867 tangor, Nouvelle tangor and Pomelit Pomelo.

The increasing demand for citrus with internal red/pink pigmentation has seen a surge in interest for varieties in the program such as Tarocco Ippolito blood orange (anthocyanin pigment) and Kirkwood Red navel (lycopene pigment). A late Cara Cara navel was provided by a Riverina citrus grower group in 2015 and produced its first fruit at the Dareton site in 2017. There is a high level of domestic and international interest in this natural mutation as it has the potential to extend the harvest season for the pink fleshed Cara Cara navel and increase export opportunities for Australian pigmented navels in the Asian market. A pink fleshed Valencia orange will also produce its first field fruit in 2018 and provides another pigmented orange choice for Australian growers. Early and late maturing Star Ruby grapefruit introduced from South Africa have also proven true to type from fruit produced in the NSW DPI Dareton hothouse in 2016. These pigmented grapefruit will also produce field fruit for evaluation in 2018.

The level of grower interaction through phone enquiry, individual farmer, small group, tour group and international visitors, along with demand for new variety presentations has increased during the term of the project. This highlights the current redevelopment and expansion phase of the Australian citrus industry and the desire to select and assess potential new citrus varieties that could meet local and export market demand.

The success of the on-going evaluation program has seen local citrus mutations nominated for inclusion in the trials. Most of these were identified by Australian citrus growers then 'passed' to a variety manager to handle their potential commercialisation in Australia and overseas.

Good working relationships with variety managers have been maintained and supported by new varieties continuing to enter the program to undergo independent evaluation by NSW Department of Primary Industries. Auscitrus has now re-entered the variety development field with the introduction of 5 early Japanese Satsuma mandarins. These were introduced into Australian Plant Quarantine in early 2017 and will be treated as public access varieties once released for evaluation.

The Australian citrus industry has expanded slightly between 2014 and 2016 to 24,053ha and is expected to increase based on the high number of trees under nursery propagation. The biennial Citrus Australia Tree Census now has new varieties such as Gold Nugget, Orri, low seeded Murcott, Summerina, and Afourer (seeded and seedless currently combined) mandarins, Kirkwood navel and Eureka SL lemon included in the National Variety List. This will continue to grow as Auscitrus production of private varieties in 2015/16 was the highest to date at 174,000 buds and expected to continue with the introduction of many new citrus varieties still to be evaluated.

Evaluation and discussion

An embargo was in place on the importation of citrus varieties into Australia up until 1986. After this date it was deemed that the plant health testing capability and technologies in Australia were sufficient to provide an effective quarantine barrier for serious citrus pest and disease incursions. There was an influx of public access varieties after this date with the first releases beginning in 1988. The embargo protected Australia from potentially devastating citrus diseases, but also put the local citrus industry many years behind the rest of the world in terms of variety development. Approximately 60 new varieties became available as public access with only 1 in 6 becoming a significant budwood sale item for Auscitrus. A lot of these new varieties were planted only to fail commercially and be removed or be top worked to another variety. Varieties released from Post Entry Quarantine (PEQ) since 1988 now comprise half of the public access varieties sold by Auscitrus. In the early 2000's another 'wave' of citrus introductions began with many as managed varieties with PBR protection. In 2004 a cooperative agreement was developed between Auscitrus, New South Wales Department of Primary Industries (NSW DPI), Horticulture Innovation Australia and citrus variety managers for NSW DPI to independently evaluate new citrus varieties introduced to Australia or found as local mutations. As a result of international commercial relationships, Australia now has access to purportedly the best new varieties being developed in overseas breeding and selection programs. This current project is the third in a series to independently evaluate the majority of these new varieties and local mutations under Australian growing conditions and present the results to the citrus industry.

The aim of the project has been to rapidly assess the local performance of new citrus varieties and transfer this information to industry. A perennial tree crop such as citrus is not considered to reach a bearing age until 4–6 years after planting. With the added nursery propagation phase to produce a tree this can be increased by several more years, particularly for new varieties released from PEQ. Often one or two small trees are released from PEQ and budwood obtained from these seedling trees must be rapidly multiplied to provide sufficient plant material for commercial nursery propagation. Another delaying factor is the need to confirm that the variety released is true to type which requires the production of fruit on nursery trees. The evaluation program is capable of having field grown fruit available for testing and presentation to industry 4 years from receiving budwood from PEQ. This also involves a multiplication phase in a heated glasshouse to generate budsticks for top working and produce fruit on potted trees for trueness to type assessment. With some varieties such as Afourer induced mutations (Tang Gold, Nadorcott SL) the time from budwood received to field fruit production has been 3 years. When graft sticks have been supplied direct from local citrus mutations fruiting can be as soon as 2 years from top working, as demonstrated by the Late Cara Cara navel. Several graft sticks were supplied in late March 2015 and top worked on the 2nd April 2015 with the tree producing sufficient fruit for quality assessment and presentation to industry in 2017.

The field evaluation phase is set at 4 harvests of fruit from top worked trees to determine fruit quality characteristics, maturity period and management issues associated with the variety. Top worked trees also provide a larger volume of fruit for potential yield assessment and supply of fruit to variety managers for market testing. The second crop of fruit on a top worked tree can be considered equivalent to yield from a 4–6 year old field planted nursery tree. When a top worked tree produces its 4th crop it can be considered a mature bearing tree. Varieties which create commercial interest are maintained past their 4th fruiting year, but others are typically removed by chainsaw back to the Valencia inter-stock and regrown for future top working. Varieties fail commercially for a range, and often combination of reasons, such as poor fruit quality, low productivity, seediness, tendency to granulate in a warm climate, tree thorniness, sensitivity to sunburn and the maturity period overlapping with popular established varieties. An example of a variety which did not progress past the first few harvests was Primosole mandarin from Italy. Fruit quality was poor with low sugar content and fruit dried internally (granulated) before full maturity in the warm Sunraysia climate. The potential harvest period was also very short and fruit quickly became puffy and too large to be considered an early mandarin on the Australian market. The project has a strong focus on showing citrus growers the trees and fruit grown to a high standard in an orchard

situation. Many commercial decisions have been made while viewing top worked new varieties for the first time at the Dareton trial site. Often the decision has been to not invest in establishing a particular new citrus variety when its local field performance has been presented, reinforcing the value of the program to citrus growing decision making.

During the term of the project evaluation was completed on 28 varieties with a further 20 entering the program. An additional 6 were hot house propagated in 2016 and 4 others from the University of California breeding program are due for release in 2017. Variety Access, which is linked to the Biogold International variety management group, has also introduced 7 new varieties to PEQ from the Korean breeding program in early 2017. Auscitrus also introduced 5 early Japanese Satsuma mandarins to PEQ for future evaluation and potential supply as public access varieties to the local industry. The Satsuma introduction was an outcome from a CAL sponsored citrus tour to Japan in 2013 to assess the market potential for very early maturing Japanese Satsuma varieties in Australia.

New varieties are and will continue to be introduced to Australia. Local citrus growers are also now more aware of the commercial potential of natural mutations being located on their properties. New variety development is a priority of many citrus producing countries and Australian citrus producers need to be up to date with international citrus market trends. There is currently a system in place to undertake independent and rapid evaluation of new varieties for the benefit of the Australian citrus industry. On-going funding will be sought to continue the program into the future and maintain the strong working relationship between Citrus Australia Ltd, NSW DPI, Auscitrus and variety commercialisers.

Recommendations

1. NSW DPI should continue its lead role in new citrus variety evaluation in Australia. The Dareton site is usually the first in Australia to produce field fruit of new citrus varieties in Australia allowing commercial decisions to be made at an early stage of variety assessment. The Dareton Agricultural Research Station has the expertise, experience and facilities to conduct intensive variety evaluation of new citrus varieties and present the results to local and interstate audiences.
2. The majority of new citrus varieties available for evaluation are now PBR protected and there is a need to maintain the current good working relationships developed with local variety managers. The aim of the program is to have the majority of new citrus varieties in Australia included in the independent evaluation program coordinated from Dareton.
3. Under the direction of the Citrus Australia Ltd (CAL) 'Variety Leadership Group' (VLG) coordinate with Auscitrus to import public access varieties to fill niche market opportunities for the Australia industry. Varieties to be imported should be determined by the VLG and then presented to Auscitrus Directors to shortlist selections and investigate funding options to meet quarantine costs.

Scientific refereed publications

Journal article

Sanderson, G.P., Treeby, M.T., 2014. Fruit yield of common orange varieties in south –east Australia; Initial evaluation versus long term performance. *Scientia Horticulturae* **180**, 111-117.

Conference Proceedings refereed paper

Sanderson, G.P., Creek, A., Lacey K., Wallace, M., 2015. New citrus variety evaluation in Australia 2005-2012. *Acta Horticulturae* **1065**, 201-208. In: Sabater-Munoz, B., Moreno, P., Pena, L., Navarro, L. (Eds), Proceedings of 12th International Citrus Congress, Valencia, Spain Nov. 18th -23rd, 2012.

Intellectual property/commercialisation

'No commercial IP generated'

Acknowledgements

I wish to acknowledge Troy Witte, Technical Assistant - NSW DPI for his on-going role in site management, fruit quality assessment, harvest and data collection at the Dareton Agricultural Research Station evaluation site. The farm operational staff at the station is also acknowledged for assistance with site management and harvest. Valerie Draper – Professional Officer, Project Support and Editing is also acknowledged for her work on development and production of the Citrus Variety fact sheets.

I also would like to acknowledge casual staff Julie Andrews (deceased) and Luke Kelly for their assistance in site and propagation nursery management along with their many hours of assistance in fruit quality assessment during the citrus season.

Appendices

A selection of new variety fact sheets are attached in a NSW DPI template format. All fact sheets (35) are to be finalised with disclaimers and data qualification prior to posting on the NSW DPI website in July 2017. Fact sheets will be updated and new ones added as additional information is generated from the variety evaluation program.

Attached sheets include:

Royal Honey Murcott (RHM)
Tang Gold mandarin
Hadass mandarin
Turkey Valencia
Kirkwood Red navel orange
Tarocco Ippolito blood orange
Eureka SL

NSW DPI disclaimer text

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Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing (June 2017). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of the Department of Primary Industries or the user's independent adviser.

Published by the Department of Primary Industries.

Disclaimer for Fruit Quality Table

Juice quality levels considered adequate for harvest and developed by sequential analysis of fruit from top worked evaluation trees

Disclaimer for Average yield per tree table results

Average yield per tree results are from a small number of evaluation trees and should only be used as a general indication of the variety's potential yield.

Royal Honey Murcott (RHM)

Draft 2017

Citrus variety factsheet

June 2017

Figure 1. RHM tree



Figure 2. RHM mandarins



Estimated maturity period

Region	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Sunraysia												

Origin

Queensland. Natural mutation from the central Burnett region. Variety manager: Variety Access

Fruit quality

Skin	Easy peel, orange, smooth. Maintains good external appearance with prolonged storage on the tree.
Average rind thickness (mm)	2.6
Internal quality	High juice content. Very low acid which gives a flat, insipid flavour for typical Australian palates.
Average seed number per fruit	0.6 (2016)
Juice per cent (%)	50
°Brix	11.0
Acid per cent (%)	0.55
Brix/acid ratio	20
Average fruit weight (gm)	117
Average fruit diameter (mm)	65

Comments

- First fruit produced in 2016 with a low seed count not typical for the variety. Seed count is higher in fruit produced in Queensland. Difficult climatic effects (high heat) during October 2015 may have affected pollination at the Dareton evaluation site as low seed counts were common in other varieties.
- Upright, very vigorous tree which will require specific management to develop a cropping habit. Limb girdling and the use of GA sprays at flowering helped to set fruit in 2015.
- Strong flowering and fruit set in October/ November 2016 will provide a large volume of fruit for southern Australia market testing.
- Asian fruit buyers familiar with RHM commercially produced in Queensland inspected and tasted a range of new mandarin varieties at the evaluation site in early July 2016 and favoured the RHM over other selections. Key criteria were the visual appearance of the fruit, low acid content with high juice, low seed number and medium fruit size.

Table 1. Fruit quality of RHM mandarin top worked to Valencia orange on Carrizo citrange rootstock, Dareton Primary Industries Institute, NSW 2016

Date	% Juice	°Brix	% Acid	Brix:Acid ratio	BrimA
6/5/2016	53	10.1	0.64	15.8	124
16/5/2016	55	10.0	0.67	15.0	121
27/5/2016	52	10.6	0.58	18.2	136
7/6/2016	47	10.2	0.51	19.9	135
21/6/2016	54	11.2	0.58	19.4	147
4/7/2016	51	11.2	0.46	24.3	154
18/7/2016	49	11.3	0.40	28.0	160
Mandarin Minimum Standard	35				110

The future market for this variety may be as an export mandarin to Asia.

Acknowledgments

Horticulture Innovation Australia Ltd (HIAL)

Department of Agriculture and Food, Western Australia (DAFWA)

Citrus Australia Ltd (CAL)

Variety Access

Tang Gold mandarin

Citrus variety factsheet

June 2017

Figure 1. Tang Gold mandarin tree



Figure 2. Tang Gold mandarins



Estimated maturity period

Region	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Sunraysia												

Origin

Irradiated selection of W. Murcott Afourer mandarin developed by the University of California. (PBR).
Variety manager: nuleaf IP Pty Ltd

Fruit quality

Skin	Easy peel, orange, smooth to slightly pebbled
Average rind thickness (mm)	3.3
Internal quality	Sweet flavour at maturity with good acid balance. Orange flesh colour.
Average seed number per fruit	0.1
Juice per cent (%)	44
°Brix	11.6
Acid per cent (%)	0.82
Brix/acid ratio	14.1
Average fruit weight (gm)	110
Average fruit diameter (mm)	66

Comments

- The first irradiated selection of W. Murcott Afourer released for commercial planting. Extensive plantings have occurred in the USA with the variety licensed and with a planting 'cap' in Australia.
- Strong international interest in Tang Gold with plantings to occur in China, Spain and several South American countries.
- Very low seeded, even under heavy pollination pressure at the Dareton, New South Wales evaluation site. Average seed count of 0.1 seeds per fruit in the first cropping season (2013) was similar to levels recorded in California. An assessment in 2015 gave an average seed count of 0.14 seeds per fruit from a sample size of 320 fruit.
- **Fruit production** began 3 years from top working to mature Valencia trees, as well as field planted nursery propagated trees.
- Tree habit is vigorous and initially upright, similar to W. Murcott Afourer.
- Initial maturity testing data suggests that Tang Gold may be earlier maturing than W. Murcott Afourer, due to a lower juice acid content.

Table 1. Average yield per tree on trees top-worked to Valencia orange

Rootstock	Average yield per tree (kg)			
	2013	2014	2015	2016
Citrange	30	20	67	59
Trifoliata	20	34	75	116
Cleopatra	15	17	24	47

Seedless fruit

W. Murcott Afourer can produce fruit without bee pollination and usually has near seedless fruit. Low seeded W. Murcott Afourer mandarin has become a major new variety for the Australia citrus industry.

Low seeded fruit is produced by:

- isolating commercial blocks from pollen viable citrus varieties
- growing trees under protective nets
- disrupting bee activity

Tang Gold mandarin does not require isolation from pollinating insects to achieve seedless fruit.

There is strong commercial interest in Tang Gold and the Australian planting cap is close to being met with any additional plantings to be determined by the variety manager and predominantly allocated to existing Tang Gold growers.

Acknowledgments

Horticulture Innovation Australia Ltd (HIAL)

Department of Agriculture and Food, Western Australia (DAFWA)

Citrus Australia Ltd (CAL)

nuleaf IP Pty Ltd

Hadass mandarin

Citrus variety factsheet

June 2017

Figure 1. Hadass mandarin tree



Figure 2. Hadass mandarins 2015



Estimated maturity period

Region	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Sunraysia												

Origin

Israel. Selected from open pollinated Ellendale mandarin seedlings. (PBR) Variety Manager: Variety Access

Fruit quality

Skin	Relatively easy to peel, orange/yellow, slightly pebbled
Average rind thickness (mm)	2.9
Internal quality	Dark orange colour with distinctive taste associated with Ellendale parent.
Average seed number per fruit	7 in 2015 and 1.6 in 2016, low seeded if isolated from other citrus with viable pollen
Juice per cent (%)	45
°Brix	12.3
Acid per cent (%)	1.1
Brix/acid ratio	11.2
Average fruit weight (gm)	137
Average fruit diameter (mm)	68

Comments

- Considered to be a late maturing variety with high eating quality.
- First Australian fruit produced in 2015 from top-worked Valencia trees. Fruit did not maintain its condition into the late September/October period.
- Fruit tended to granulate, with fruit condition deteriorating quickest on trees top-worked to Valencia with a Cleopatra mandarin rootstock. This could be related to the light crop and first fruiting of the variety in the warm Sunraysia region.
- Acid level remains high for a prolonged period.

Table 1. Fruit quality of Hadass mandarin top worked to Valencia orange on Carrizo citrange rootstock, Dareton Primary Industries Institute, NSW 2015

Date	% Juice	°Brix	% Acid	Brix:Acid ratio	BrimA
22/6/2015	51	10.4	1.37	7.6	81
29/7/2015	50	11.6	1.32	8.8	104
10/8/2015	48	12.4	1.18	10.5	126
20/8/2015	42	12.4	1.01	12.3	138
1/9/2015	46	12.2	1.07	11.4	131
Mandarin Minimum Standard	35				110

Table 2. Fruit quality of Hadass mandarin top worked to Valencia orange on Carrizo citrange rootstock, Dareton Primary Industries Institute, NSW 2016

Date	% Juice	°Brix	% Acid	Brix:Acid ratio	BrimA
7/6/2016	49	10.7	1.86	5.8	54
21/6/2016	52	10.7	1.62	6.6	70
4/7/2016	51	11.3	1.60	7.1	81
18/7/2016	52	11.8	1.57	7.5	91
29/7/2016	50	12.0	1.41	8.5	105
11/8/2016	49	11.9	1.34	8.9	108
29/8/2016	49	12.4	1.14	10.9	129
12/9/2016	41	11.9	0.98	12.2	132
22/9/2016	45	12.7	1.06	12.0	140
13/10/2016	32	12.4	0.78	15.9	153
Mandarin Minimum Standard	35				110

Commercial interest in Australia is low. The need to isolate trees from viable pollen to obtain seedless fruit is too difficult for most citrus growers.

Acknowledgments

Horticulture Innovation Australia Ltd (HIAL)

Department of Agriculture and Food, Western Australia (DAFWA)

Citrus Australia Ltd (CAL)

Variety Access

Turkey Valencia orange

Citrus variety factsheet

June 2017

Figure 1. Turkey Valencia orange tree



Figure 2. Turkey Valencia orange



Estimated maturity period

Region	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Sunraysia												

Origin

Turkey. Found in a Valencia orchard near Mersin, Turkey in 1987. Developed as a commercial variety in South Africa during the 1990's. (PBR) Variety manager: Variety Access

Fruit quality

Skin	Relatively easy to peel, orange/yellow, slightly pebbled
Average rind thickness (mm)	6.2
Internal quality	Consistently high juice content, soft flesh, good eating quality and low seed number help to differentiate Turkey from the standard Valencia orange
Average seed number per fruit	1.8
Juice per cent (%)	51
°Brix	10.6
Acid per cent (%)	0.92
Brix/acid ratio	11.6
Average fruit weight (gm)	270
Average fruit diameter (mm)	82

Comments

- First fruit production in Australia 2014, from top worked trees.
- Early maturity, high eating quality and large fruit size features of the first crop.
- Turkey commercialised in South Africa under the trade name Juvalle® meaning 'juicy Valencia'.
- Considered a dual purpose orange; suitable for both the fresh fruit and fresh juice markets.
- South African experience suggests Turkey Valencia is a heavy bearing variety with a consistent cropping pattern.
- Maturity in South Africa is considered to be 6 weeks earlier than Valencia orange and the initial fruit quality tests in Australia confirm that Turkey can be added to the early Valencia group of selections currently in Australia such as Midnight, Delta and McMahon.

Table 1. Average yield per tree on trees top-worked to Valencia orange, Dareton 2011

Rootstock	Average yield per tree (kg)		
	2014 (3-yr-old trees)	2015 (4-yr-old trees)	2016 (5-yr-old trees)
Carrizo citrange	Approx. 40	91	74
Trifoliata	Approx. 40	56	91

Table 2. Fruit quality Turkey Valencia orange top-worked to Valencia orange on Carrizo citrange rootstock, Dareton Primary Industries Institute, NSW, 2014 - 2015

Date	% Juice	°Brix	% Acid	Brix:Acid ratio	BrimA	Date	% Juice	°Brix	% Acid	Brix:Acid ratio	BrimA
23/5/2014	48	8.9	1.44	6.2	52	17/7/2015	51	10.4	2.02	5.2	39
3/6/2014	49	10.0	1.36	7.4	75	29/7/2015	52	10.7	1.78	9.1	99
12/6/2014	47	9.2	1.25	7.4	69	10/8/2015	52	11.2	1.13	9.9	110
26/6/2014	53	9.6	1.24	7.7	76	20/8/2015	49	10.5	1.02	10.3	106
14/7/2014	50	9.4	1.07	8.8	85	1/9/2015	44	10.4	0.97	10.7	107
23/7/2014	49	10.2	1.20	8.5	89	11/9/2015	48	10.2	1.01	10.1	102
13/8/2014	51	10.1	1.09	9.2	94	2/10/2015	48	10.9	0.83	13.2	125
1/9/2014	48	9.8	1.10	8.9	89	19/10/2015	47	10.3	0.74	14.0	121
17/9/2014	51	10.6	0.92	11.6	114						
7/10/2014	49	11.1	0.95	11.7	121						
Orange Minimum Standard	38	9.0		9	90		38	9.0		9	90

Date	% Juice	°Brix	% Acid	Brix:Acid ratio	BrimA
7/6/2016	46	10.3	1.34	7.7	81
21/6/2016	47	11.2	1.28	8.8	100
4/7/2016	50	11.0	1.17	9.4	104
18/7/2016	48	10.8	1.13	9.5	103
29/7/2016	47	11.2	1.08	10.4	113
11/8/2016	49	11.6	1.04	11.1	123
29/8/2016	48	11.5	0.97	11.9	126
12/9/2016	52	12.5	0.92	13.6	145
22/9/2016	50	12.4	0.88	14.1	147
13/10/2016	47	12.4	0.77	16.1	154
31/10/2016	43	12.0	0.76	15.9	148
Orange Minimum Standard	38	9.0		9	90

Initial fruit quality tests in Australia confirm that Turkey can be added to the early Valencia group of selections currently in Australia, such as Midnight, Delta and McMahon.

Acknowledgments

Horticulture Innovation Australia Ltd (HIAL)

Department of Agriculture and Food, Western Australia (DAFWA)

Citrus Australia Ltd (CAL)

Variety Access

Kirkwood Red navel orange

Citrus variety factsheet

June 2017

Figure 1. Kirkwood Red navel orange tree



Figure 2. Kirkwood Red navel oranges



Estimated maturity period

Region	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Sunraysia												

Origin

South Africa. Limb mutation of Palmer navel orange. (PBR) Variety manager: Variety Access

Fruit quality

Skin	Easy to remove at full maturity; orange to dark orange colour; slightly pebbled
Average rind thickness (mm)	5.2
Internal quality	Good sugar acid balance with a high juice content. Distinctive, pleasant flavour likely related to the lycopene pigmentation in the flesh.
Average seed number per fruit	Usually nil but an occasional seed can be found in some fruit
Juice per cent (%)	52
°Brix	11.1
Acid per cent (%)	0.91
Brix/acid ratio	12.2
Average fruit weight (gm)	270
Average fruit diameter (mm)	81

Comments

- A red fleshed navel orange mutation similar to the Cara Cara navel, but discovered on a Palmer Washington navel orange from the Eastern Cape region of South Africa. Some fruit grown in South Africa has a slight external red blush, which helps to distinguish it as a red fleshed navel.
- Fruit was produced in Australia on top worked Valencia trees in 2014, but no blush evident with first crop. Fruit set was throughout the canopy, but no blush occurred even on fruit held long past its ideal maturity period. The ability to produce an external skin blush under Australian growing conditions will be assessed with subsequent crops.
- Kirkwood Red fruit maintained its condition and adherence to the tree for an extended period, which supports the South African conclusion that it is slightly later maturing than the Cara Cara navel.

Table 1. Average yield per tree on trees top-worked to Valencia orange

Rootstock	Average yield per tree (kg)		
	2014	2015	2016
Trifoliata	44	66	70
Cleopatra	47	72	98

Table 2. Fruit Quality of Kirkwood navel orange top-worked to Valencia orange on *Poncirus trifoliata* rootstock, Dareton Primary Industries Institute, NSW. 2014 - 2016

Date	% Juice	°Brix	% Acid	Brix:Acid ratio	BrimA	Date	% Juice	°Brix	% Acid	Brix:Acid ratio	BrimA
24/4/2014	46	8.5	1.20	7.1	61	11/6/2015	50	10.4	1.00	10.4	105
2/5/2014	50	9.0	1.15	7.8	72	22/6/2015	49	11.0	1.02	10.7	114
12/5/2014	51	9.2	1.13	8.1	77	9/7/2015	47	11.2	0.93	12.0	123
23/5/2014	54	9.6	1.02	9.4	91	17/7/2015	49	11.3	0.91	12.4	126
3/6/2014	51	9.7	0.90	10.7	100	29/7/2015	49	11.5	0.87	13.2	132
12/6/2014	56	10.2	1.01	10.1	102	1/9/2015	47	12.1	0.84	14.3	144
26/6/2014	56	10.4	0.93	11.2	110						
14/7/2014	52	11.1	0.91	12.2	123						
30/7/2014	51	11.2	0.93	12.1	124						
13/8/2014	52	11.6	0.88	13.2	134						
1/9/2014	56	11.7	0.80	14.6	140						
Orange Minimum Standard	38	9.0		9	90	Orange Minimum Standard	38	9.0		9	90

Date	% Juice	°Brix	% Acid	Brix:Acid ratio	BrimA
26/4/2016	47	10.4	1.13	9.2	97
6/5/2016	50	10.7	1.01	10.6	110
16/5/2016	51	11.0	1.08	10.2	111
27/5/2016	50	11.6	0.97	11.9	127
7/6/2016	49	11.4	0.95	12.0	125
21/6/2016	50	11.8	0.93	12.6	133
4/7/2016	47	12.4	0.87	14.2	147
18/7/2016	48	12.3	0.90	13.6	143
29/7/2016	48	12.0	0.78	15.4	146
Orange Minimum Standard	38	9.0		9	90

Kirkwood Red navel could help to extend the commercial Cara Cara navel harvest period by several weeks, but its promise of a differentiating external blush has not been observed in Australia to date.

Acknowledgments

Horticulture Innovation Australia Ltd (HIAL)

Department of Agriculture and Food, Western Australia (DAFWA)

Citrus Australia Ltd (CAL)

Variety Access

Tarocco Ippolito blood orange

Citrus variety factsheet

June 2017

Figure 1. Tarocco Ippolito blood orange tree



Figure 2. Tarocco Ippolito blood oranges



Estimated maturity period

Region	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Sunraysia												

Origin

Italy, mid-season Tarocco blood orange selection. (Public) Auscitrus

Fruit quality

Skin	Orange to red/orange at full maturity; smooth to slightly pebbled; rind easily removed at full maturity. External red skin blush not on all fruit.
Average rind thickness (mm)	4.9
Internal quality	Anthocyanin development superior to both Tarocco Rosso and Tarocco Meli. Flavour is similar to that associated with the Arnold blood orange, but not as intense. Ippolito could be consumed as both fresh fruit and juice.
Average seed number per fruit	0.1
Juice per cent (%)	55
°Brix	10.0
Acid per cent (%)	0.93
Brix/acid ratio	10.8
Average fruit weight (gm)	290
Average fruit diameter (mm)	83

Comments

- A mid-season maturing Tarocco selection with fruit capable of remaining in good condition on the tree longer than Tarocco Rosso.
- Internal and external pigmentation (anthocyanin) developed naturally in the field trials in 2012 (strong contrast to the other two Tarocco selections Rosso and Meli).
- Cool storage of fruit (5°C for several months) after harvest intensified the internal anthocyanin pigmentation with minimal reduction in fruit quality.
- Trees lack thorns (easier to harvest than Tarocco Rosso and Meli).
- Cit-tite® growth regulator to hold fruit on the tree longer could help to improve the internal sugar to acid ratio.
- Fruit was beginning to fall naturally from the trees in late August 2012, but there was no obvious deterioration in rind quality or 'off-flavours' in the fruit.
- Fruit size larger than the Arnold blood orange (dominant blood orange on the Australian fresh fruit market).
- Potential exists as a blended juice product to improve the quality of Moro blood (Arnold blood) orange juice.
- Large juice processor interest could stimulate the uptake of Tarocco Ippolito as it would ensure an outlet for 'over-run' fruit.
- Strong red pigment development in 2015 related to very cool winter conditions.

Longer term yield characteristics in Australia of Tarocco Ippolito are yet to be determined.

Table 1. Average yield per tree on trees top-worked to Valencia orange

Rootstock	Average yield per tree (kg)				
	2012	2013	2014	2015	2016
Citrance	15	74	41	95	77
Trifoliata	23	63	32	79	62
Cleopatra	3	75	38	109	34

Commercial interest is being shown in Tarocco Ippolito mainly due to its ability to produce anthocyanin pigmentation in 'warmer' regions, its thornless nature and larger fruit size than Arnold blood orange.

Acknowledgments

Horticulture Innovation Australia Ltd (HIAL)

Department of Agriculture and Food, Western Australia (DAFWA)

Citrus Australia Ltd (CAL)

Auscitrus

Eureka SL lemon

Citrus variety factsheet

June 2017

Figure 1. Eureka SL lemon tree



Figure 2. Eureka SL lemon



Estimated maturity period

Region	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Riverina												
Sunraysia												

Origin

South Africa. Irradiated, seedless Eureka lemon. (PBR). Variety manager: ANFIC

Fruit quality

Skin	Smooth, fine textured and yellow at full maturity
Average rind thickness (mm)	5.8
Internal quality	Flesh is greenish/yellow, medium juice content with high acidity
Average seed number per fruit	0
Juice per cent (%)	43
°Brix	7.8
Acid per cent (%)	5.6
Brix/acid ratio	1.4
Average fruit weight (gm)	197
Average fruit diameter (mm)	70

Comments

Tree: Medium vigour, spreading tree. Fruit tends to set in terminal clusters, which is typical of Eureka. A range of fruit stages on the trees, due to the extended flowering characteristic of lemons.

Fruit: Totally seedless. Initial juice quality tests suggest it is earlier maturing than its parent Eureka lemon.

- Exposed fruit is very sensitive to sunburn in hot southern Australia conditions.
- Extreme heat conditions occurred at the Sunraysia evaluation site during late January and early February 2009, when temperatures exceeded 41°C for 13 consecutive days (average temperature 44°C). Extremely high and sustained air temperatures caused significant burn to exposed fruit, as well as internal desiccation of fruit within the canopy. The effects were most severe on young seedling trees under drip irrigation that had not yet developed a large canopy similar to top-worked trees.
- The heavy crop load on top-worked trees in 2009, combined with high air temperatures during mid-November, affected fruit set and retention of the 2010 crop.

Table 1. Average yield per tree on nursery propagated field trees (Sunraysia site)

Rootstock	Average yield per tree (kg)		
	2011 (6-yr-old trees)	2012 (7-yr-old trees)	2013 (8-yr-old trees)
Benton citrange	81	30	60
Cox hybrid	73	54	98

Table 2. Average yield per tree on nursery propagated field trees (Queensland site)

Rootstock	Average yield per tree (kg)		
	2011 (6 yr old trees)	2012 (7 yr old trees)	2013 (8 yr old trees)
Benton citrange	72	108	155
Cox hybrid	74	130	175

Table 3. Average yield per tree from trees top-worked to Valencia orange in 2005 (Sunraysia)

Rootstock	Average yield per tree (kg)							
	2009	2010	2011	2012	2013	2014	2015	2016
Citrangle	96	22	170	120	99	106	134	88
Trifoliata	58	18	120	76	83	74	91	68
Cleopatra	41	20	129	90	49	73	99	33

A high level of enquiry began in 2012 and 2013 about seedless lemons for southern Australia, due to citrus growers looking at other variety options. This interest has been maintained to 2016.

Acknowledgments

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ANFIC (Australian Nurserymen's Fruit Improvement Company)