Australian Processing Tomato Research Council Inc.

Australian Processing Tomato Grower

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Hort Innovation
Strategic levy investment

PROCESSING TOMATO FUND

AUSTRALIAN PROCESSING TOMATO GROWER

ISSN 1322-8617 VOLUME 43, 2022

APTRC Committee meeting in Echuca. Absent: James Weeks and Sean Kennedy.

FINANCE REPORT - 2021/22	APTRC Account (Audited)	Hort Inn Account (Unaudited)
INCOME		
Levies	111,269	111,269
Interest Received	2,304	22
Donation/Loan forgiven		31,000
Total Income	***113,573***	***142,291***
EXPENDITURE		
Accounting	959	
Bank Charges	30	30
Depreciation	10,863	
Donation - Development Manager	1,912	
Donation - Hort Innovation	31,000	
Grower Levies - Hort Innovation		118,186
Memberships & Subscriptions	1,500	
Project - Soil Moisture Characteristics	20,886	
Projects - ANU - Gasification	20,000	
Projects - Deakin University Irrigation	34,000	
Projects - Global Tomato Foundation	16,589	
Projects - Melbourne University PhD Hanyue	10,000	
Total Expenses	***147,739***	***118,216***
Net Surplus/(Deficit)	***(34,166)***	***24,075***

Cover Photo

Annual APTRC Forum, taken by Matthew Stewart.

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INTRODUCTION

The APTRC is once again pleased present this publication as a record of the industry's research and development program and major events. We also thank all the businesses and agencies that support these activities.

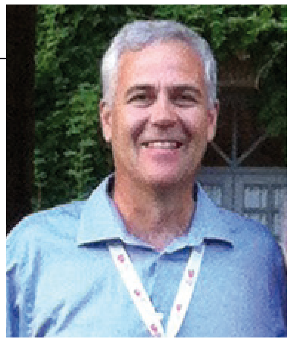
Editors Matthew Stewart and Bill Ashcroft APTRC Inc
Design and Printing Willprint Shepparton

The project [Australian Processing Tomato Industry Development and Extension Program (TM20000)] which includes the production of this magazine has been funded by Horticulture Innovation Australia Limited with co-investment from Australian Processing Tomato Research Council Inc. and funds from the Australian Government.

Notice to Contributors:

Authors wishing to contribute articles to the next 'Australian Processing Tomato Grower' should submit copy to IDM, Matthew Stewart at APTRC Inc., aptrc.idm@outlook.com NO LATER THAN June 30, 2023.

APTRC – Chairman's Report 2021/22



Charles Hart, Chair, Australian Processing Tomato Research Council Inc.

For the third consecutive season, the processing tomato industry experienced difficulties resulting from the pandemic. Although widespread lockdowns had ceased, the difficulty with workforce shortages continued. There were numerous challenges with individual Covid-positive absences and a lack of itinerant workforce to adequately meet harvest requirements both in the field and the factory. This unfortunately contributed to delays in harvest schedules and processing timelines.

The season's harvest was significantly hampered by rainfall events from mid-April onwards, effectively reducing yields and quality until it was declared that some remaining fields would be ultimately un-harvestable.

The new season has begun with the declaration of a third La Niña weather event and promise of another wet season, at least to begin with, bringing with it a challenge of managing a later than ideal harvest window once again.

The 2021/22 season saw growers deliver a total of 226,439 tonnes of processing tomatoes, which is a moderate decrease on the 2020/21 season. Although early season yields were impressive, the average yield recorded across industry for the season tallied at 99.1 t/ha, which is down noticeably from last year's record high.

Both the Boort/Boga and Rochester District crop inspection days were successfully held and given the recent R&D focus on irrigation; the discussions centred around individual and collective irrigation strategies. The accompanying dinner events were held at the Boort Tennis Club and Moama Bowling Club pavilion respectively and again provided a valuable opportunity for industry members to socialise and connect.

The highlight of the season for the APTRC was without a doubt the 2021/22 Annual Processing Tomato Forum in May. After pulling together a virtual forum in 2021, our IDM Matt Stewart got to spread his wings this year and put on a face-to-face event. The daytime forum and evening dinner were held at the Moama Bowling Club, a first-class setting befitting our collection of respected and talented growers, processors, and industry support network.

At the forum we heard about promising varieties in the pipeline from the APTRC's trial program as well as TM20000 activities planned for the season ahead. We learned about new irrigation monitoring approaches from Kagome and Kilter farms and had a re-cap on our recent irrigation R&D from Sam North of NSW DPI. Finally, we were able to hear from our partnering researchers on their work, with opportunity for participants to connect directly with them and discuss industry issues.

In the R&D space, industry partnered with Deakin University once again, this time to assist them in developing an algorithm for 'Tomato flower classification using machine learning'. This project forms a first step in potentially automating the flower selection process for hybrid variety breeding in the future. The project still requires further industry involvement if it is to progress, however with the help of Ann Morrison's extensive photo library, captured during the season, they have an ideal start.

Our studies into soil borne diseases through the University of Melbourne are back up and running with the return of PhD student Hanyue Feng to the country after a lengthy delay due to pandemic restrictions. Hanyue outlined her research plans to the forum, focusing on the impact of *Fusarium oxysporum* on tomato crops in studies that will further advance our knowledge on this important subject area.

Seed importation was a challenge once again this season, and in a further initiative to address the seed supply issue, Matt on behalf of the APTRC gained membership to the Australian Seed Federation (ASF) and attended their annual conference in June. With closer industry ties to seed industry personnel, the APTRC aim to do whatever they can to advance the collective efforts of industry to improve the importation process.

This was the first year of our TM20000 Development and Extension project and with a new strategic plan in place, the APTRC are focussing in on our key priority areas of seed, disease and sustainable growing. Our regional manager from Hort Innovation, Adrian Englefield again proved to be a valuable resource for connecting with industry, helping Matt get the new project underway and keeping the industry partnership on track.

It was pleasing to see our grower numbers swell slightly with the return of Stotts' to the industry.

This highly skilled growing family, operated now by Andrew Stott will add further to the capacity and resilience of our industry.

Once again, I would like to thank the growers and processors for their assistance and cooperation in facilitating the APTRC trial program, especially under tough harvest conditions like those at the end of last season, where resources can be stretched. I also wish to thank Matt and Ann, with assistance from Bill and the volunteer committee members for their continued enthusiastic support of our industry members.

Update from Hort Innovation

Adrian Englefield – Industry Services and Delivery Manager

Led by Matt Stewart and Ann Morrison with support from Bill Ashcroft, the *Processing Tomato industry development and extension* (TM20000) project is the only processing tomato project funded by Hort Innovation, using a voluntary research and development levy, funds from the Australian Government and in-kind contributions from the APTRC.

In the Hort Innovation Processing Tomato Fund Annual Report 2021/22 you can read about the cultivar trial program within the *Processing Tomato industry development and extension* (TM20000) project, including several new, high-performing cultivars that are suitable to match or potentially replace the older 'mainstay' cultivars. Matt Stewart discusses the extension of these findings to the processing tomato industry and second-generation grower; David Chirnside, provides his insights from the cultivar trials and shares his experiences growing with support from the APTRC.

The Hort Innovation processing tomato financial operating statement for 2021/22 (below) is also included in the report.

Fund Annual Reports from the 37 Hort Innovation industries are also available on the Hort Innovation website.

I encourage you to have a read of the Hort Innovation Annual Report 2021/22. Information includes a background to Hort Innovation – who we are and how we operate, consult, invest, work with our partners and report. Last year Hort Innovation invested over $125.9 M in levies, Australian Government contributions, grants and co-investment. Soon the process of engagement and consultation to develop the next company strategy will start. Hort Innovation looks forward to your insights.

With the recent Hort Innovation restructure, I have started a new role as the Industry Services and Delivery Manager (Citrus and Berries). I would like to introduce Jason Hingston as the Industry Services and Delivery Manager for Processing Tomatoes. Jason is based in the Yarra Valley and has an extensive knowledge of the Victorian Horticulture sector from previous agronomy roles.

If you have any questions or would like to discuss anything with Hort Innovation, please feel free to call:

- Adrian Englefield on 0427 143 709 or email adrian.englefield@horticulture.com.au

- Jason Hingston on 0429793496 or email Jason.hingston@horticulture.com.au

Processing Tomato Fund (collective)
Financial operating statement 2021/22

	R&D ($)	Total ($)
	2021/22 July – June	2021/22 July – June
OPENING BALANCE	**-30,816**	**-30,816**
Voluntary levies from growers	118,186	118,186
Australian Government money	273,923	273,923
Other income*	–	–
TOTAL INCOME	**392,109**	**392,109**
Project funding	481,556	481,556
Consultation with and advice from growers	–	–
Service delivery	66,289	66,289
TOTAL EXPENDITURE	**547,845**	**547,845**
Levy contribution to across-industry activity	–	–
CLOSING BALANCE	**-186,552**	**-186,552**
Levy collection costs	–	–

* Interest, loyalties

Levy collection costs – These are the costs associated with the collection of levies from industry charged by Levy Revenue Services (LRS)
Service delivery – Also known as Corporate Cost Recovery (CCR), this is the total cost of managing the investment portfolio charged by Hort Innovation

Annual Industry Survey 2022

Matthew Stewart

Executive Summary

The annual industry survey provides a year-on-year comparison, detailing industry performance in the current year compared with the previous one.

The data also tells the 'story' of Australian production and international trade over a longer period of time, supporting analysis of where the industry is headed, for example in terms of grower numbers, production, and location.

In previous iterations of this survey, the long-term perspective has been portrayed by APTRC to get a more complete, historical idea of the industry's trajectory. This could create the impression that the processing tomato industry is in continuous decline, of grower numbers, total growing area, and total production.

When focus shifts to the past 10 years however, the story looks vastly different to the decades long perspective and describes a resilient and robust industry. The shorter reference period also allows us to better see the subtleties of the last 10 years, which are sometimes missed within the larger range of figures.

Over recent years, the data portrays how industry has managed to stabilise its production levels in terms of average yields and soluble solids. It shows that the industry maintains production each season around the 200,000-tonne mark (climate notwithstanding) with a reasonably stable core group of specialized tomato growing enterprises and processors. The industry over the past 10 years demonstrates how it consistently manages to harvest and process over 90% of its planted area every season, which is impressive considering the challenges faced by growers and processors to coordinate growing schedules and harvest delivery operations.

During the 2021/2022 season, twelve growers produced 226,439 tonnes of processing tomatoes, a slight decrease on the volume grown in 2020/21, and the crop was again processed by three companies.

Some 2480 hectares were planted, with total use of sub-surface drip irrigation. The use of transplants decreased slightly to 85% of the total area under production, with seeded tomatoes making up the remaining 15%.

In 2021/22, the Australian processing tomato industry achieved an average yield/ha of 99.1 tonnes and 93% of planted area was harvested, which was a less than ideal outcome. However, considering the difficult harvest period, these figures still demonstrate the overall robust nature of Australian growers, and their ability to grow high performing and resilient crops.

Soluble solids averaged 5.1%, which continues the trend of recent years where solids have been consistently above the 5.00% benchmark. These impressive solids figures are a combination of good cultivars (often selected from the APTRC field trial program) and good crop management (a testament to the core grower skill level in irrigation, nutrition and overall crop husbandry).

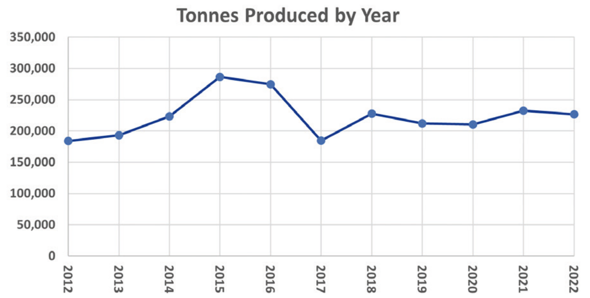
On the international scene, imports of processed tomato products into Australia decreased during the 2021 calendar year but are still at an elevated level compared to previous years. Exports of Australian processed tomatoes increased in 2021, and now, when viewed on a raw tonne equivalent basis, represent about one quarter of all Australian production.

Total Australian domestic consumption dropped slightly in 2021, however it was supplied by an increased percentage of local product, which is beneficial for Australian processors. Ideally a trend toward domestic consumption of more local product will continue in the coming years.

After a spike in 2020, Australian consumers returned to their long-term average consumption of 23 kg/capita of processed tomato products, in equivalent raw weight. On a positive note, this figure remains among the highest consumption of tomato products per capita in the world.

2 Industry Size

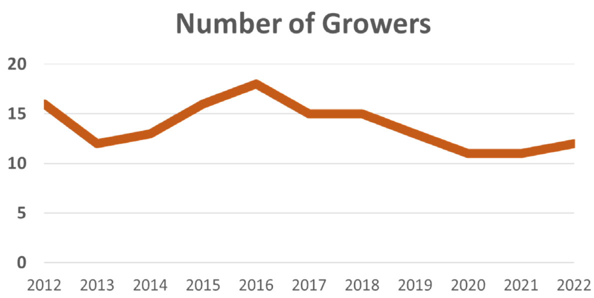
2.1 Volume



1-1: Paid tomato volumes delivered (tonnes)[1] (APTRC)

Growers produced 226,439 tonnes of processing tomatoes during the 2021/22 season, with the bulk of demand coming from the two major processing operations in Australia. Contained in the total production figures are organically grown tomatoes, which contributed 3,901 tonnes of produce (an increase on the previous season), as well as 357 tonnes of cherry tomatoes.

2.1 Producers



2-2-1: Number of growers (APTRC)

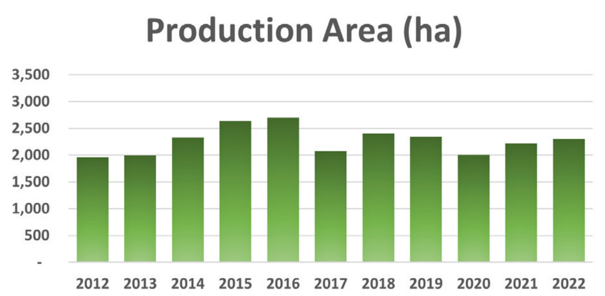
Grower number increased to 12 specialist businesses for the 2021/22 processing tomato season, spread mainly across Northern Victoria, with a lesser number growing in Southern NSW.

2.3 Processors

As in the previous season, the crop was processed by three businesses, with Kagome (79%) and SPC (19%) taking most of the harvest.

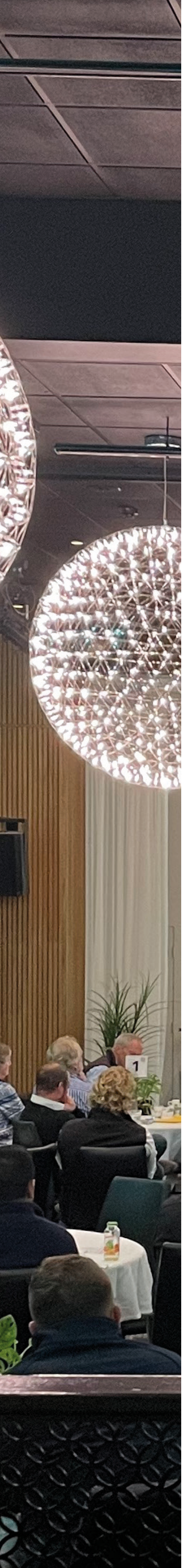
2 The Crop

3.1 Area and management



3-1-1: Planted production area (ha) (APTRC)

The area under production increased to 2,478 hectares, of which 93% was harvested. The larger area planted this season reflected the growth in global demand as well as increased capacity in Australia from some growing enterprises.



Season	Transplanted	Seeded
2010/11	79%	21%
2011/12	81%	19%
2011/13	72%	28%
2013/14	59%	41%
2014/15	68%	32%
2015/16	69%	31%
2016/17	86%	14%
2017/18	88%	12%
2018/19	91%	9%
2019/20	86%	14%
2020/21	90%	10%
2021/22	85%	15%

3-1-2: Proportions of transplants vs seed by area grown (APTRC)

This season, the crop was again fully grown under sub-surface drip irrigation, which is likely to remain the status quo for the Australian industry.

There was an increase in the proportion of seeded crop grown this season, due to an increase in production in the Boort region in Victoria. The Boort region is still the only area direct-seeded and represented 15% of the total industry by area in 2021/22.

Area and Production by State	VIC	NSW
Area Planted	71.0%	29.0%
Tomato Volume Processed	75.4%	24.6%

3-1-2: Proportions of transplants vs seed by area grown (APTRC)

In the 2021/22 season, NSW contributed 24.6% of the total volume processed but accounted for 29% of the total area planted. There are many reasons why the planted area totals and production levels may not align exactly by state; including time of harvesting, yield potential of the growing system, soil type and of course the vagaries of climate influence across the season.

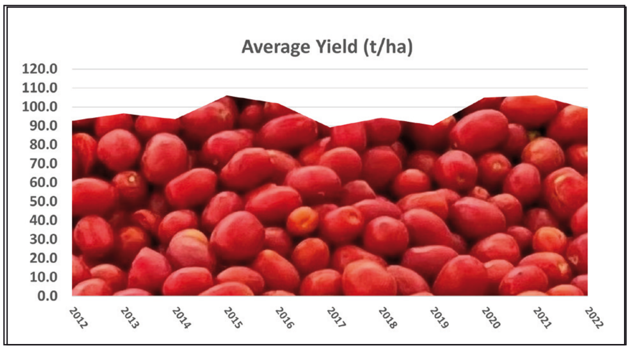
3.2 Yield

Season	Area (ha)	Area (ha)	Harvested	Average Yield	Seasonal Comments
	Planted	Processed	Area %	t/ha	
2012/13	1999	1998	100%	96.6	Wet, late harvest
2013/14	2386	2330	98%	93.6	Wet, late harvest
2014/15	2700	2635	98%	106.1	Early crop failure
2015/16	2782	2697	97%	101.9	Poor crop stand, delayed harvest, over-contract fruit
2016/17	2183	2071	95%	89.2	Delayed harvest due to rain
2017/18	2457	2407	98%	94.4	Abandoned due to factory power outage and resulting delay
2018/19	2347	2347	100%	90.3	Extreme bacterial speck, high temperatures
2019/20	2073	2003	97%	105.1	Hot and windy during growing; late harvest rains

Season	Area (ha)	Area (ha)	Harvested	Average Yield	Seasonal Comments
	Planted	Processed	Area %	t/ha	
2020/21	2215	2215	100%	106.13	Dry start, strong winds mid spring, some hail, mild summer
2021/22	2480	2300	93%	99.1	Delays from staff scarcity and crops abandoned due to wet finish

3-2-1: Average yield, harvest conditions (MT/ha) (APTRC)

The 2021/22 season saw a decrease in overall yield average. This was due primarily to delayed harvests. In the first instance, the harvest delays were due to a slower than ideal harvest resulting from stilted processing operations and harvesting complications. This was due in large part to the great challenge faced by all of horticulture in 2021/22, which was a lack of available itinerant and local seasonal staff. In the second instance, rainfall from mid-April onwards further delayed harvest operations and ultimately left 180 ha of crop in the field.

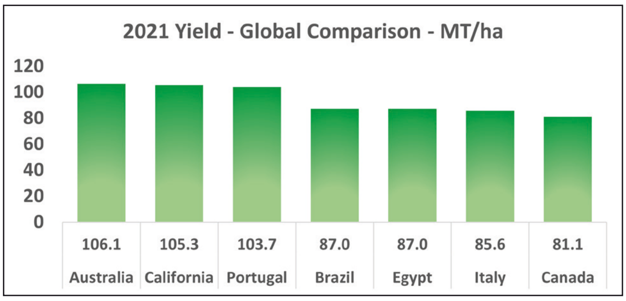


3.2.2: Average yield (t/ha) (APTRC)

Even with the challenge of labour and seasonality, the industry recorded an average yield of 99.1 tonnes per ha, which by global standards is still an exemplary outcome.

The industry has been aiming to shift the harvest schedule to earlier in the season, with the goal of avoiding harvest delays and minimising the chance of abandoned crops due to overripe fruit or poor paddock conditions. With the pandemic-related staffing issues in labour largely past us now, hopefully the harvest recovery will return to near 100% in the coming seasons.

The industry is focussed on ever higher yields and solids to stay competitive internationally and to maintain grower profitability and sustainability. The ongoing annual industry cultivar evaluation trials and research into root disease are some of the current actions the APTRC and the Australian processing tomato industry are undertaking to help achieve ever higher yield outcomes.

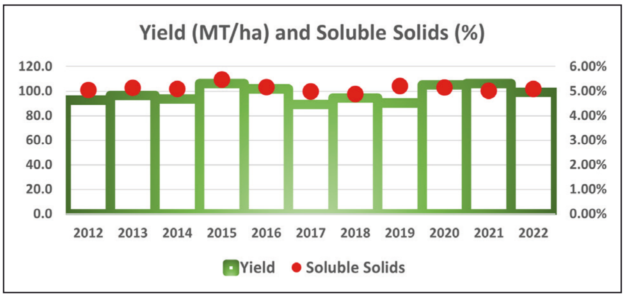


3.2.3: 2021 average yield (MT/ha), by country (Colvine)

Note: To get the most accurate global comparison, data for international production is a season behind and in this report, represents the previous season (2020/2021). This is due to availability of data from the Northern Hemisphere.

Australia achieved a record high of 106.13 tonnes per ha in 2021, which was slightly above figures for California and Portugal. Brazil, Egypt, Italy, and Canada were all close behind with strong industry averages.

3.3 Soluble Solids



3.3.1: Soluble solids (%) and yield (t/ha) (APTRC)

Average soluble solids for the season were 5.1%, which is above the minimum benchmark of 5.0% preferred by processors. The past decade of results shows that the minimum soluble solids benchmark is being met (or very close to it) every season.

CULTIVARS	Percentage of Total Area Grown	
	2021/22	2020/21
H3402	35.0%	18.5%
UG19406/UG16112	16.1%	14.6%
H1015	8.2%	9.0%
H1311mix	8.1%	16.7%
H3402mix	7.6%	17.0%
H1014	4.6%	5.6%
UG4014	4.0%	0.3%
SVTM9024	3.3%	0.0%
SVTM9000	3.1%	0.5%
H1311	2.5%	5.6%
H3406mix	2.4%	0.0%
H1301	2.1%	0.0%
H3406	1.5%	0.0%
UG16112	1.0%	0.6%
TCP94829 (Cherry Tomatoes)	0.3%	0.0%
HM58811	0.2%	0.0%
H1175mix	0.0%	7.8%
H4401	0.0%	3.3%
H1428	0.0%	0.3%

3.4.1: Cultivar by proportion of total area

When comparing the 2020/21 and 2021/22 seasons, there were some significant shifts in the balance of cultivars grown by area. Many factors influence the dominance of cultivars being grown from season to season and may reflect a change in bias towards customer requirements, upgrading of processing infrastructure, new market access or loss of previous markets, seasonal harvesting logistics and agronomic suitability to growing region and soil type.

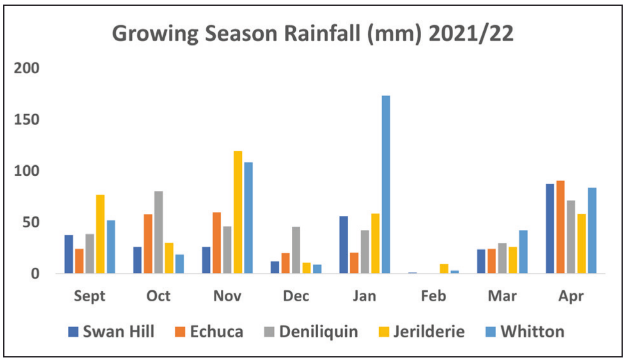
One major example of this in the 2021/22 season was a shift away from the blending of cultivars in field to attain a desirable processing outcome. With the introduction of alternative processing techniques, the mixing of cultivars has become less important and hence more pure cultivars were planted.

The other notable observation from these trials is that the range of varieties being grown increased, which in part shows the industry's commitment to testing more varieties on a commercial scale.

The industry is still being heavily challenged by seed availability. The main issues are related to unwanted viroids being detected in seed destined for Australia, delays from laboratory analysis and more expensive testing and import biosecurity protocols. Seed shortages in certain cultivars have also influenced the balance of crop area grown by cultivar and been a significant factor in shaping the figures in the table above.

4 The Season

4.1 Rainfall

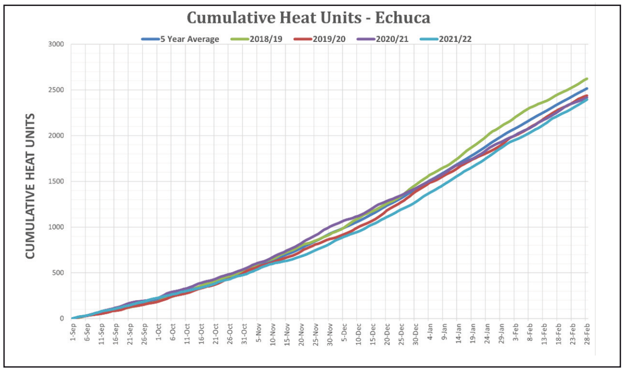


4.1.1: Rainfall across the major growing regions (mm) (BOM)

As seen in the above chart, for most regions, rainfall was moderate for the start of the season and as such close to ideal, with planting and sowing operations running from late September to late November. December was dry across all areas, however the most northern grower (Whitton region NSW) experienced high rainfall in the January period, which put extra strain on the start of harvest. The Appin and Jerilderie region (ref. Swan Hill and Jerilderie) also recorded high rainfall events, putting late season disease pressure on maturing plants.

There was almost no rainfall in February, which helped processors get off to a relatively good start. However, the delays in processing and harvest operations due to staffing challenges, coupled with frequent rainfall from mid-April onwards, meant harvest was significantly and negatively impacted late in the season.

4.2 Heat Units



4.2.1: Heat units – Echuca (BOM)

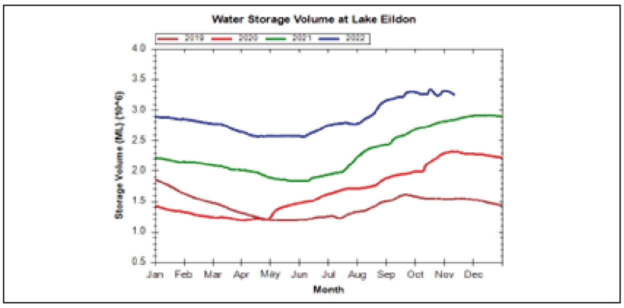
The heat units recorded during the major crop growth period demonstrate that the season was cumulatively milder than the previous 5-year average and indeed the last 4 individual growing seasons.

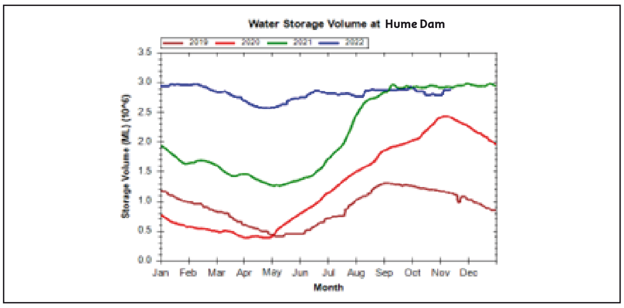
This mild weather seemed to delay crops early in the season, which was difficult for our early industry plantings, however the lack of heat stress during December and January meant crops were looking outstanding in many regions. However, the harvest delays ultimately impacted quality and tested the field storage attributes of cultivars to their limits.

Although this graph uses data from Echuca, it's a central point for industry and can be generally considered indicative of what was experienced by growers in surrounding regions.

Early climate indicators suggest that the season ahead will be wetter than average and mild once again, so delayed harvest schedules are to be expected in 2022/23.

4.3 Water Storages

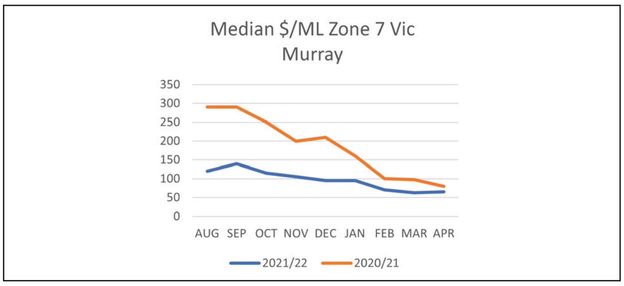


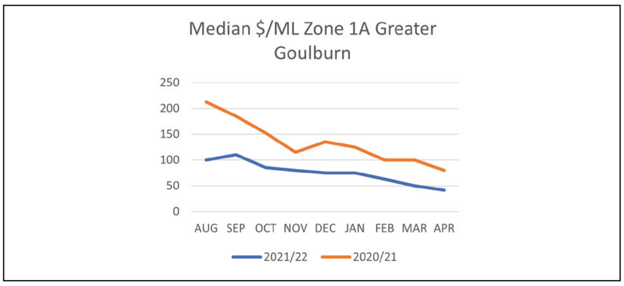


4.3.1: Storage Volume, Lake Eildon and Hume Dam (GMW)

The water storage levels across all catchments have remained high or increased significantly throughout the calendar year due to high inflows from the persistent La Niña climate conditions. The cost of water will be low throughout the 2022/23 growing season and due to the quantum of water in storages, availability should be relatively stable for at least the next few seasons.

4.4 Water Price





4.4.1: Zone 1A and Zone 7 median water price ($/ML) (Registry)

The price of water during 2021/22 remained low and the price of water could be seen as a direct reflection of higher allocations and inflows into major water storages for Victoria and NSW during this period.

The outlook for the 2022/23 season is for higher rainfall and average to lower temperatures, so water prices are predicted to remain suppressed for at least another season.

5 Trade

5.1 Imports

Product	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Dried/powder	39,155	39,125	35,940	26,875	34,506	37,934	37,660	34,880	28,017	29,143
Whole/pcs <1.14L	49,173	48,060	42,660	45,222	40,965	43,354	42,683	41,799	51,121	36,356
Whole/pcs >1.14L	18,661	18,911	28,402	28,088	22,997	24,002	24,275	22,369	21,129	21,316
Paste/puree<1.14L	73,484	80,602	83,976	153,210	102,733	107,923	109,578	110,328	159,447	137,971
Paste/puree>1.14L	148,728	145,214	109,242	102,866	130,171	140,532	144,906	133,524	143,118	140,502
Juice [1]	264	137	116	75	83	38	75	50	30	17
Sauce/ketchup	28,902	33,633	38,628	39,276	38,462	45,705	45,946	47,050	48,375	45,788
Total Tomato	**358,367**	**365,682**	**338,964**	**395,612**	**369,917**	**399,488**	**405,123**	**389,999**	**451,236**	**411,093**

5.1.1: Imports of Tomato Products (equivalent raw tonnes) (ABARES)

The volume of imports decreased quite significantly during 2021, with most of the decrease coming from the 'paste/puree' categories and small pack size 'whole/pcs' category.

The largest importing countries, sorted by category were as follows (where the major importer supplied less than 90% of the total, the next most significant supplier/s are also included).

- **Dried/powder** – Turkey 51.3%, New Zealand 11.67%, China 11%
- **Whole/pcs <1.14L** – Italy 96.51%
- **Whole/pcs >1.14L** – Italy 97.05%
- **Paste/puree<1.14L** – Italy 81.89%, China 14.92%
- **Paste/puree>1.14L** – USA 44.25%, China 25.14%, Italy 20.01%
- **Juice** – USA 35.15%, Georgia 18.25%, Mexico 17.8%
- **Sauce/ketchup** – Italy 39.42%, New Zealand 24.14%, Netherlands 12.01%

At 68% of total volume (last year 70%), Italy remains the dominant source of imported processed tomato products into Australia.

Product	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Dried/powder	4.48	4.83	5.32	5.98	5.33	5.61	5.77	5.69	6.22	5.42
Whole/pcs <1.14L	0.94	0.99	1.16	1.17	1.22	1.10	1.17	1.26	1.39	3.02
Whole/pcs >1.14L	0.72	0.83	0.99	0.99	0.92	0.89	0.97	1.00	1.00	2.05
Paste/puree<1.14L	1.05	1.13	1.35	1.36	1.34	1.27	1.27	1.40	1.56	1.54
Paste/puree>1.14L	0.85	0.86	1.05	1.27	1.14	1.08	1.15	1.24	1.31	1.20
Juice [1]	0.99	0.91	1.22	1.54	0.88	2.37	1.79	1.87	3.09	3.31
Sauce/ketchup	0.49	1.44	1.62	1.71	1.73	1.75	1.78	1.91	2.19	2.15
Total Tomato	**0.90**	**1.09**	**1.27**	**1.31**	**1.31**	**1.26**	**1.32**	**1.42**	**1.54**	**2.11**

5.1.2: Average import prices ($/kg), in 2021 monetary values (ABARES)

5.2 Correlation of Imports and Price

- The price for imports for 2021 increased significantly, which aligns with surging inflation and commodity price indicators worldwide as well as the effects of the pandemic and high global shipping charges.

- There was a moderately strong correlation across the past 10 years for Juice and the Sauce/ketchup categories.

o Juice exhibits a negative correlation, meaning as price goes up, imports go down.

o Sauce/ketchup exhibits a positive correlation, so as price goes up, imports also increase.

- The exchange rate correlation over the past 10 years has shown a moderately negative correlation overall. This indicates that it's likely as exchange rates go up, Australian imports decrease, which seems to be the scenario for the 2021 calendar year.

- The other correlations for imported product are quite varied and swing from moderately positive to moderately negative and deviate within different package sizes within category groups. Therefore, it suggests that overall, the variability in imported volumes does not appear to be strongly price driven for most categories.

5.3 Exports

Product	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Whole/pieces	1,581	1,075	2,552	746	461	133	62	139	623	273
Paste/puree	11,492	14,987	33,800	43,747	104,518	21,852	16,402	11,695	32,766	38,323
Sauce/ketchup	4,134	3,218	3,524	8,196	4,039	8,799	11,636	13,227	14,788	17,986
Juice [1]	237	224	195	131	57	50	80	106	52	47
Total Tomato	**19,456**	**21,517**	**42,084**	**52,819**	**109,075**	**30,834**	**28,180**	**25,167**	**48,228**	**56,629**

5.3.1: Exports of tomato products (ABARES) (equivalent raw tonnes)

The volume of exports increased substantially again in 2021, most noticeably in the paste/puree and sauce/ketchup categories.

The largest export markets, sorted by category and then by country were as follows:

- **Whole/pieces –** Thailand 45%, New Zealand 13%, USA 13%
- **Sauce/ketchup –** New Zealand 50%, Japan 25%, China 14%
- **Paste/puree –** Japan 58%, New Zealand 18%, Vietnam 16%
- **Juice –** New Zealand 56%, Fiji 11%, Singapore 7%

At 36% of all products, Japan has become the new major export destination for Australian processed tomato produce, with New Zealand close behind at 38% and China at 8% of total exports.

Product	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Whole/pieces	3.08	3.46	1.36	4.26	5.29	6.89	4.90	2.69	1.74	3.03
Paste/puree	1.46	1.46	1.45	1.33	1.03	1.22	1.46	1.85	2.32	2.16
Sauce/ketchup	3.00	2.87	2.72	2.68	2.82	2.01	2.05	2.09	2.40	2.06
Juice [1]	1.51	1.27	1.28	1.33	1.66	1.17	1.78	1.08	1.10	1.02
Total Tomato	**2.44**	**2.25**	**1.65**	**1.95**	**1.30**	**1.73**	**1.88**	**2.03**	**2.34**	**2.12**

5.3.2: Average export prices ($/kg) (ABARES), in 2021 monetary values

The real price of exports decreased slightly in 2021, which is less than ideal for Australian industry.

The data suggests a moderate or weak negative correlation between average export price and volume variability, meaning that as price goes up, volume goes down. This applies to all product categories, except for Juice, which consistently appears to have no correlation to export price whatsoever.

It's worth noting that there is a moderate, but not a strong, negative correlation between export volumes and the USD exchange rates across the last 10 years, meaning that as exchange rates decrease, exports increase and vice versa. The fact that it is only a moderate correlation may suggest that exports from Australia aren't heavily dictated by exchange rates and that other market forces are having more influence on annual export opportunities.

5.4 Market Demand

Calendar Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	5 Yr	10 yr
Imports	358,367	365,682	338,964	395,613	368,918	399,488	405,123	389,999	451,236	411,093	411,388	388,448
Net Australian	164,505	171,491	181,561	234,007	165,773	153,848	199,456	186,794	162,249	175,933	175,656	179,562
Dom Demand	522,872	537,173	520,525	629,620	534,691	553,336	604,579	576,793	613,485	587,025	587,044	568,010
Imported %	69%	68%	65%	63%	69%	72%	67%	68%	74%	70%	70%	68%
Local %	31%	32%	35%	37%	31%	28%	33%	32%	26%	30%	30%	32%
Per capita (kgs)	**23**	**23**	**22**	**26**	**22**	**22**	**24**	**22**	**24**	**23**	**23**	**23**

5.4.1: Apparent domestic market demand (ABARES) (equivalent raw tonnes)

Table 4-3 represents the Australian market demand for processed tomato products and shows how this demand is being met, i.e., from local or imported products.

For individual years, combining data can produce non-matched results; ABARES data is based on a calendar year, rather than a seasonal year, and this survey is unable to account for year-end stocks. However, these factors should tend to be mitigated when viewed over time, such as the 5-year or 10-year averages.

Considering this data, the following may be noted:

- Imports: Imports decreased quite significantly in the 2021 calendar year.
- Net Australian: The net Australian figure was higher than the previous calendar year and equates to tomatoes processed, less exports. This increase means that a greater volume of locally grown and processed product was used for domestic consumption than in the previous year.

- Domestic Demand: After the high of 2020, domestic demand for processing tomato products has scaled back, which is likely just a return to 'normal' demand levels.
- Imported %: The imported percentage of processed tomato products decreased in 2021, which is always positive to see from an Australian grower/processor perspective. Ideally, we would like to see this figure decrease further in the future, as more Australian produce meets local demand.
- Local %: The percentage of local product sold in the Australian market increased in 2021, which is a desirable outcome.
- Per Capita kgs: The average per capita consumption fell in 2021 and now aligns with the 5 and 10-year average consumption of 23 kilograms of equivalent raw tomatoes. It was hoped that the consumption would remain high after a significant increase in 2020, however this does not seem to be the case.

By comparison, in 2019/20 US consumption was 21.7 kilograms and Europe (Non-EU) was 18.8 kilograms and Western EU consumption was 17.3 kilograms (Branthôme).

6 Global Industry

6.1 Production

In 2021, recorded global production totalled 39.184 million tonnes, compared to 38.402 million tonnes the previous year; an increase of 2.04%.

In 2021, Australia contributed 0.6% of global production and maintained its ranking at 18th for industry volume.

Country	Season	2020	2021	2022E	% Change 2021-22E	Ranking 2021	% Total 2021
USA	Jul-Dec	10,721	10,223	9,975	-2%	1	26.1%
Italy	Jul-Dec	5,166	6,059	5,480	-10%	2	15.5%
China	Jul-Dec	5,800	4,800	6,200	29%	3	12.2%
Spain	Jul-Dec	2,650	3,185	2,100	-34%	4	8.1%
Turkey	Jul-Dec	2,500	2,200	2,350	7%	5	5.6%
Portugal	Jul-Dec	1,262	1,596	1,330	-17%	6	4.1%
Brazil	Jul-Dec	1,421	1,525	1,500	-2%	7	3.9%
Iran	Jul-Dec	1,300	1,300	1,300	0%	8	3.3%
Chile	Jan-Jun	907	1,174	971	-17%	9	3.0%
Algeria	Jul-Dec	800	1,000	800	-20%	10	2.6%
Tunisia	Jul-Dec	961	940	610	-35%	11	2.4%
Ukraine	Jul-Dec	800	800	120	-85%	12	2.0%
Argentina	Jan-Jun	454	596	626	5%	13	1.5%
Russia	Jul-Dec	515	523	638	22%	14	1.3%
Egypt	Jul-Dec	420	440	440	0%	15	1.1%
Greece	Jul-Dec	420	420	340	-19%	16	1.1%
Canada	July-Dec	438	399	535	34%	17	1.0%
Australia	**Jan-Jun**	**210**	**233**	**227**	-3%	**18**	**0.6%**
Dominican Republic	Jul-Dec	181	227	227	0%	19	0.6%
Israel	Jul-Dec	200	200	200	0%	20	0.5%
Poland	Jul-Dec	175	175	175	0%	21	0.4%
France	Jul-Dec	136	164	142	-13%	22	0.4%
India	Jan-Jun	152	162	162	0%	23	0.4%
South Africa	Jan-Jun	150	125	120	-4%	24	0.3%
Peru	Jan-Jun	100	120	125	4%	25	0.3%
Hungary	Jul-Dec	82	115	80	-30%	26	0.3%
Morocco	Jul-Dec	100	100	100	0%	27	0.3%
Senegal	Jan-Jun	73	73	73	0%	28	0.2%
New Zealand	Jan-Jun	50	50	52	4%	29	0.1%
Syria	Jul-Dec	42	40	40	0%	30	0.1%
Thailand	Jan-Jun	40	40	40	0%	31	0.1%
Mexico	Jan-Jun	40	40	40	0%	32	0.1%
Bulgaria	Jul-Dec	40	40	40	0%	33	0.1%
Japan	Jul-Dec	23	28	27	-4%	34	0.1%
Czech Republic	Jul-Dec	25	25	25	0%	35	0.1%
Venezuela	Jan-Jun	20	20	20	0%	36	0.1%
Slovakia	Jul-Dec	20	20	20	0%	37	0.1%
Malta	Jul-Dec	8	7	7	0%	38	0.0%
Total		**38,402**	**39,184**	**37,257**	**-5%**	**38**	**100.0%**

6.1.1: World Production by Country ('000 tonnes) (Colvine).

6.2 Outlook

- It is currently anticipated that production will decrease in 2022 by 5%, due to a range of undesirable global and climatic influences.
- Australia has initially forecast a reasonable rise in production for 2022/23: with the primary estimate of 241,000 tonnes, which includes small amounts of organic and cherry tomatoes. However, the early season has been hampered by cold weather, persistent rainfall and flooding so this figure will likely be revised down.

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** n.d. denotes where 'no date' could be found for publishing.*

TM20000: Development and Extension Program

Matthew Stewart, Industry Development Manager

Introduction

The overall objective of this project is to deliver effective research, development, and capacity building solutions to Australian processing tomato businesses, to improve their profitability and sustainability. It also operates within the framework outlined in the industry's strategic plan for research and development.

Project activities encompass to following:

1. Increasing the reach of the processing tomato industry R&D program by engaging stakeholders in the R&D process, including on-farm trials.
2. Effectively communicating R&D outcomes and applicable industry information to Australian processing tomato businesses and assisting with adoption of relevant R&D.
3. Being actively involved with relevant stakeholders, including seed suppliers into Australia, to facilitate the importation process.
4. Collecting industry benchmark data and statistics to help identify gaps and direct industry development efforts.
5. Identifying and securing other funding sources (including cross-industry projects) to support R&D and extension aimed at industry development.

The target audience for these activities is primarily processing tomato growers and farm managers; however, advisors and professional industry stakeholders are also actively engaged due to their extension roles in industry.

TM20000 activities and outcomes

Annual APTRC forum

The largest item on the annual extension program is the APTRC Forum, which was successfully held as a face-to-face event after a 3-year hiatus. The Forum ran on Thursday 26th May at the Moama Bowling Club .

The forum was attended by 56 delegates and the follow-on dinner and drinks at Junction Restaurant was attended by 44 members and partners.

A total of 15 different and interesting speakers, presenting on a range of topics throughout the day over three sessions, categorised as 'RD&E', 'Industry Insights' or 'Into the Future'.

There were three technical stalls at the forum this year; I K Caldwells and MAIT Industries contributed with displays of their irrigation monitoring technologies and IPL Fertilisers displayed their new humate formula,. All displays were attended by skilled representatives who were available to answer questions from delegates and network about their respective areas of expertise.

The evening dinner at the Junction Hotel provided a further opportunity to consolidate on the learnings from the day by allowing growers, processors, suppliers, and academics to continue the discussions into the night.

Matt at Hort Connections 2022, taking a virtual greenhouse tomato cultivar tour, thanks to the team at Bayer.

The full listing of presentations from the day can be found at https://www.aptrc.asn.au/info-for-industry.

Field Days

During the 2021/22 season, both scheduled crop inspection days were successfully held. On December 16th at Boort, 33 participants took part, whilst 21 participants continued on for dinner at Boort Tennis Club.

On January 22nd at the Netafim-sponsored Rochester Tour, there were 41 participants and afterwards, 38 members (including kids) attended an Industry Dinner at Moama Bowling Club.

This season, the APTRC facilitated lengthy, in-paddock discussion on growers' irrigation management techniques at the Boort day and systems management, rotations, and crop monitoring at the 'Netafim' Rochester Day. A full Q&A record can be found in December 2021 Tomato Topics and March 2022 Tomato Topics

Processing Tomato Cultivar Evaluation

Throughout this project, industry will continue its focus on evaluating cultivars under local growing conditions for a range of field performance and quality criteria. The basis for our cultivar selection criteria is developed in consultation with the Australian processors and growers.

New cultivars to Australia are first included in small plot screening trials in several locations across northern Victoria and southern NSW. These are assessed on a range of vine and fruit characteristics at the end of the season, with input from seed providers, local growers, and processors. The most promising selections then advance to larger scale, replicated trials which are machine harvested to provide comparative yield and fruit quality information.

Results for each trial are presented in table form to growers, processors, and seed suppliers as soon as practicable. For example, several promising new 'mid-season' varieties are identified from the most recent trials reported herein.

Industry Publications

The industry newsletter "Tomato Topics" has been a long-standing feature of capacity building projects delivered by the APTRC and issues are available via the APTRC website; aptrc.asn.au. Also available online are the past "Processing Tomato Grower" Magazine editions, which provide a detailed account of APTRC work during each season.

The online R&D database, established and maintained by Ann Morrison; continues to provide a searchable platform where industry researchers, growers and service providers can review past findings and help streamline investigations into previous R&D.

Johanna Morgan of Kilter Rural presenting at Boort Crop Inspection Day.

Annual Industry Statistics

The data that is generated for the annual report serves as an industry survey for monitoring and evaluation purposes and for project planning based on local and world trends.

This is published as a stand-alone document, loaded onto the website, and included in the annual Processing Tomato Grower magazine (see previous article).

Evaluate New Crop Threats and Inform Industry

The industry continues to monitor the present threats of Fall Army Worm, & Serpentine Leaf Miner, as well as the detection of Silverleaf White Fly and Tomato Yellow Leaf Curl Virus in Victoria. Also, APTRC are keeping tabs on a detection of Guava Root Knot Nematode in the Northern Territory and ongoing monitoring for incursions of Brown Marmorated Stink Bug. None of these new threats have been identified in the processing tomato industry to date. The APTRC also supports on-going seed testing to prevent the entry of seed-borne viroids into Australia, even though it can at times impact seed availability.

As well as liaising with regulatory authorities, the APTRC have taken up membership in the Australian Seed Federation (ASF) and taken part in the ASF business convention and regional meetings to help better understand international seed issues.

Together with processors, growers and Hort Innovation, our goal is to help find a way to better manage biosecurity risks and improve our national seed security.

Pest & Disease Updates

Timely and accurate information on pest and disease pressures in the field is essential for effective control. During 2021 the APTRC continued to utilise a Pest & Disease update system, via the 'Workplace' app. Using information provided by a network of crop scouts and agronomists, this service delivered regular updates for growers and advisors throughout the season on regional crops and pest/disease observations, thereby assisting with on-farm pest management as well as local and national biosecurity programs.

The app is subscription based and had a closed group of 30 members, including growers, farm managers, their advisors, and some key industry personnel. The posts are seen by an average of 10-15 people per post, which was a decline on the previous season by about 25-50%.

Tony Henry discussing irrigation practices at Boort.

Dinner at Boort Tennis Club.

This communication is being reviewed and a more direct messaging service investigated for the 2022-23 season to improve reach.

Raising Awareness of the Australian Processing Tomato Industry locally and internationally

The IDM role provides a central contact point for the processing tomato industry, consolidating relevant information, coordinating industry activities, and facilitating innovation.

Locally, this means being involved in relevant industry networks, such as the annual Hort Connections event (Brisbane 2022), Horticultural Industry Network (HIN), APEN (Austral-Asia Pacific Extension Network) and Plant Health Australia (PHA). APTRC staff also actively engaged with researchers from several Australian universities, including The University of Melbourne, Swinburne University, Deakin University, Australian National University (ANU) and Latrobe University. The APTRC also maintains strong linkages with government agencies including state Departments of Primary Industries (DPIs) and Biosecurity Australia.

In 2022 the APTRC also attended and presented at the 14th World Processing Tomato Congress & 16th ISHS Symposium on the Processing Tomato. The poster APTRC presented was "An industry wide approach to lifting productivity in the Australian Processing Tomato Industry: 2019 to 2021". Due to the Pandemic, the event was held fully online from Monday 21 March to Friday 25 March for the congress and from Monday 28 March to Friday 1 April for the Symposium . The IDM also has direct input to the World Processing Tomato Council (WPTC) meetings, reporting on Australian crop status and forecasted tonnages.

Projects extended during TM20000 but funded by the APTRC

Although much of the RD&E conducted in the processing tomato industry was directly through APTRC committee-funded projects, the extension of findings from them was vital to industry development and forms a major part of the TM20000 program. This extension would not be possible without the support of the Hort Innovation TM20000: Processing tomato industry development and extension project.

Extension activities covered results from the following projects:

University of Melbourne – 2021 PhD (ongoing) – "Integrated disease management of poor root growth of processing tomato plants"

University of Melbourne – 2021 Honours – "Interactions between waterlogging and a novel *Fusarium oxysporum* disease in Australian processing tomato plants"

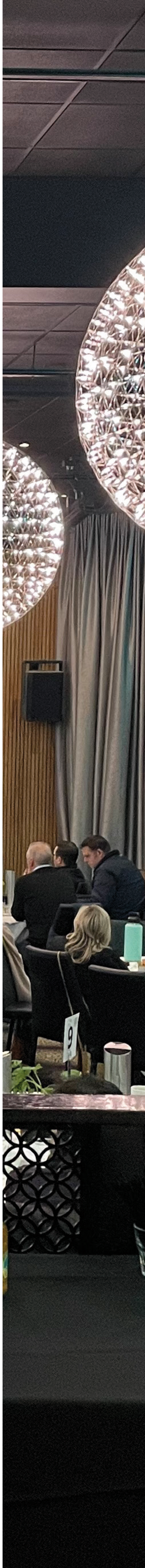
Deakin University – 2022 – "Towards Autonomous Cross-Pollination: Portable Multi-classification System for In Situ Growth Monitoring of Tomato Flowers"

Australian National University – 2022 (ongoing) – "Tomato waste to profit: converting harvest and processing waste into green energy, fuels and fertiliser"

Acknowledgements

The APTRC would like to thank the processing tomato growers and the processors for the support they give freely and unreservedly to the APTRC, its employees, and its volunteer committee members. The APTRC would also like to acknowledge Bill Ashcroft and Ann Morrison, as well as the APTRC committee members who continue to step forward and take on the many and varied duties required by the project.

The author would like to acknowledge the support of Hort Innovation and in particular, the regional extension manager, Adrian Englefield. The APTRC look forward to working with Hort Innovation to deliver effective and relevant projects in the future together.



Progress in understanding *Fusarium oxysporum* associated with poor root growth of Australian processing tomatoes

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Introduction

Previous PhD student Dr Sophia Callaghan showed that declining yields of processing tomatoes grown under sub-surface drip irrigation were in part due to diseases caused by soil-borne pathogens. Infected plants were characterised by stunting, collar and root rot, poor root growth and ultimately yield loss [1-3]. Pathogens consistently associated with these disease symptoms included a novel *Fusarium oxysporum* and nine *Pythium* species. Glasshouse pathogenicity bioassays at the University of Melbourne developed to study the host-pathogen interactions identified the importance of *F. oxysporum* as a major pathogen of tomatoes. These glasshouse pathogenicity trials now need to be optimised to enable further studies into developing more targeted disease management strategies to mitigate the risk of disease occurring in the field. The APTRC is supporting a new PhD study to better understand the biology and impact of *F. oxysporum* on growth of processing tomatoes. This study involves determining the minimum amount of inoculum in the soil that will cause disease (threshold level), screening of tomato cultivars to assess resistance and identifying resistant rotation plant species. This report presents results from initial experiments to develop an optimised glasshouse pathogenicity assay for *F. oxysporum*, in which the physiological response of plants to various concentrations of inoculum was measured using cutting-edge technology.

6 Material and methods

2.1 Glasshouse bioassay

Fusarium oxysporum strain UMT01 isolated from diseased plants collected from processing tomato fields in early 2022 was used to infect tomato seedlings of cultivars H3402 and V2, a cultivar with reportedly higher resistance to soilborne pathogens, at the two-leaf stage. Roots of seedlings were trimmed and dipped into spore suspensions with different concentrations of *F. oxysporum*, or sterile water (H2O) for control. The concentrations of spore suspensions included: 102 ml -1 (Low), 104 ml -1 (Medium), 106 ml -1 (High), and 5x106 ml -1 (Very high). Seedlings with different treatments were then transplanted to 1.5 L sterile pots containing sterilized potting mix soil. Plants were watered to maintain field capacity to avoid waterlogging or drought conditions. The experiment had five replicates with five treatments (four different levels of *F. oxysporum* inoculum and a control treatment with no pathogen). Above ground height was measured fortnightly, root dry weight was measured at harvest by drying the roots at 70°C for 48 hours.

2.2 Physiological measurements

Plant physiological parameters, including stomatal conductance (gs; mol H2O m-2s-1), transpiration (E; mmol H2O m-2s-1), and photosynthesis (A; µmol CO2 m^{-2} sec^{-1}), were measured using a Li-6400 XT open gas exchange system (Li-Cor Inc., Environmental Sciences, Lincoln, NE, USA) of both cultivars H3402 and V2. Measurements were taken on the youngest fully expanded leaves and repeated twice in different leaves of each plant (n = 10 per treatment, n = 50 in total). Physiological measurements were taken every two weeks throughout the glasshouse pathogenicity test.

2.3 Low-cost electronic nose measurements

A portable and low-cost electronic nose (Figure 1) developed by the Digital Agriculture Food and Wine Group from the University of Melbourne (DAFW-UoM) was used to assess the production of volatile organic compounds from processing tomato plants of cultivar H3402 with different inoculum concentrations. This e-nose consists of an array of nine sensors that are sensitive to different volatile compounds: (i), MQ3 (alcohol), (ii) MQ4 (methane: CH4), (iii) MQ7 (carbon monoxide: CO), (iv) MQ8 (hydrogen: H2), (v) MQ135 (ammonia/alcohol/benzene), (vi) MQ136 (hydrogen sulphide: H2S), (vii) MQ137 (ammonia: NH3), (viii) MQ138 (benzene/alcohol/ammonia), and (ix) MG811 (carbon dioxide: CO2), as well as a humidity and temperature sensor to measure the ambient conditions (Henan Hanwei Electronics Co., Ltd., Henan, China). The device was placed on top of each plant to record data for 2 mins. E-nose measurements were taken from the day of transplanting (day 0) and three days later, followed by four fortnightly measurements throughout the glasshouse pathogenicity test (weeks 2, 4, 6, and 8).

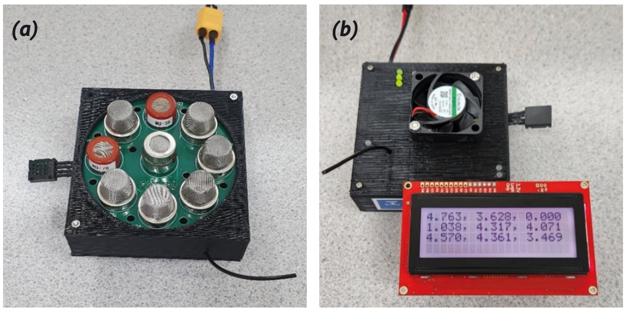


Figure 1. Low-cost electronic nose showing (a) the different sensors and (b) extracting fan and liquid-crystal display (LCD) screen for data monitoring. The e-nose has connectivity for an external battery and wireless data transmission capabilities.

2.4. Data analysis

Above ground height, root dry weight, e-nose output data and plant physiological results were analysed using analysis of variance in Minitab 2019 (Minitab LLC, State College, Pennsylvania, USA). Post-hoc comparison of means was determined using Tukey's honestly significant difference (HSD) ($P \leq 0.05$).

3. Results

For cv. H3402, the Low inoculum treatment at 102 ml-1 did not cause significant growth reduction considering both above and below ground biomass production. Clear disease symptoms and growth reduction started from Medium inoculum treatment at 104 ml-1, and as pathogen inoculum gradually increased, above ground height and root dry weight both decreased significantly. At Very high inoculum treatment at 5x106 ml-1, root production was significantly reduced and there was severe shrinkage near the collar region (Figures 2 and 4). In contrast, cultivar V2 started to exhibit growth reduction at the Low inoculum treatment at 102 ml-1, and plant production significantly decreased as pathogen inoculum increased (Figure 3).

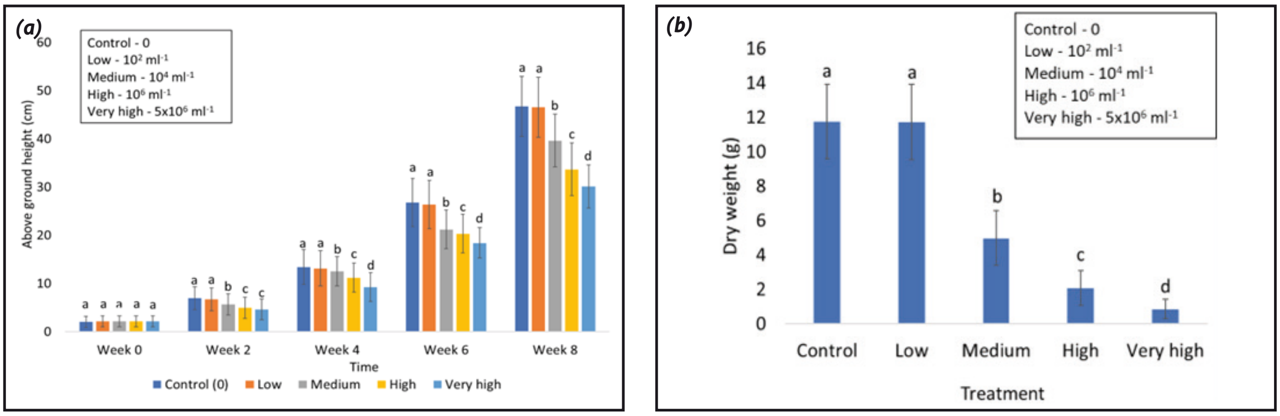


Figure 2. Fortnightly above ground height (a) and root dry weight (b) data of cultivar H3402 of the glasshouse pathogenicity bioassay, error bars represent 95% of confidence intervals for the means, columns do not share the same letter are significantly different (p < 0.05).

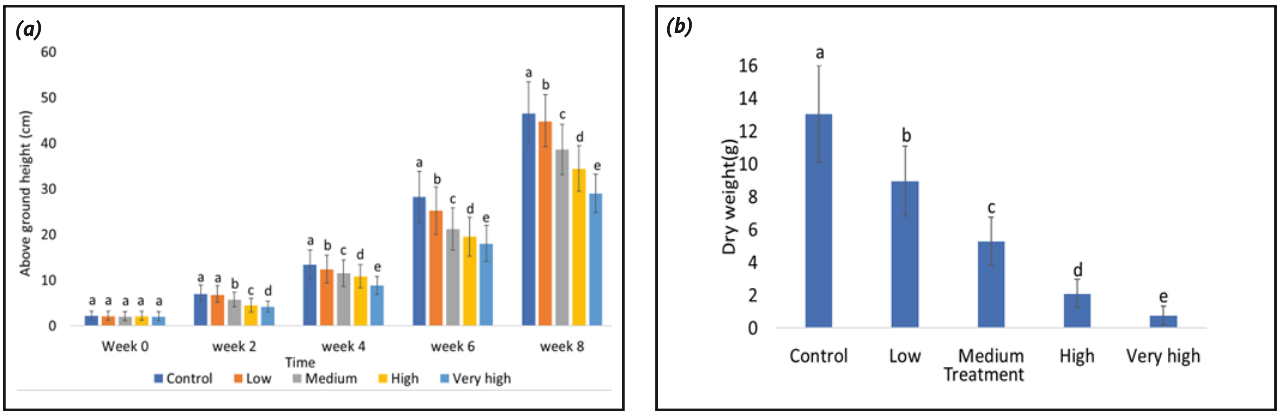
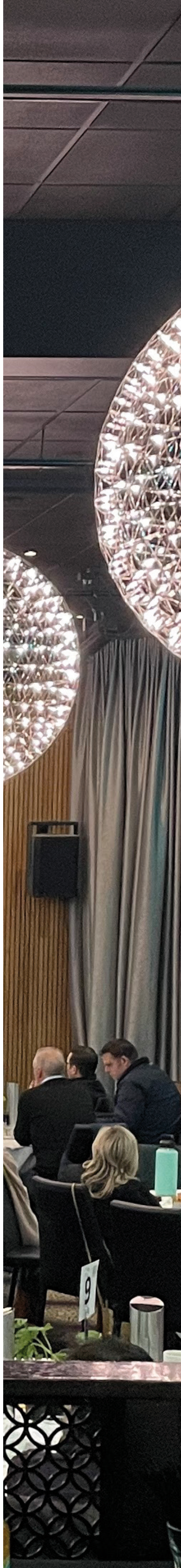


Figure 3. Fortnightly above ground height (a) and root dry weight (b) data of cultivar V2 of the glasshouse pathogenicity bioassay, error bars represent 95% of confidence intervals for the means, columns do not share the same letter are significantly different (p < 0.05).

Figure 4. Comparison of root growth between tomato plants from Control (a) and Very high (b) treatments of cultivar H3402 from the glasshouse pathogenicity bioassay.

There were significant differences ($p < 0.05$) in photosynthesis, stomatal conductance, and transpiration from week 4 between all inoculation treatments and the uninoculated control for cultivar H3402 (Table 1). At week 2 only photosynthesis was significantly different between control and the lowest inoculum concentration. In general, the control plants had the highest gas exchange rates for all three parameters, and as the pathogen inoculum gradually increased, all three parameters decreased significantly. Similar results were observed for the physiological data of cultivar V2 (Table 2). Plants from the control treatment had the highest rates of photosynthesis, stomatal conductance and transpiration. With increased inoculum, all three parameters decreased significantly.

Photosynthesis and transpiration of cultivar H3402 had a



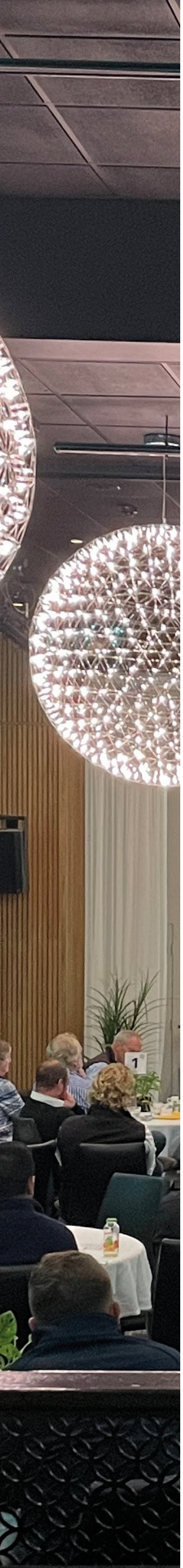


Table 1. Mean values of the plant physiological data for all treatments of cultivar H3402.

Treatment	Photosynthesis (µmol CO_2 m^{-2} s^{-1})				Stomatal Conductance (mol H_2O m^{-2} s^{-1})				Transpiration (mmol H_2O m^{-2} s^{-1})			
Measurements	W2	W4	W6	W8	W2	W4	W6	W8	W2	W4	W6	W8
Control	14.86a	14.17a	17.84a	15.42a	1.03a	0.94a	0.93a	0.98a	5.19ab	6.60a	6.46a	5.61a
102 (Low)	10.98b	10.42b	11.77b	9.41b	0.77ab	0.44bc	0.68b	0.57b	4.68b	4.55b	4.20b	4.47b
104 (Medium)	6.32c	9.75b	8.28bc	6.60c	0.37bc	0.38bc	0.59b	0.47bc	3.31c	4.11b	3.89bc	3.41c
106 (High)	4.89cd	6.03d	4.43cd	3.55dc	0.36bc	0.31bc	0.34bc	0.23c	2.92cd	3.45c	3.07c	3.05c
5x106 (Very high)	2.29d	2.26d	2.49d	1.07d	0.20c	0.16c	0.13c	0.11c	2.56d	2.40d	1.39d	1.27d

Different letters a - d show significant differences between treatments (rows) based on ANOVA and the Tukey honestly significant difference (HSD) post hoc test (a = 0.05; p < 0.05).

Table 1. Mean values of the plant physiological data for all treatments of cultivar H3402.

Treatment	Photosynthesis (µmol CO2 m^{-2} s^{-1})				Stomatal Conductance (mol H_2O m^{-2} s^{-1})				Transpiration (mmol H_2O m^{-2} s^{-1})			
Measurements	W2	W4	W6	W8	W2	W4	W6	W8	W2	W4	W6	W8
Control	13.72a	14.14a	13.82a	13.90a	0.99a	0.91a	0.89a	0.94a	6.74a	6.60a	6.46a	6.58a
102 (Low)	9.48b	9.56b	9.92b	8.95b	0.72ab	0.67ab	0.66ab	0.58b	5.01b	4.92b	4.87b	4.81b
104 (Medium)	8.86b	8.23bc	8.14bc	7.89bc	0.39c	0.36c	0.34c	0.35c	3.92c	4.01c	3.76c	3.45c
106 (High)	5.71c	5.48c	5.41c	5.33c	0.38c	0.37c	0.38c	0.29d	3.01cd	3.22cd	3.13cd	3.09cd
5x106 (Very high)	4.74cd	4.22d	4.13d	3.94d	0.24d	0.24d	0.19d	0.15d	2.32d	2.17d	2.09d	1.94d

Different letters a - d show significant differences between treatments (rows) based on ANOVA and the Tukey honestly significant difference (HSD) post hoc test (a = 0.05; p < 0.05).

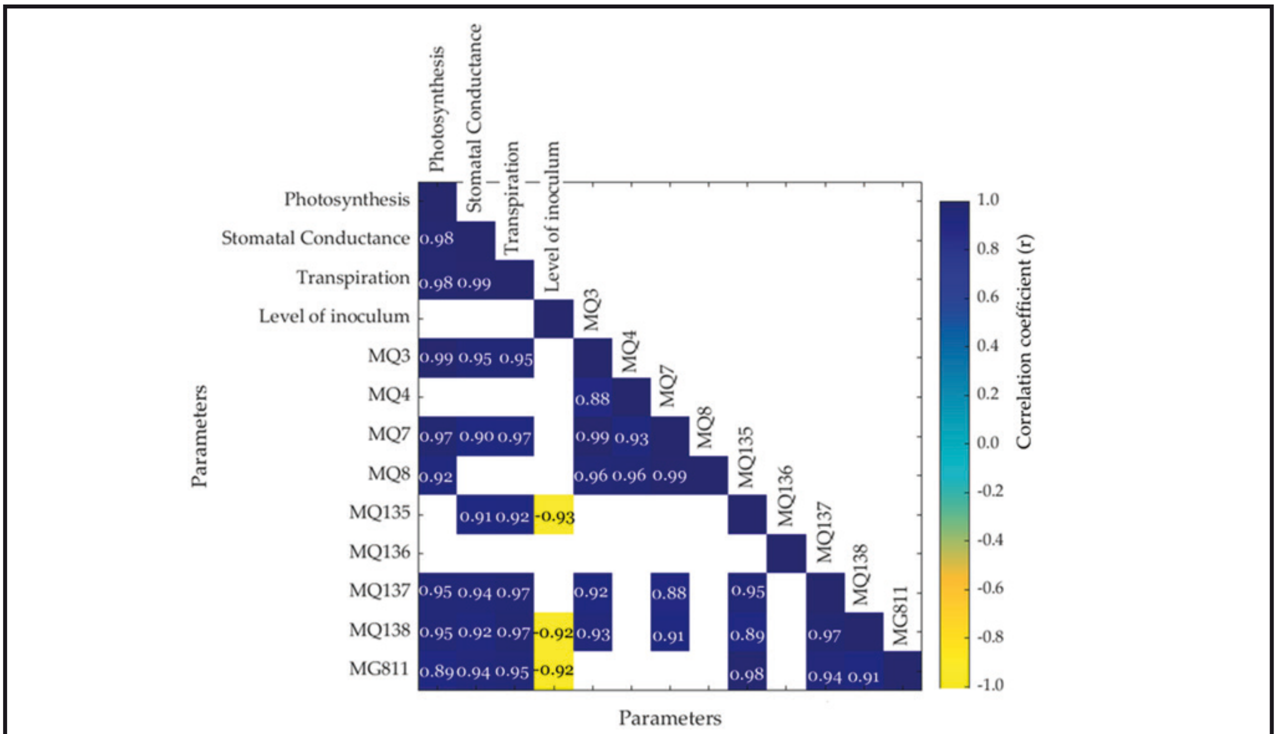


Figure 5. Matrix showing the significant correlations (p < 0.05) between the physiological data, level of pathogen inoculum and the electronic nose sensors of cultivar H3402. Color bar represents the negative (yellow) to positive (blue) correlations, numbers within each box are the correlation coefficients (r)

positive significant correlation ($p < 0.05$) with production of VOCs MQ3 (alcohol; r = 0.99 and r = 0.95 respectively), MQ7 (CO; r = 0.97 and r = 0.91, respectively), MQ137 (ammonia, r = 0.95 and r = 0.97, respectively), MQ138 (benzene/alcohol/ammonia; r = 0.95 and r = 0.97, respectively) and MG811 (CO2; r = 0.89 and r = 0.95, respectively; Figure 2). Furthermore, MQ135 (ammonia/alcohol/benzene), MQ138 (benzene/alcohol/ammonia) and MG811 (CO2) had a significant negative correlation with level of inoculum (r = -0.93, r = -0.92 and r = -0.92, respectively). Similarly, stomatal conductance had a positive correlation with MQ3 (r = 0.95), MQ7 (r = 0.90), MQ135 (r = 0.91), MQ137 (r = 0.94), MQ138 (r = 0.92) and MG811 (r = 0.94). Additionally, transpiration and stomatal conductance also had a significant positive correlation with MQ3 (r = 0.95 for both), MQ7 (r = 0.90 and r = 0.91, respectively), MQ135 (r = 0.91 and r = 0.92, respectively), MQ137 (r = 0.94 and r = 0.97, respectively), MQ138 (r = 0.92 and r = 0.97, respectively) and MG811 (r = 0.94 and r = 0.95 respectively). On the contrary, inoculum concentration had a negative correlation with MQ135 (ammonia/alcohol/benzene, r = -0.93), MQ138 (benzene/alcohol/ammonia, r = -0.92) and MG811 (CO2, r = -0.92).

4. Discussion

The minimum amount of inoculum required to establish infection and cause disease symptoms in the glasshouse bioassay was determined to be 104 spores ml -1. Disease symptoms and growth reduction also correlated with plant physiological responses. The reduction in plant physiological parameters may have been a result of water and nutrient deficits due to roots being infected by *Fusarium oxysporum* [4-7]. Transpiration and photosynthesis were found to be positively correlated with stomatal conductance and stomata opening. The results were consistent with previous research where infection by collar and root rot *Fusarium oxysporum* led to necrosis of collar and root rot [1-3,7], reducing the capacity of plants to uptake water and nutrients [8-10]. High levels of *F. oxysporum* inoculum causing root infection has also been reported to cause significant stomatal closure due to water deficit, and hence limit gas exchange. Consequently, plants were unable to capture and utilize CO_2 from the ambient environment to achieve effective gas exchange with low stomatal conductance and photosynthesis [11,12].

The threshold levels, or the minimum amount of pathogen inoculum required to cause disease symptoms, of cultivars H3402 and V2 were found to differ, with V2 being more susceptible at the very low inoculum concentration. H3402 may be slightly more resistant against lower inoculum levels of the particular *F. oxysporum* strain UMT01 used in this experiment. However, although there were no significant differences in plant height and root dry weight between control and 102 ml-1 treatments of cv. H3402, the physiological parameters between these two treatments were significantly different. It is possible that although the lowest level of pathogen inoculum was not adequate to cause clear disease symptoms in H3402, plant growth and development was affected as indicated by significant decreases in photosynthesis, stomatal conductance and transpiration. This demonstrates the power and capability of e-Nose in early disease detection in the absence of any visual symptoms. For V2, biomass production and physiological response were consistent. It was highly sensitive to the *F. oxysporum* strain UMT01 as above ground height, root dry weight and all three physiological parameters decreased significantly from the Low inoculum concentration treatment at 102 ml-1. Further research is required to determine the correlation between level of inoculum and impact on disease development in processing tomato fields. The variability of the production of VOCs was expected, which was assumed to be correlated with the interactions between *F. oxysporum* and processing tomato plants. The increase in volatile compounds MQ135 and MQ138 (alcohol/ammonia/benzene), correlated with previous research where *F. oxysporum* was found to be able to assimilate ethanol from plant cell walls [13-17]. Early detection of changes in production of volatile compounds could hence be further applied in the field to identify early signs of plant diseases and pathogen infection. The increase in ethanol production and decrease in gas exchange rates could provide preliminary evidence of compromised plant health conditions especially in early growth stage.

5. Conclusions

Fusarium oxysporum collar and root rot pathogen was shown to cause significant growth damage and yield loss of processing tomatoes in a glasshouse bioassay, and the threshold levels to cause infection and disease symptoms varied for different tomato cultivars. Based on the glasshouse pathogenicity assays of the two cultivars tested, there was no adequate resistance against *F. oxysporum* from either of the cultivars, especially under high levels of infection. Future studies and experiments will focus on testing and screening more processing tomato cultivars for identification of putative host resistance to this novel *Fusarium oxysporum* collar and root pathogen and correlating disease development with level of inoculum in the field soil.

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Tomato Flower Classification for Better Cross-pollination

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Matthew Stewart, Ann Morrison and Bill Ashcroft; APTRC
Sam North; NSW Department of Primary Industries

Introduction

The availability of "clean" (virus-free) seed is a major issue for the Australian processing tomato industry. All seed comes from overseas, where hybrid varieties are produced by crossing parent lines in countries where labour costs are low, but where viroids are known to occur. Australia is currently free of these pathogens and industry want to keep it that way, but seed treatment takes time, costs are prohibitive, and seed companies are reluctant to supply a relatively small market, where consignments are destroyed if found to be contaminated. If it were possible to automate the crossing process, we may be able to produce clean seed in Australia, thereby securing seed supplies and reducing costs to Australian growers. This project was instigated as a first step in this process.

This study focused on identifying appropriate flowers for crossing, using viable technology. When implementing artificial cross-pollination, a crucial step is selecting the flowers appropriately, either for pollen extraction or for pollen fertilization. The maturity of a tomato flower is the main factor in the selection process. To create a supportive and accurate foundation for determining which flowers to use when performing artificial cross-pollination, the portable solution developed will classify tomato flowers in terms of maturity using an image input provided anytime, anywhere and with ease.

This approach uses advanced machine learning techniques commonly known as deep learning. A deep learning model is trained using labelled images of tomato flowers to perform multi-class image classification under three maturity classes – high maturity, low maturity, and ineffective flowers (in terms of cross-pollination). To aid the training process, a comprehensive dataset containing more than 2,000 images of individual tomato flowers was created in collaboration with the APTRC. The dataset includes diversity in terms of lighting condition, view-angle, and proportion (flower to image) which contributes to the robustness of the solution. Out of many deep learning algorithms, Convolutional Neural Networks (CNN) were selected in this instance due to their success in other image classification situations. Finally, to make the trained CNN model accessible, it was implemented through an Android-based mobile phone application with a simple user-interface. With the common use of smartphones and integrated camera accessibility, a mobile application is highly feasible. Mobile phones also provide portability, facilitating the classification of tomato flowers in the field in real time for successful artificial cross-pollination.

Flower Images and CNN Performance

The tomato flower dataset resulting from this research is the world's first dataset to hold images showing individual tomato flowers. The floral images were initially categorized into four age groups – early-aged, middle-aged, matured, and old (dried out) flowers. Thinking in terms of maturity levels to distinguish flowers for successful cross-pollination, early-aged and dried-out flowers were considered "ineffective" as early-aged flowers are yet to open. Middle-aged flowers on the other hand are suitable for initiating cross-fertilization, as self-pollination is yet to happen. Compared to matured flowers where pollen extraction can be done easily, middle-aged flowers are considered as flowers with "low maturity" levels. Matured flowers can be identified as those with "high maturity" levels. These flowers are highly likely to be self-fertilized, but pollen extracted from them can be brushed upon the stigma of a flower with a low maturity level to make a successful cross. The multi-class image classification problem was therefore formulated in line with the three classes. Figure 1 shows some images from the dataset belonging to each class.

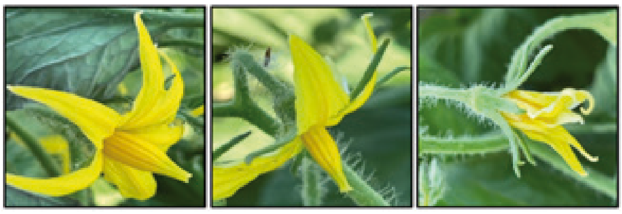


Figure 1: Images from the dataset (from left to right – high maturity, low maturity, and ineffective).

With the data prepared, the training was carried out for the CNN algorithm. A customized CNN was developed before training, and through many trials it was adjusted and hyperparameter tuned to achieve a promising accuracy with the data at hand. Out of the 2,000+ images, 80% was used for training, 15% for validation, and 5% for testing. While training, data augmentation was implemented as layers of the CNN with settings such as randomized flipping, rotation, and contrast for the images. This consolidates the performance of the CNN algorithm to be thorough with the data and to tackle further diversity when tested. Figure 2 shows the accuracy showcased by the deployed CNN when it was trained and validated for 30 epochs (turns).

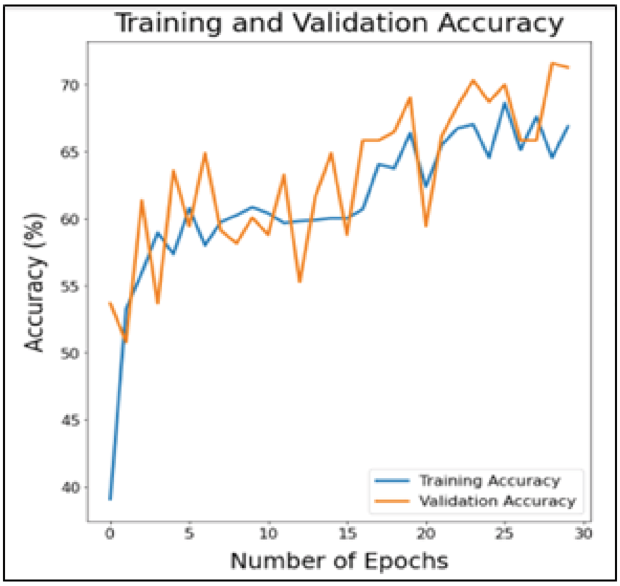


Figure 2: Accuracy curve obtained for the CNN by training and validating for 30 epochs.

After 30 epochs, the CNN achieved a validation accuracy of more than 70% which is acceptable given the nature of the problem. As the maturity of flowers is a biological scale, the prediction probability output of the CNN is useful and can be utilized via the mobile application. The CNN shows potential (with the upward trend) of reaching a more significant accuracy through increasing the number of epochs and by expanding the dataset. However, the deployed CNN with 70% accuracy is sufficient to work with and obtain reliable results.

Mobile Application and Usage

The Android-based mobile application was designed with a minimalistic layout, allowing the user to access necessary tools to insert a tomato flower image. The user can choose to capture a picture of a tomato flower in real-time or insert one from their device storage. These tools can be accessed through the application's homepage (see figure 3).

The mobile application accesses the CNN using the cloud, as the CNN is deployed into the Google Cloud Platform (GCP). When an input is given, the application feeds it to the CNN model and the output is displayed in a comprehensive manner. The predicted class with the highest prediction probability is displayed after the result is obtained along with the inserted image. The prediction probability percentage is also shown so that the user has more insights into the prediction to support their judgement. If the CNN predicts the "Ineffective" class, the application displays "Unusable flower" to make the result more comprehensive to the user. Once the image input is given, the CNN algorithm will run in under 6 seconds to return the result to the user. Figure 4 illustrates two instances where predictions were made on flowers.

Figure 3: Homepage user interface of the mobile application

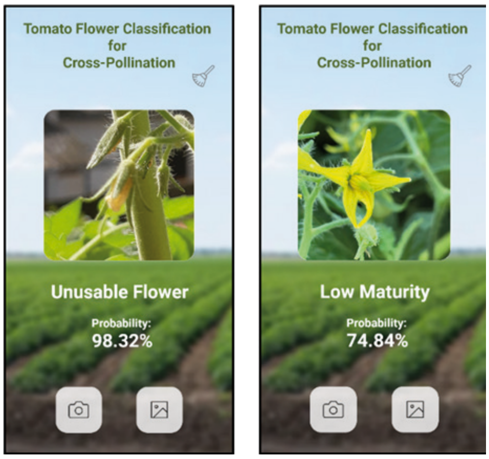
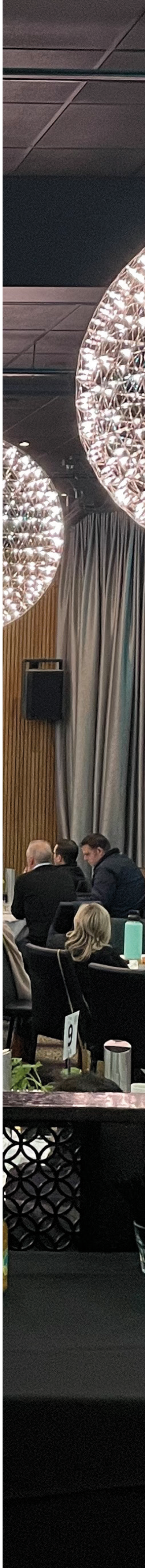


Figure 4: Predictions made with a flower bud (left) and a flower with low maturity level (right)

Conclusion

This research focuses on developing a portable solution to automate the flower selection process for tomato flower cross-pollination in terms of flower maturity. Flower images were considered effective as the flower's appearance can emphasize the maturity level. A dataset with more than 2,000 images of individual flowers was therefore put together in collaboration with the APTRC to train a customized CNN. Enabling more robustness and reliability by utilizing deep learning, an accuracy of 70% was obtained after 30 rounds of training to predict flower maturity under three classes in line with the objective of implementing successful tomato flower cross-pollination. The CNN was later deployed into an Android-based mobile phone application efficiently addressing the need for portability. With a comprehensive output of results, anyone can predict the maturity levels of tomato flowers that will aid them to carry out successful tomato flower cross-pollination.



Australian Processing Tomato Cultivar Trials 2021-2022

Ann Morrison and Bill Ashcroft

Introduction

Cultivar selection remains a critical step in growing a processing tomato crop, affecting field performance, pest and disease tolerance and processing efficiency. In a continuation of the Australian Processing Tomato Research Council's on-going cultivar improvement program, five preliminary "observational" field trials were established along with a number of mid-season replicated machine harvested trials in season 21/22.

The trials were located within an area stretching from Corop to Lake Boga in northern Victoria and up to Deniliquin in southern NSW.

Five varieties were given an initial rating based on a visual assessment of vine and fruit characteristics in the 21-22 season screening trials. These screening trials are used to identify promising lines for inclusion in the following season's machine harvest trials.

Two early season and seven mid-season replicated trials were successfully machine harvested over the season. The four mid-season trials in the Boort region were direct seeded, while all other areas used transplant seedlings.

Seed availability remained a limitation this season, so as direct seeded crops require approximately three times the seed per hectare in comparison to transplanted crops, the number of cultivars available for direct seeded trials was unfortunately restricted.

Materials and Methods

Cultivars

Cultivars (or mixes) assessed in the 2021-22 screening and machine harvest trials are listed in Table 1.

Table 1. Cultivars evaluated during the 2021-22 growing season

	Screening (transplants)					Machine Harvest (transplants)					Machine Harvest (direct seeded)			
	Early		Mid-season			Early		Mid-season						
	Kagome (Deniliquin NSW)	Kilter (Winlaton Vic)	Kagome (Rochester Vic)	Kilter (Winlaton Vic)	Weeks (Strathallan Vic)	Kagome (Deniliquin NSW)	Kilter (Winlaton Vic)	Kennedy (Corop Vic)	Kagome (Rochester Vic)	Weeks (Strathallan Vic)	Lehmann (Boort Vic)	Lawrence (Boort Vic)	Sawer (Boort Vic)	Henry (Boort Vic)
H1015		✔					✔							
H1014	✔					✔								
SPS 220-0	✔	✔												
SVTM9000						✔	✔							
HM Encina						✔	✔							
HM Pumatis						✔	✔							
HM Enotrio						✔	✔							
H3406									✔					
H1307									✔					
H1311 Mix											✔	✔	✔	
H1996			✔	✔	✔									
H2011									✔					
H3402			✔	✔	✔			✔	✔	✔	✔	✔	✔	✔
H3402 Mix								✔	✔	✔				
H3406 Mix								✔	✔	✔				
H5408			✔	✔	✔									
HM 4885			✔	✔	✔									
HMX 5558													✔	
HM 58811								✔	✔	✔	✔	✔	✔	✔
HM Nava										✔				
SVTM 9008			✔	✔	✔									
SVTM 9023								✔	✔	✔			✔	
SVTM 9024								✔	✔	✔			✔	
UG 16112								✔	✔	✔				✔

H - Heinz, HM - HM Clause, SPS - South Pacific Seeds, SVTM - Seminis

Seed mixes: H3402 Mix = H3402:H2401 60:40
H1311 Mix = H3402:H1311 70:30
H3406 Mix = H3406:H1311 70:30

Introduction

Preliminary Screening trials

Two early and three mid-season transplanted screening trials were established, with each consisting of two ten metre plots per cultivar. These trials were visually assessed and rated prior to the paddock being harvested.

Machine harvested trials

The machine harvested trials were laid out in a randomised complete block (RCB) design. This is a standard design for agricultural experiments used to help mitigate the impact of variations in trial results due to spatial effects in the paddock e.g., soil type or irrigation.

Where possible, trials were set out with five replicates (blocks) repeating along the rows. Plots ranged from 60 to 100 metres in length depending on the trial site. All sites were drip irrigated single row beds ranging from 1.52 to 1.67 metres in width and trial cultivars were assigned at random across each block.

A hand-held GPS unit was used to measure and peg out the machine harvest trial rows. During planting, cultivars were swapped at each peg in accordance with the trial plan. The weight of harvestable fruit produced from each trial plot was measured using load cells on the bulk harvester trailers.

As a measure of site variability, plant counts were performed on all machine harvest trials within a month of crop emergence or transplanting. The number of plants within a two-metre section was counted at five locations spread evenly across each trial plot. These figures were then used to estimate the plant population within that plot.

Prior to harvest, twenty healthy red fruit were randomly sampled from each trial plot and taken to the Kagome Laboratory for Brix, pH, and colour testing. A pureed sample of raw fruit was used for Brix and pH testing using a refractometer for the former and pH meter for the latter test. A hand diced fruit sample was also tested for colour, using a Hunter Lab Colorimeter.

Fruit moisture content was also measured from the fruit sample with a Mettler Toledo moisture analyser HC103 using AOAC prescribed method number 972.20.

The preferred raw fruit pH is around the 4.3 - 4.4 range or lower, and the desirable a/b colour score (obtained by dividing colour a by colour b) is 1.9 or higher.

Red fruit yields (tonnes per hectare) from trial plots were calculated using trial plot weights together with the row length and width.

Yield and Brix results were multiplied together to determine the tonnes per hectare of soluble solids (labelled as soluble solids (t/ha)).

Statistics

Trial results were analysed using the ARM 9 statistical program to perform analysis of variance (ANOVA), comparing the differences between group means. Whether the difference between means was significant or not was determined using Tukey's HSD (honest significant difference) P = 0.05.

Results and Discussion

The 2020 - 21 growing season was relatively cool with early season trial harvest starting after 122 days in the field at the Kagome Moonee Valley (Deniliquin) site. The mid-season trials ranged from 141 to 162 days in the field compared with 126 to 164 days for the previous season. Trials were restricted once again by the lack of new material available for testing – a consequence of the difficulty and expense involved with bringing "clean" seed into the country. We are particularly grateful for the continuing efforts of seed companies such as HM Clause and Seminis in sourcing and providing new cultivars for the program this season.

Early Season Trials

Five cultivars were included in the two early machine harvested trials, both of which were planted in the second week of October and harvested around the 10th of February.

Tables 2 and 3 contain the ANOVA results from these trials (in the tables, average values followed by same letter do not significantly differ (P=.05, Tukey's HSD)). The commercial standard available at the Kagome site was H1014 and for Kilter H1015.

Table 2. ANOVA results for Kagome Moonee Valley (Deniliquin, NSW) early season transplant trial (122 days in the field).

Variety	Plants/ha		Yield (t/ha)		°Brix		Soluble solids (t/ha)		pH		Colour a/b		Fruit Moisture %	
H1014	19211	a	171.67	a	4.99	a	8.57	a	4.55	a	2.52	a	93.98	a
HM Encina	17500		161.53	ab	4.98	a	8.01	a	4.50	a	2.25		94.02	a
HM Enotrio	18816	a	134.45	b	5.67	a	7.60	a	4.78		2.65	a	93.78	a
HM Pumatis	18289	a	158.90	ab	5.27	a	8.39	a	4.50	a	2.43	a	94.17	a
SVTM9000	19474	a	161.17	ab	5.35	a	8.58	a	4.51	a	2.43	a	94.19	a
Tukey's HSD (P=.05)	1847		29.75		0.77		1.502		0.09		0.39		1.48	
Treatment Prob (F)	0.298		0.019		0.080		0.254		0.295		0.312		0.913	

Excluded Encina from data plants/ha to correct heterogeneity of variance/skewness.
Excluded Enotrio from pH to correct heterogeneity of variance/skewness/kurtosis.
Excluded Encina from colour a/b to correct heterogeneity of variance.

Table 3. ANOVA results for Kilter (Winlaton, Vic) early season transplant trial (123 days in the field).

Variety	Plants/ha		Yield (t/ha)		°Brix		Soluble solids (t/ha)		pH		Colour a/b		Fruit Moisture %	
H1015	19474	a	145.88	a	5.27	a	7.65	a	4.47	ab	2.51	a	93.52	a
HM Encina	18290		156.18		5.19	a	8.07	a	4.37	c	2.36	a	94.79	a
HM Enotrio	18289	b	134.63	a	5.46	a	7.31	a	4.50	a	2.60	a	94.22	a
HM Pumatis	18684	ab	131.58	a	5.33	a	6.93	a	4.38	bc	2.38	a	93.78	a
SVTM9000	18421	ab	148.36	a	5.17	a	7.55	a	4.45		2.41	a	94.81	a
Tukey's HSD (P=.05)	1128		36.44		0.89		0.125t		0.10		0.30		1.49	
Treatment Prob (F)	0.037		0.468		0.860		0.699		0.003		0.118		0.059	

Excluded HM Encina from plants/ha & yield to correct heterogeneity of variance/skewness/kurtosis.
Excluded HM Pumatis from pH to correct heterogeneity of variance.

Both early trials were high yielding with the average gross red fruit yield across the Kagome trial being 157 tonnes per hectare and in the Kilter trial 143 tonnes. The highest yielding cultivar was H1014, producing just over 171 tonnes per hectare in the Kagome trial and HM Encina yielding 156 tonnes per hectare at Kilter.

The only statistically significant difference in yields was from the cultivar HM Enotrio which produced 134 tonnes per hectare, 37 tonnes per hectare less than the standard (H1014) at Moonee Valley.

There were no significant differences in Brix across the two sites with the lower yielding varieties tending to have higher Brix readings.

Figure 1 shows yield and Brix as a percentage of the control varieties (H1014 and H1015). In the two early season trials, cultivars tended to have either a higher yield or Brix than the controls but not both. HM Enotrio's data point with a statistically significant lower yield appears as the light blue circle in the lower right corner of the graph.

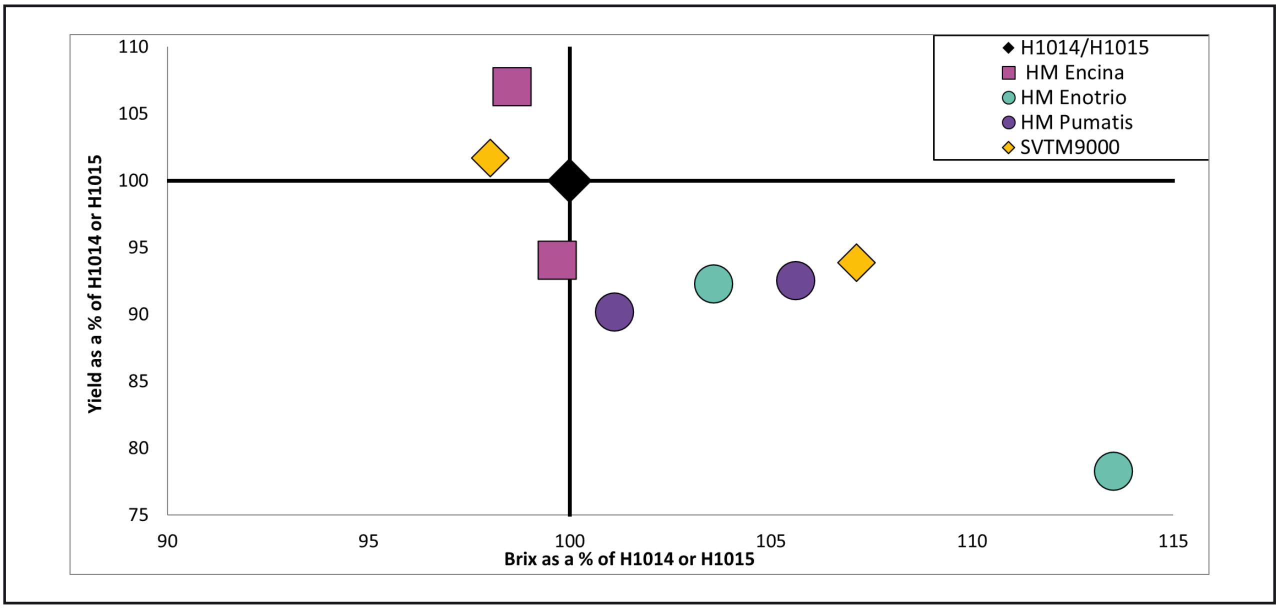


Figure 1. Early season cultivar yield and Brix as a percentage of standards H1014 or H1015.

Raw fruit pH ranged from 4.37 to 4.78 across the two trials and HM Encina had a significantly lower pH in the Kilter trial.

Across the two trials, a/b colour ranged from 2.25 to 2.65 with no differences between the cultivars, however HM Enotrio had the highest a/b colour score at both sites.

Mid-Season Trials

The first direct seeded trial was sown on 11th October, and the first transplant trial was established on 20th October 2021. All seven trials were successfully harvested. Constraints in seed availability limited the cultivar range in some trials.

Mid-season trial harvests commenced later than ideal, starting on the 10th of March. The final trial (Henry's) was harvested on the 26th of April 2022, so trials ranged from 141 to 162 days in the field.

Analysis of Variance Tables

In the ANOVA results tables, numbers in red font signify results that are significantly worse than the mid- season industry standard cultivar (H3402) and green font numbers are significantly better for that parameter. Data which has been excluded from analysis is highlighted grey with the reason for exclusion listed below the table.

Table 4. ANOVA results for Henry (Boort, Vic) direct seeded trial (162 days in field).

Variety	Plants/ha		Yield (t/ha)		°Brix		Soluble solids (t/ha)		pH		Colour a/b		Moisture %	
H3402	51138	a	97.83	b	5.86	a	5.72	b	4.43	a	2.38	a	93.30	a
HM58811	48383	a	128.32	a	6.25	a	7.99	a	4.36	a	2.17	a	92.47	a
UG16112	50060	a	131.89	a	5.72	a	7.55	a	4.35	a	2.19	a	92.81	a
Tukey's HSD (P=.05)	12126		14.03		1.07		1.035		0.18		0.34		0.90	
Treatment Prob (F)	0.812		0.000		0.390		0.001		0.403		0.207		0.102	

Table 5. ANOVA results for Kagome (Rochester, Vic) transplanted trial (149 days in field).

Variety	Plants/ha		Yield (t/ha)		°Brix		Soluble solids (t/ha)		pH		Colour a/b		Moisture %	
H3406	18684		151.51	a	5.12	b	7.74	a	4.54	ab	2.11	b	94.61	a
H1307	19137	a	126.353	b	6.21	a	7.83	a	4.65	a	2.14	b	92.51	a
H2011	18816	a	146.72	ab	5.48	b	8.04	a	4.53	ab	2.31	ab	93.91	a
H3402	18421	a	134.482	ab	5.43	b	7.31	a	4.77		2.30	ab	94.49	a
H3402 Mix	18947	a	136.03	ab	5.35	b	7.29	a	4.47	bc	2.48	a	93.87	a
H3406 Mix	18816	a	146.67	ab	5.06	b	7.43	a	4.49	bc	2.22	ab	94.02	a
HM58811	19211	a	151.90	a	5.45	b	8.31	a	4.48	bc	2.30	ab	93.30	a
SVTM9023	18553	a	148.22	ab	5.66	ab	8.42	a	4.45	bc	2.11	b	94.34	a
SVTM9024	19211	a	143.58	ab	5.37	b	7.72	a	4.36	c	2.24	ab	94.36	a
UG16112	18816	a	144.16	ab	5.50	b	7.92	a	4.47	bc	2.12	b	93.82	a
Tukey's HSD (P=.05)	1633		22.69		0.69		1.776		0.15		0.32		2.13	
Treatment Prob (F)	0.735		0.010		0.000		0.384		0.0001		0.008		0.071	

Excluded H3406 from Plants/ha to correct heterogeneity of variance/skewness/kurtosis.
Excluded H3402 from pH to correct heterogeneity of variance/skewness/kurtosis.
Excluded replicate 4 from Colour a/b to correct kurtosis.

Table 6. ANOVA results for Kennedy (Corop, Vic) transplanted trial (141 days in the field).

Variety	Plants/ha		Yield (t/ha)		°Brix		Soluble solids (t/ha)		pH		Colour a/b		Moisture %	
H3402	19605	a	79.23	a	4.99	b	3.68	b	4.73	a	2.25	a	93.64	a
H3402 Mix	19474	a	91.67	a	5.35	ab	4.59	ab	4.61	ab	2.35	a	93.25	a
H3406 Mix	19605	a	76.44	a	5.21	ab	4.22	b	4.66	ab	2.35	a	94.28	a
HM58811	19605	a	101.24	a	5.83	a	5.55	ab	4.56	abc	2.29	a	93.33	a
SVTM9023	19342	a	103.59	a	5.67	ab	6.49	a	4.49	bc	2.34	a	92.72	a
SVTM9024	18947	a	80.68	a	5.65	ab	4.61	ab	4.40	c	2.19	a	92.96	a
UG16112	18816		86.17	a	5.25	ab	4.68	ab	4.52	bc	2.20	a	93.34	
Tukey's HSD (P=.05)	1006		39.01		0.73		2.004		0.19		0.39		2.15	
Treatment Prob (F)	0.299		0.187		0.012		0.004		0.0002		0.680		0.302	

Excluded UG16112 from plants/ha to correct heterogeneity of variance/skewness/kurtosis.
Excluded replicate 2 from Yield (t/ha) to correct kurtosis.
Excluded UG16112 from data Moisture % to correct heterogeneity of variance.

Table 7. ANOVA results for Lawrence (Boort, Vic) direct seeded trial (159 days in the field).

Variety	Plants/ha		Yield (t/ha)		°Brix		Soluble solids (t/ha)		pH		Colour a/b		Moisture %	
H1311 Mix	58563	a	165.45	a	5.78	b	9.57	a	4.34	a	2.50	a	93.17	a
H3402	62275	a	150.81	a	5.48	c	8.25	a	4.33	a	2.36	a	93.10	a
HM58811	57485	a	155.91	a	6.17	a	9.60	a	4.24	a	2.26	a	92.30	a
Tukey's HSD (P=.05)	8321		30.93		0.30		1.561		0.11		0.25		0.89	
Treatment Prob (F)	0.282		0.429		0.001		0.063		0.070		0.065		0.041	

Table 8. ANOVA results for Lehmann (Boort, Vic) direct seeded trial (159 days in the field).

Variety	Plants/ha		Yield (t/ha)		°Brix		Soluble solids (t/ha)		pH		Colour a/b		Moisture %	
H1311 Mix	61317	a	95.75	a	5.02	a	4.83	a	4.53	a	2.36	a	94.51	
H3402	60719	a	80.45	a	4.93	a	4.08	a	4.55	a	2.32	a	93.11	a
HM58811	51377	a	106.04	a	5.01	a	5.52	a	4.42	b	2.30	a	93.48	a
Tukey's HSD (P=.05)	12089		0.1314t		0.69		1.515		0.10		0.31		1.32	
Treatment Prob (F)	0.082		0.085		0.917		0.074		0.008		0.872		0.477	

Applied automatic data correction transformation 'Log(n+1)' to Yield (t/ha) to correct skewness.
Excluded H1311 Mix from Moisture % to correct skewness/kurtosis.

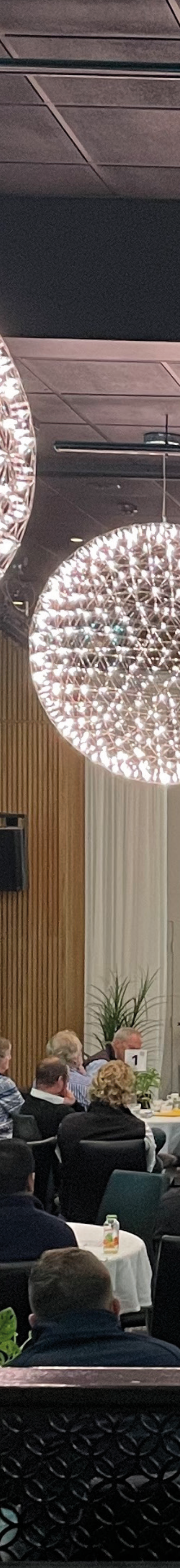
Table 9. ANOVA results for Sawer (Boort, Vic) direct seeded trial (148 days in the field).

Variety	Plants/ha		Yield (t/ha)		°Brix		Soluble solids (t/ha)		pH		Colour a/b		Moisture %	
SVTM9023	51579	a	115.59	ab	6.284	a	7.30	a	4.37	a	2.40	a	91.94	a
HMX5558 (Orsorosso)	66184	a	98.99	b	5.8	a	5.69	b	4.42	a	2.17	a	92.03	a
H1311 Mix	57632	a	128.13	a	6.108	a	7.79	a	4.44	a	2.42	a	92.56	a
H3402	61711	a	129.73	a	5.706	a	7.38	a	4.48	a	2.18	a	92.55	a
HM58811	58816	a	120.02	a	6.242	a	7.51	a	4.37	a	2.30	a	92.85	a
SVTM9024	54869	a	128.87	a	6.23	a	8.04	a	4.35	a	2.41	a	92.27	a
Tukey's HSD (P=.05)	20504		18.49		0.92		1.515		0.20		0.34		2.58	
Treatment Prob (F)	0.329		0.0003		0.249		0.002		0.3465		0.079		0.863	

Table 10. ANOVA results for Weeks (Rochester, Vic) transplanted trial (148 days in the field).

Variety	Plants/ha		Yield (t/ha)		°Brix		Soluble solids (t/ha)		pH		Colour a/b		Moisture %	
H3402	19869	ab	144.17	a	5.12	b	7.39	bc	4.70	a	2.29	a	93.47	a
H3402 Mix	19605	ab	143.36		5.05	b	7.18	bc	4.62	ab	2.10	a	93.88	a
H3406 Mix	19211	ab	143.16	a	5.11	b	7.33	bc	4.54	abc	2.41	a	93.93	
HM58811	19342	ab	164.14	a	5.63	ab	9.25	a	4.48	bc	2.33	a	93.43	a
HM Nava	19737	ab	113.38	b	6.09	a	6.94	c	4.41	c	2.32	a	93.45	a
SVTM9023	19211	ab	158.70	a	5.59	ab	8.91	ab	4.50	bc	2.19	a	93.50	a
SVTM9024	20000	a	145.59	a	5.30	ab	7.73	abc	4.42	c	2.07	a	93.33	a
UG16112	18947	b	156.13	a	5.02	b	7.82	abc	4.48	bc	2.20	a	93.30	a
Tukey's HSD (P=.05)	1050		21.96		0.0589t		1.74		0.17		0.36		2.69	
Treatment Prob (F)	0.032		0.000		0.005		0.001		0.000		0.056		0.995	

Automatic data correction transformation 'Log(n+1)' to °Brix to correct heterogeneity of variance/kurtosis.
Excluded H3406 Mix from Moisture % to correct heterogeneity of variance.



Plant density

Plant numbers were counted within three weeks of emergence/transplanting with populations ranging from 18,400 to 19,800 plants per hectare in transplant trials and 51,300 to 66,100 plants per hectare in direct seeded trials. Whilst there were no statistically significant differences in plant populations compared to H3402, UG16112 had a significantly lower plant population than SVTM9024 in the trial at Weeks' however yields were not significantly different.

Yield and Brix

The following figures (Figure 2 onwards) show data from all mid-sesson sites in graphical format for ease of comparison. In these figures green indicates values which are significantly better than the industry standard, red significantly worse and data which has been excluded from analysis is grey.

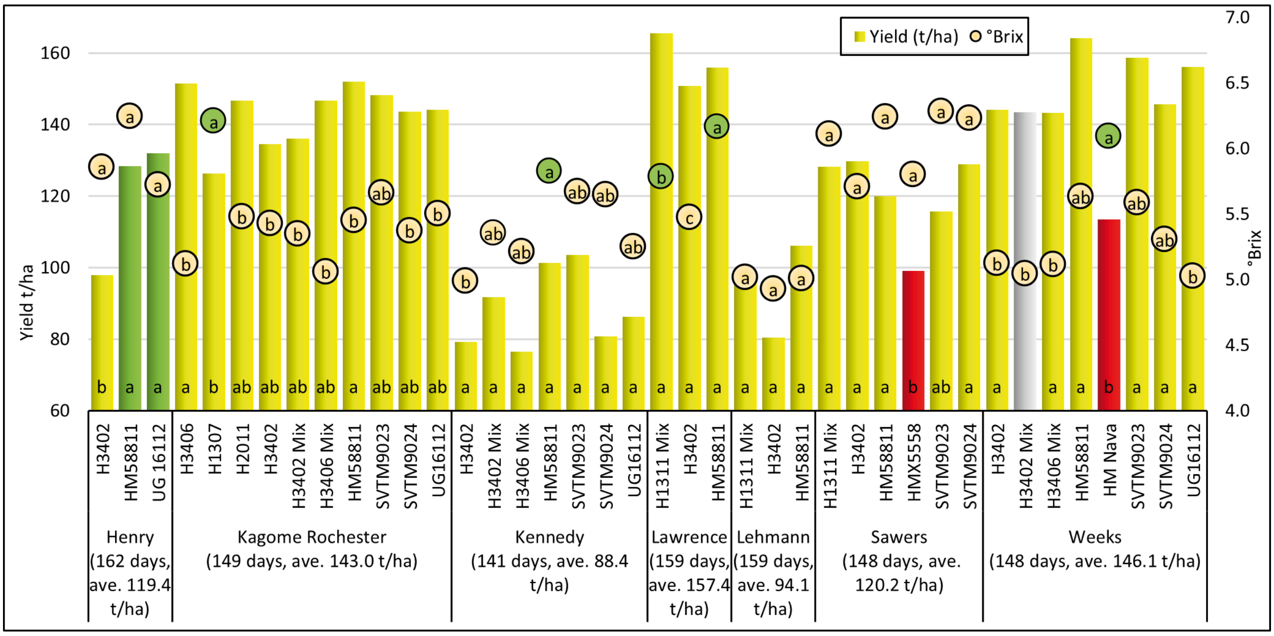


Figure 2. Mid-season trials' average yield and Brix compared to H3402 (with days in field and trial average yield).

Yields

The mid-season trial yields ranged from 76 to 165 tonnes per hectare. The lowest yielding trial was at Kennedys, which was severely affected by bacterial speck/spot disease early in the growing season.

The Henry, Sawer and Weeks trials all showed at least one cultivar with significant yield variation from that of the control cultivar H3402.

In the direct seeded trial at Henry's both HM58811 and UG16112 had significantly higher yields than H3402. This trial was harvested after 162 days and both higher yielding cultivars appeared to have less breakdown than H3402 (Figure 2).

HMX5558 also showed a significantly lower yield at Sawer's, as did HM Nava in the trial at Weeks'. Both these trials were also harvested later than ideal at 148 days and fruit breakdown was evident at both sites.

Brix

Average raw fruit Brix readings ranged from 6.28 for SVTM9023 at Sawer's to a low of 4.93 for H3402 at Lehmann's. Kagome, Kennedy, Lawrence, and Weeks trials all had at least one cultivar with significantly higher red fruit Brix values than H3402 (Figure 2).

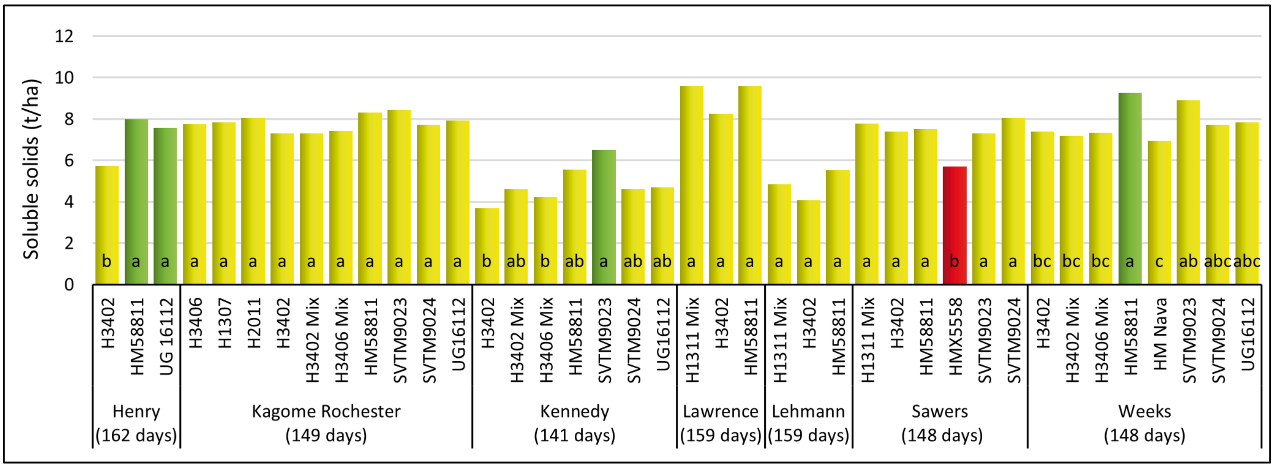


Figure 3. Mid-season trial average tonnes per hectare of solids compared to H3402 at each site.

Tonnes per hectare soluble solids

Soluble solids ranged from a low of 3.7 for H3402 at Kennedy's to a maximum of 9.6 from HM58811 in the trial at Lawrence's.

Four trials showed statistically significant results (Figure 3). HM58811 had significantly higher soluble solids in two trials and both SVTM9023 and UG16112 were higher in one trial each. The only significantly lower soluble solids result was from HMX5558 at Sawers'.

Figure 4 compares average yields and Brix as a percentage of H3402, which is represented by the black diamond in the cross hairs in the graph. HM58811, SVTM9023, UG16112, H2011 and H1311 Mix all showed both higher yields and Brix in at least one trial (indicated by data points in the upper right hand quadrant of the graph), although these differences are not necessarily statistically significant. SVTM9024 also tended to have similar yields to H3402 with slightly higher Brix.

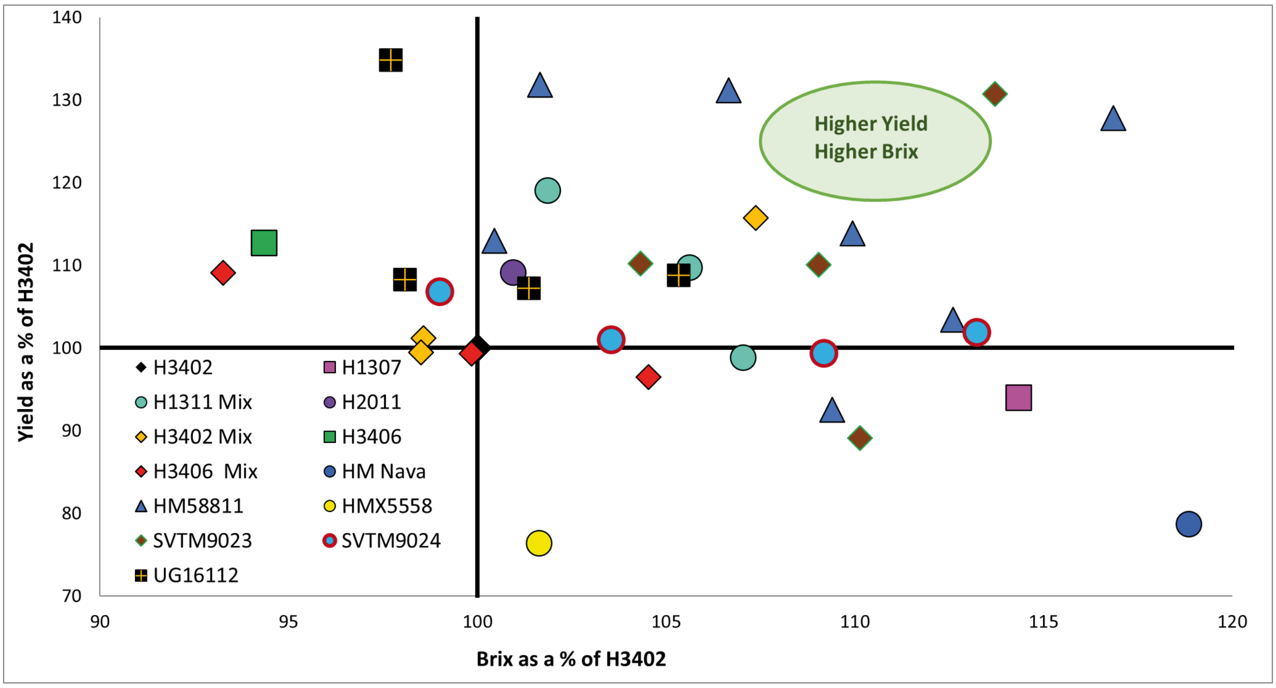


Figure 4. Average yields and Brix as a percentage of H3402.

pH

Raw fruit pH ranged from 4.24 to 4.77, with three quarters of the trial samples being over 4.4 (the upper limit of the preferred pH range). This may partially be due to the late harvest, as fruit pH tends to increase the longer fruit are left on the vine.

SVTM9023, SVTM9024, UG16112, HM58811 and HM Nava all had significantly lower pH values than that of H3402.

Colour

There were no statistically significant variations in average colour a/b scores from that of H3402. The colour scores across all mid-season trials ranged from a high of 2.50 from H1311 Mix (comprising H1311, a high lycopene cultivar, and H3402) at Kagome Rochester to a low of 2.07 for SVTM9023 at Weeks'.

Yield variation within mid-season cultivars

Differences in red fruit yields between replicates within a trial ranged from over 97 tonnes per hectare for HM 58811 in the mid-season trial at Lehmann's to around seven tonnes per hectare for H3402 in the trial at Henry's (Figure 5). This large variation between treatment plot yields underlies the difficulties in obtaining statistically significant differences in these trials.

The highest yield from a replicate across all trial sites this season, was 184 tonnes per hectare from HM58811 at Lawrence's.

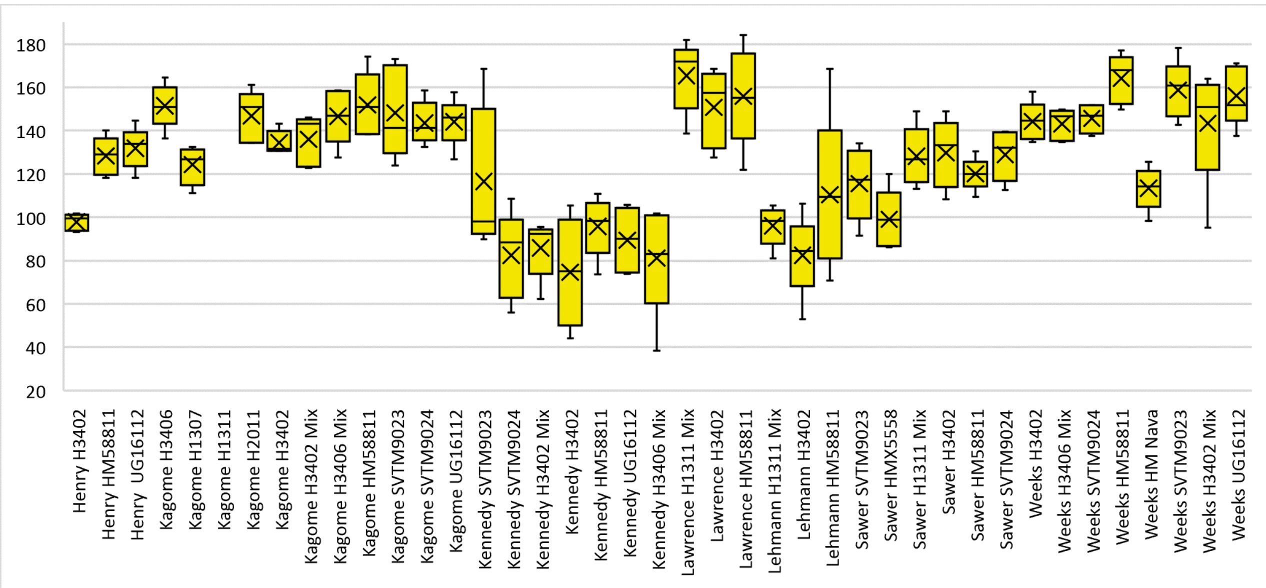


Figure 5. Box and whisker plot of mid-season replicate yields grouped by grower.

Average yearly yields and Brix over three seasons

Figure 6 shows the average yearly red fruit yields and Brix as a percentage of H3402 over the previous three seasons. These results are not necessarily statistically significant but show there are a range of cultivars which have consistently performed "as well as" the industry standard over several years (these are the varieties in the top right quadrant of the graph). These longer term results give confidence that these varieties will hold up under a range of seasonal conditions.

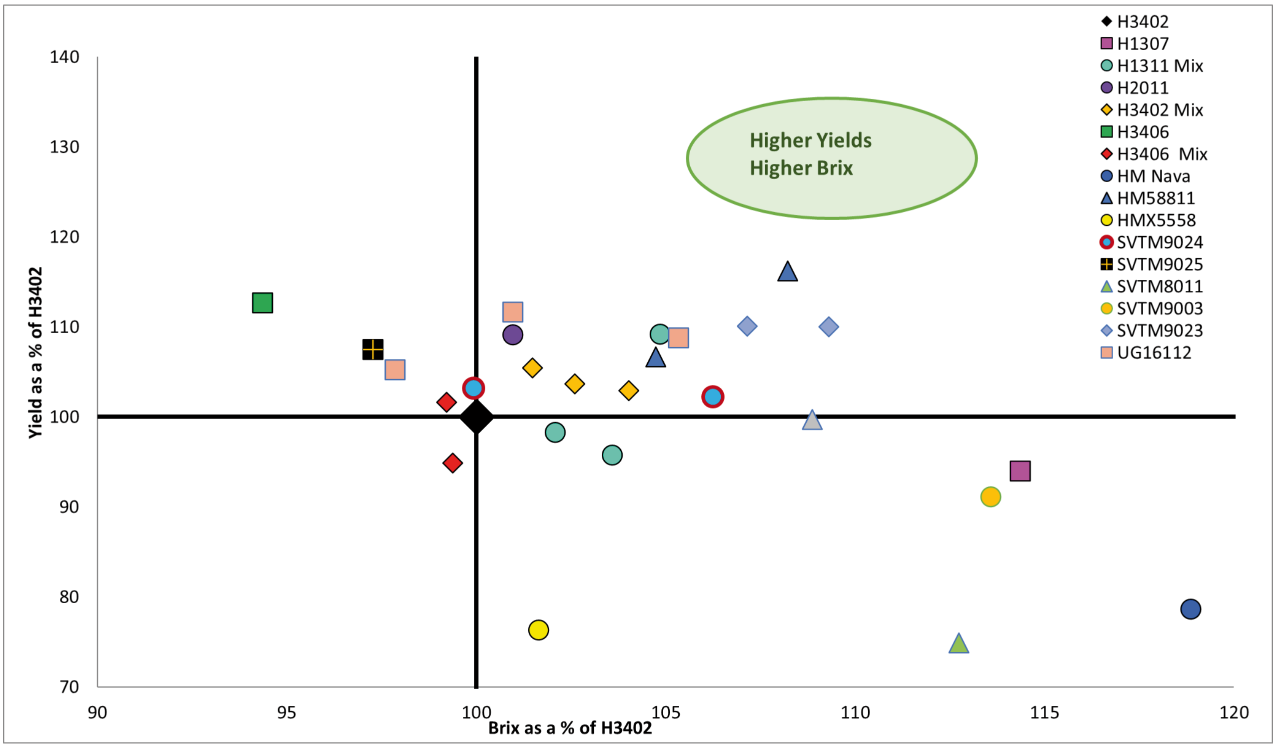


Figure 6. Average yearly mid-season trial results as a percentage of H3402 for the past 3 years

Moisture content

It has been suggested that fruit moisture content will decrease the longer fruit is left in the paddock past optimum harvest time, and consequently will impact the tonnes per hectare of fruit harvested.

Adverse weather conditions, among other factors, delay crop harvest. Variations in maturation times of the cultivars being assessed can also result in plots being harvested past their optimum maturity date. It has been proposed that standardising trial yields to 94% moisture content may help mitigate these effects and perhaps increase the sensitivity of the trials to detect significant differences.

To this end, fruit moisture content measurements were taken from the standard twenty fruit samples collected for laboratory analysis. Statistical analysis of the results found that there were no significant differences in moisture content in the trials (Table 4 to Table 10).

Looking at the variation in fruit moisture content of a cultivar across multiple trials harvested at different maturities did not show a clear pattern (data not shown). In addition, in a single trial, sampled on the 4th of April (after 149 days in the field) and again on the 17th (162 days), the tested moisture content increased in two out of the three cultivars planted (data not shown).

The result of adjusting yields to 94% moisture content in the trial at Kagome's Rochester site (harvested after 149 days) was variable, with the moisture corrected yields being lower for some cultivars in comparison to the red fruit yields straight from the paddock (Figure 7).

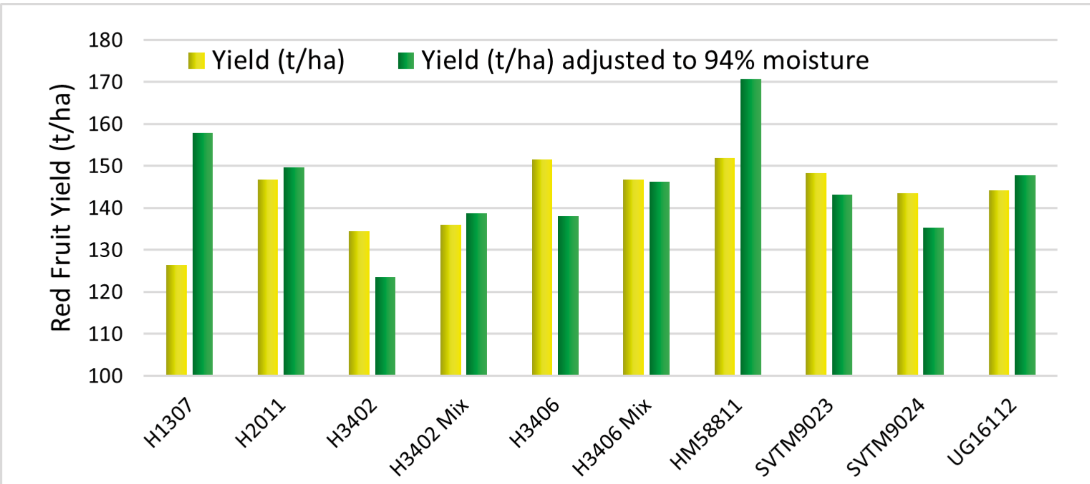


Figure 7. Kagome Rochester Vic red fruit yields from paddock and adjusted to 94% moisture.

Factors such as planting date may affect fruit moisture loss. Crops with delayed harvest in the hotter months would be expected to lose more moisture than those later in the season when the weather is milder. More work is needed to assess the limitations and implications of this approach.

Screening Trials

Two early season screening trials were established in the second week of October 2021, one at Kilter (Winlaton, Victoria) and the second at a Kagome Farms' block east of Deniliquin NSW. Visual assessment of the early cultivars was performed on February 8th, 2022, at 119 and 122 days after transplanting respectively (Table 11).

Mid-season screening trials were planted in two locations in Victoria, one at Kagome's Wilson Road paddock out of Rochester (planted 28th October 2021), and the second at Weeks' in Strathallan planted 5 days later on the 2nd of November. Both sites were assessed on March 7th, 130 and 125 days after planting respectively. Both crops were within a week or two of harvest and were starting to show leaf disease and in some cases fruit breakdown enhanced by moist/humid seasonal conditions.

Table 11. Early season screening trial assessments (compilation of assessments from both sites)

Cultivar	Comments	Rating (-/10)
H1014	Kagome site only, where it was the control. Medium-vigorous vine on the bed, dark foliage, cover ok. Fruit medium-firm, small-medium egg-plum shaped, fruit with some very good colour. Concentration good, with good yield also. Not much bleach but a bit of breakdown evident.	7 Small fruit and hint of breakdown?
H1015	Kilter site only, where it was the control. Medium-spreading vine on the bed with dark foliage. Bit of leaf roll and disease on top but not bad. Medium sized, firm, blocky plum-egg shaped fruit with good colour. A few dimpled and a hint of bleach. Good yield and concentration.	8
HM Encina	Medium-vigorous vine – a bit upright but on the bed with large, dark, leaves -some rolled. Good sized (some large) blocky plum-pear fruit – a few puffy, medium firmness with a bit of grey-wall and veining detracting from good colour. Good concentration but question over holding – breakdown evident at both sites. Some patches of leaf disease also. Good yield but holding the issue (though rated as a 105 day cv in Spain).	5.5
HM Enotrio	Medium-vigorous vine – a bit upright and maybe opening up at MV, but on the bed at both sites and with good concentration. Medium sized plum-egg fruit, firm with very good colour, small core and good yield. Hint of bleach and leaf disease, with a little breakdown just showing at MV. Overall pretty good.	7
HM Pumatis	Medium/compact vine on the bed with some leaf roll. Foliage a bit lighter but not much disease and cover still ok. Yield and concentration good. Fruit a bit variable but mostly medium egg-plum fruit, firm with good colour although a little bleach and shoulder discoloration noted. A few dimples and a hint of breakdown at MV but still ok.	7
SVTM 9000	Medium-vigorous vine, spreading but on the bed with dark foliage. Fruit size and shape a bit variable, mainly medium but some smaller fruit, and shape blocky egg-plum with a few elongated and dimples. Good colour. Firm with thick walls. A few greens but concentration good. A hint of bleach but holding so far – maybe a tad later maturing. Yield good.	7 Size
SPS 220-0	**An observation line planted at both sites.** Row trimmed by a bin trailer at one site. Medium vigorous vine on the bed, a bit open at one site, medium-light foliage. Cover and yield ok, some good colour and fruit very firm with good colour. Size a little variable but ok, blocky plum-eggs. Hint of bleach and leaf disease at one site, but overall, looks ok. Maybe second early?	7
Cultivars at both sites generally had medium-vigorous vines with good canopy retention, although there was a little breakdown beginning to show up in some lines mainly at the Deniliquin (Moonee Valley) site.		

Table 12. Mid-season screening trial assessments

Cultivar	Comments	Rating (-/10)
H3402 Standard site 1	Medium/vigorous vine sitting well on the bed. Fruit firm with good colour, blocky egg-plum shaped and generally good size. High yielding with good concentration. A little bit of leaf disease and bleach evident at site 1.	7.5/8 **(Avg 7.8)**
H1311 Standard site 2	Grown at S2 only. Medium-vigorous vine falling open a bit with some fruit breakdown. Leaf disease also appeared more prevalent in this. Fruit firm with good colour (Hi-lycopene). Blocky egg/pears (some points) of variable size – some small. Yield and conc. ok.	**-/6.5**
H1307	Site 2 only. Medium-vigorous vine on the bed. Medium foliage providing reasonable cover. Firm, medium blocky plums showing a hint of breakdown. Colour ok and yield good. Some big bud. Breakdown the main question mark.	**-/6.5**
H1996	Medium-vigorous vine a bit upright and may open up a bit. Leaves a bit smaller and darker. Cover ok generally. Plum fruit very firm with good colour. Size variable with some small. A bit of breakdown at S2. Yield and concentration ok.	7/6 **(6.5)**
H3406	Site 2 only. Medium-vigorous vine sitting well on the bed but growing into the gutters and opening up a bit. Plum-egg fruit of variable size – mainly medium. Some bleach and splitting evident but looks to be holding. Firm with some good colour and good yield.	**-/6.5**
H5408	Spreading medium/vigorous vine with dark foliage. Very firm blocky plum-egg fruit with some dimpled. Some good colour and yield also looks good. Some breakdown at both sites with splitting also. Holding the main concern, particularly at S1.	5.5/7 **(6.3)**
SVTM 9008	Medium-vigorous vine on the bed with medium-dark smaller leaves on top providing good cover. Fruit very firm blocky plum-eggs – a few pointed - of good size but a bit puffy. Some bleach and colour average-poor at both sites. Medium-good yield. Fruit quality?	6/5 **(5.5)**
SVTM 9023	Spray-row at S2. Vigorous-medium vine at S1, with dark leaves providing good cover. Blocky egg-pear fruit of good size (some large at S1) – a few puffy. Firm, colour and yield ok although a bit of yelloweye and grey wall seen at S2. A bit of bleach also but seems to be holding ok.	6.5/6.5 **(6.5)**
SVTM 9024	Medium-vigorous vine with lighter foliage and smaller leaves on top. Good cover and concentration. Firm blocky plum-egg fruit of good size. Colour ok but a few puffy and bleached fruit plus a couple split. Good yield.	7/7 **(7)**
HM 4885	Medium/vigorous vine – a bit upright - on the bed with medium-dark foliage not showing much disease. Medium sized egg-elongated fruit, firm with good colour. A bit of bleach, yellow eye and fence-posting at S2. Yield medium.	6/6.5 **(6.3)**
HM 58811	Upright medium-vigorous vine – might be floppy - with medium/dark foliage. Cover ok and not much foliar disease. Blocky egg-pear shaped fruit with good size (some large) and a few pointed. Very firm but a bit puffy. Colour and yield ok.	6.5/6.5 **(6.5)**
HM Nava	Site 1 only. Medium vine, a bit upright but on the bed – with dark foliage providing mainly good cover. Medium-large, firm, egg-pear fruit showing breakdown. A bit puffy and with medium colour (some greywall and core). Yield ok but breakdown a problem this season.	**5/-**
UG 16112	Medium/compact vine on the bed with large rolled purple leaves on top. Cover ok. Medium-large blocky egg-pear shaped fruit. Very firm, colour ok-good, a few puffy. Quite a few bleached fruit at S2. Good concentration and yield. Holding.	7/6 **(6.5)**
Site 1. Weeks Strathallan	A high yielding site on second year ground with good leaf cover on most lines, not many greens and breakdown only evident in a few.	
Site 2. Kagome Wilson Rd	This crop was a little more advanced and on older ground, but still produced good yields. Breakdown was evident to a small degree in most lines, as was leaf disease, and bleach was an issue in areas where fruit were exposed. Fruit colour was not as good at this site, with the physiological issues yellow eye and grey wall apparent in many lines	

Scores are shown for each site in order, then (where appropriate) averaged.
Not all lines were grown at all sites and seed mixes were not assessed.

Summary

This season there were a number of varieties which produced higher yields or solids than the standard cultivars.

In early season trials, SVTM9000 has been a consistent performer in our trials over a number of years. In addition, we hope to continue to assess the HM Clause cultivars. HM Encina showed good yields but also some fruit breakdown, however this variety is only listed as a 105 day cultivar in Spain. SPS 220-2 was another promising cultivar in the early screen trials.

Mid-season varieties such as HM58811, SVTM 9023, SVTM 9024 and UG16112 have performed well over several years. Newer varieties to the program such as H1996 and HM4885 also show promise

Acknowledgements

We are very grateful to participating growers, seed companies and processors for their co-operation and interest in the conduct of these trials.

Plant spacing trials 2021-22

Ann Morrison

Historically, replicated plant spacing trials using transplants have been difficult to conduct with traditional semi-automatic transplanters due to the difficulties in changing plant spacings. Kagome Australia's acquisition of a Ferrari Transplanter, which has electronic control of plant spacing, has enabled these types of trials to be conducted.

With Kagome's support, two machine harvested replicated transplant plant spacing trials were established, one at Thyra in NSW and the other just out of Rochester in Victoria. Plant spacings ranged from 21.9 to 43.9 centimetres (equivalent to plant populations of 15,000 to 30,000 plants per hectare, increasing in increments of 3,000 plants) on 1.52m sub surface drip irrigated beds .

The commercial crop at Thyra was UG 4014, and Rochester was planted with a mix of H3406 and H1311 (70:30). The water and fertiliser inputs across all trial plots were kept the same as the commercial crop which had a standard plant population of around 18,600 plants per hectare.

The trial at Thyra was affected by water quality issues which impacted water distribution along the trial rows during the growing season, restricting plant growth and yields in a gradient down the rows.

Harvest was delayed at both sites, commencing after 151 days and 154 days in the field at the Rochester and Thyra sites respectively. Fruit yield and quality at both sites suffered as a result of the seasonal growing conditions and late harvest.

Whilst there were statistically significant differences in plant populations in both trials, this did not translate into statistical differences in yields or brix (brix data not shown).

A replicated direct-seeded trial was also established by a grower in Boort using a 70:30 mix of H3402 and H1311 seed, with harvest completed after 161 days in the field. Direct seeded crops are planted with seeds in groups of three. The trial seed clump spacing ranged from 23 to 93 centimetres (equivalent to approximately 21,000 to 86,000 seeds per hectare) on 1.52 m beds.

Unfortunately, again the delayed harvest had negative impacts on fruit quality and yields, with red fruit yields across the trial ranging from 145 to 159 tonnes per hectare with no significant differences between treatments.

No consistent relationship was apparent when plotting plant spacing against yields (Figure 1). However, the results show that a lower plant population did not necessarily result in lower yields.

Although the trial results were inconclusive, all parties are keen to continue to investigate the influence of plant spacing on production in the future.

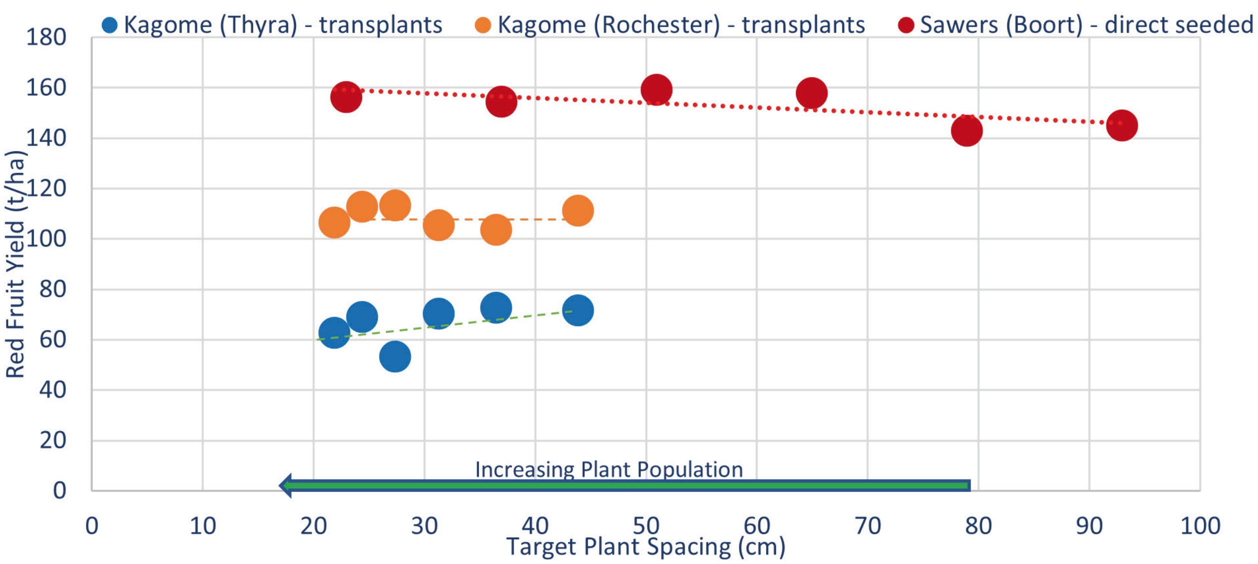
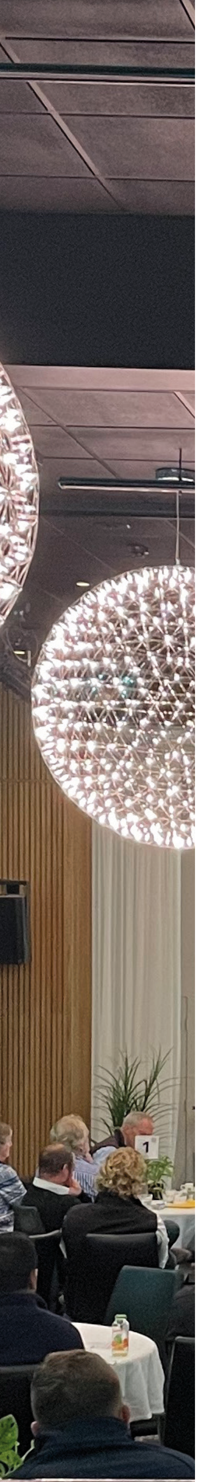


Figure 1. Plant spacing versus yield.



2022 SPC Field Report

Andrew Ferrier, Field Manager, SPC

With continued strength in sales of canned tomatoes, SPC entered the 2022 season with optimism, engaging the same 5 growers from the previous season and increasing its contracted tonnage to 48,500 tonnes across 433 hectares. In addition, SPC contracted the growing of 280 tonnes of cherry tomatoes for the first time since 2019. Most of the tonnes were again grown from transplants in the Corop/Rochester region, with the Boort area continuing to direct seed their crops. H3402 remained the dominant variety grown for SPC (355Ha) with H1015 (48Ha), an increased area of UG16112 (25Ha), TCP94829 (cherry, 7.7Ha) and a trial of HM58811 (5.5Ha) making up the total area grown.

Transplanting began in the Rochester region as usual at the end of September and continued through until the end of November, with direct seeding at Boort stretching from early October through until the end of November also. There were few interruptions to planting/sowing despite several rain events throughout the planting period. Mild, relatively wet Spring conditions slowed early crop growth and interruptions to spray programs at critical times resulted in isolated areas of grub damage as well as disease issues across all regions. Conditions began improving throughout December with warmer weather finally materialising. Crop development appeared to be at least a week behind however, due to the cooler start. Despite this, early growth in the Boort area was excellent with crops setting up strongly. A mid-January rain event and isolated storms stopped many paddocks in their tracks with increased bacterial speck in areas. A significant rain event at the end of January, with around 40mm received at Appin (Boort region), caused some physical damage to plants but also an increased incidence of disease.

The Cherry tomatoes were the first crop harvested, beginning a week behind schedule on the 24th of January but yielding well above expectations. The conventional tomato harvest began as scheduled at Corop on the 8th of February but was a week behind at Rochester and 2 weeks late starting at Boort. With the late-February and March crops appearing to be on time and above budgeted yields, this threatened to significantly disrupt the harvest schedule and SPC were faced with the prospect of being behind the crops for the remainder of the season.

However, as some crops were yielding below expectations, there was an opportunity to catch up as paddocks could be completed in a shorter time than expected. Unfortunately, due to factory reliability issues, SPC were unable to take full advantage of this and remained 3-4 weeks behind schedule for the duration of the harvest. Rain delays in early March resulted in 5 lost harvest days. Due to the rain and production delays, SPC was once again forced to continue production throughout the Easter period to try to make up ground lost throughout March. More significant rain events occurred in mid-late April, ultimately ending the harvest on the 27th of April, unfortunately with an estimated 4,500 tonnes still to be harvested, which had to be abandoned.

For season 2022, SPC processed 42,126 nett tonnes of conventional tomatoes and 357 tonnes of cherry tomatoes at the Shepparton plant. Average field yield on the conventional crops was 104 t/Ha (on harvested area) and 46 t/Ha on the cherry tomatoes. Average brix for the season across all varieties was 5.02°Brix. H3402 (78%) again accounted for the majority of tonnes processed, with H1015 (12%) and UG16112 (9%) accounting for a significant portion of the intake. HM58811 and TCP94829 (cherry tomatoes) made up the remainder.

With the delayed finish to the harvest and protracted grower negotiations which saw two growers retire from the industry, as well as wetter conditions throughout the Autumn and Winter months, preparations for the 2023 season have been severely disrupted. Fortunately, a window of fine weather in June/July has allowed bed forming and ground preparation to commence. With demand still strong for Australian tomato products, SPC will be hoping for excellent yields from 2023 crops as contracted volumes are significantly below expected requirements. The impact of a COVID-affected world is still being felt with increasing interest rates and record high input costs across the board placing increasing pressure on growers and processors alike. Near capacity water storages and anticipated low water prices at least provide some positivity as we look to consolidate in 2023 and push towards a strong future beyond.

2022 Kagome Field Report

Chris Taylor: General Manager, Field Operations, Kagome

Kagome contracted 209,916 payable tonnes for the season and commenced planting on 27th September with its conventional tomato program in Northern Victoria and Southern NSW. Organic tomatoes (cultivars H1014 & SVTM9000) were planted before the conventional crops, but with their scheduled harvests aligned. As with previous years, minor delays were faced in the planting window due to rain and wind influencing planting efficiency.

The industry saw more direct-seed planting this year due to the increase in volume contracted from the Boort region. Transplants made up 86% of Kagome's contracted volume with direct seed increasing to 14%, up from 7% in the previous year. Heinz varieties continue to supply the majority of contracted tonnes at 66% of Kagome's plan. United Genetics supplied 26% while Seminis increased its presence with 8%.

La Niña weather patterns produced milder and varied conditions throughout the growing period. A summer that didn't really eventuate (to provide heat) and isolated storms in the New Year caused some growing pains.

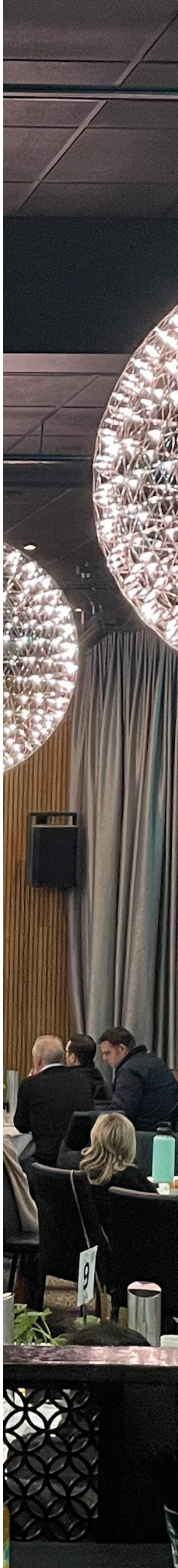
Lingering Covid-19 issues continued to interrupt labour resources and efficiencies throughout the season from planting right through to harvest.

Processing started on the 4th of February with organic tomatoes as Kilter Rural (Lake Boga) kicked the season off with 3,900 total payable tonnes of good quality fruit. Conventional tomato harvesting and processing started the 7th of February, continuing right through to early May. Significant setbacks occurred during the harvest period with labour quality issues and two tomato harvesters being destroyed by fire. One was in the Deniliquin area and the other at Lake Boga. Thankfully no one suffered serious injuries. The root cause of the fires has been determined and appropriated precautions have been put in place to remove the risk from existing and new equipment.

Early March saw the first delay from rain for the harvest period, and this was followed by further rain in the middle of that month. Significant rain from mid to late April caused major setbacks to harvesting, affecting both access and efficiency of operations. Unfortunately, this caused the season to drag out well past the scheduled window. The season was drawn to a premature close due to mould levels and poor fruit quality, causing fruit to be left in the field, which was terribly disappointing.

Kagome finished the season with a total of 175,960 payable tonnes with an average Brix of 5.17, after a gruelling 94 season days with a harvested area of 1,744ha and unfortunately leaving 144ha unharvested.

After the prolonged finish to this season, attention quickly turns to the 2022/23 crop and what another year of La Niña may bring. The industry continues to see significant price rises affecting crop inputs and factory costs due to domestic and global factors. The importance of loyalty to the Australian-grown product and country of origin will certainly be put to the test in the coming year.



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