Horticulture Innovation Australia

Final Report

Technical Development for the Australian Prune Industry – Stage 2

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Australian Prune Industry Association Inc.

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DP14000

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Summary

The Australian Prune Industry is committed to achieving world's best practice production methods, protecting the environment and maximising returns to industry stakeholders including producers.

It is relatively small compared to the prune industries in other countries however this is often used as an advantage when sharing information and experiences.

Australian prune growers are willing to share information and experiences with their peers and the Australian Prune Industry Association (APIA) has been integral in facilitating opportunities for growers to come together for both informal and formal presentations to help exchange ideas. This has been possible through the employment of an Industry Development Officer (IDO).

The industry stakeholders are very aware that to ensure a sustainable long term future for the Australian prune industry improvements in quality, productivity and returns to growers are needed.

Throughout this project, the IDO provided access to information that was current, relevant and timely. This information was delivered in written formats as emails, industry newsletters and article in the industry magazine, *The Vine*, as well as field days and at APIA's Annual Conference.

The topics covered have been varied and included:

- IPA Congress in Italy, 2015
- Thinning demonstrations
- Updates from California, including changes in drying technology
- The use of solar tunnels for drying prunes and ultrasonic technology
- Updates on the variety trial information

This information has assisted growers to make informed decisions relating to new industry developments and has helped renew the confidence of the growers in the industry.

During the past 24 months, the IDO has been able to focus on milestones set by the Project Management Committee and the APIA Executive Committee including conducting an ultrasonic and solar tunnel trial. The milestones set by the Executive and the growers involved ensures that the IDO resources are being used to their full potential on projects that will provide benefits to the whole industry.

Keywords

Prunes, Prune, Variety, International Prune Association, Variety, Ultrasonic, Solar, Drying, Dried Plums,

Introduction

Australian Prune Industry Association (APIA), processors and growers strongly agree on the need to stimulate investment in new plantings, at a sustainable rate, of new prune varieties to lift the level and quality of Australian production from current levels.

All industry sectors agree that the future for the Australian industry depends on it re-establishing itself as a reliable supplier of high quality prunes on the domestic market.

Providing growers with the opportunity to travel to California to witness the production and processing systems of the world's largest producer of prunes was one way to show the Australian growers that we are an innovative industry. While small in comparison, Australian prune growers are very knowledgeable and strive to improve returns through cutting production costs, adopting new technologies and practices and increasing volume of production.

The role of the IDO is to communicate with growers to find out what is working and what is not and to help those that are seeking to improve their production levels and efficiency and adopt the latest technology available.

The IDO uses a variety of methods to communicate with growers including phone, SMS, email, industry newsletters, magazine articles, and field days, discussions at meetings and personal visits on farm. As the IDO only works one day per week, one on ones with growers are often limited so concentrating on sharing information via the industry newsletter has been a priority. These newsletters create discussion points within the industry and keep the growers from other areas informed. Growers that do not travel to attend meetings or field days are kept in touch with the industry.

Stakeholders in the industry must provide growers with confidence in the future by offering prices at levels that stimulate investment, developing good market intelligence and providing latest research results & information on new technologies and practices which will help growers to increase their productivity and profitability.

Methodology

This project will fund Ann Furner, a dedicated Industry Development Officer (IDO), for 1 day per week for the Australian Prune Industry. The IDO is based in Yenda, NSW and will drive technology adoption and communication programs that engage industry stakeholders. This will provide growers with access to the information they require on new technologies and best practice management through training programs in relation to many relevant topics.

The key activity areas for capacity building in the Australian Prune Industry will include:

1. Communication activities, consultation & liaison with growers
2. Research through on-farm trials
3. Development and implementation of training programs
4. Deliver industry field days & seminars
5. Reporting to APIA National Executive Committee on industry R&D issues and capacity building strategies
6. Networking with other horticulture IDO's and Prune Industry stakeholders

This program is strategically important in delivering both improved producer efficiency and enhanced product quality at a time when the industry appears to be emerging from a difficult period as a result of a much-improved world supply situation.

Project DP14000 started 01/11/2014 and finished 31/10/2016.

Technology transfer and methodology/activities

A range of extension techniques were used to increase interest in the industry including field days, study tours, meetings, and a range of communication tools including the industry magazine, e-newsletter and SMS messaging.

A number of key objectives were identified by industry and project activities were tailored to help meet these targets.

Objective 1 Communication Activities, consultation & liaison with growers

- *The Vine Magazine*

The Vine is the joint Dried Fruits Australia (DFA) and the Australian Table Grape Association (ATGA) national magazine that is published quarterly. The IDO wrote or sourced articles to be published on behalf of the Australian Prune Industry Association. Two to three articles were provided quarterly to *The Vine* journalist who proof reads the stories before publishing. Copies of these articles can be seen in the appendix.

Photographs to support articles were taken and supplied as required.

- *Industry Newsletter*

Regular information updates, disease warnings, event reminders and industry news were distributed to all prune growers using the Australian Prune Industry Association E-news. The newsletters were produced on a monthly or needs basis.

- *SMS Alerts*

SMS alerts were used on a needs basis. This was a really quick way to get in touch with all growers and industry representatives about pest and disease outbreaks or reminders about field days.
In January 2014 an SMS alerts was sent to all growers about an outbreak of Queensland Fruit Fly (QFF) in the Griffith area. The IDO and local Agronomists were inundated with phone calls from prune growers who were concerned about their crops. This was an excellent example of the SMS alert system working quickly.

- *Social Media*

The IDO also sourced and distributed material on the Australian Prune Industry Associations social media pages.
Evidence has shown that the information best received by the online audience were stories about our Ausprune growers and on-farm activities. Several "Grower of the Month" profiles were sourced by the IDO and posted online. Weekly updates about on farm activities and the orchards development were posted online.

Objective 2 Research through On-farm trials

- *On farm trial – Ultrasonic pre-treatment and solar drying*

The IDO conducted a month-long trial during harvest 2016 investigating new solar drying technology which was introduce to APIA at the IPA congress in Italy, 2015. The IDO combined the use of an ultrasonic pre-treatment, solar drying and traditional tunnel drying in this trial. The results can be seen in the **appendix 1**.

- *Variety Trial Evaluation*

The IDO commence evaluating the variety trial sites in January 2016 and finished in May 2016. Results collected from these sites can be seen in **appendix 2**.

The IDO assessed the trees for flowering dates, fruit set/crop load and growth. The fruit quality parameters that were assessed were sugar levels (brix), size (mm), colour, yield, dry-out ratios, grading, pitting and processing.

Several growers have now planted the new varieties that have been evaluated in the trial sites.

Objective 3 Development and implementation of training programs

- *Bizmod*

The IDO received training in the Bizmod modelling system. The IDO tried to hold an information day about this system but there was no interest from any growers in the industry.

- *Quality Assurance*

The IDO has developed the "Dry Right" Quality Assurance Program for dehydrators in the Australian prune industry. This program has been developed to demonstrate how the industry controls quality and food safety to deliver a consistent product to customers. An introduction and training day was held on the 13th December 2016, as part of Project DP15002. This manual can be viewed by request to the IDO.

Objective 4 Deliver industry field days and seminars

Field Walks

- *Communication*

All field walks/trips were promoted through the APIA E-news email distribution lists. These events were reported as articles in *The Vine* magazine and also through the e-news.

- *Prune Field Walk and Information Session*

The IDO organised 3 local agronomists to discuss Queensland Fruit Fly at a field walk on Thursday 20th November 2014 at Yenda Producers Co-operatives prune tiral block on Myall Park Rd, Yenda.

- *Thinning field day – Joe Turkovich, California*

The IDO helped to organise a Thinning Field Day held on 30th October 2015. Grant Delves, APIA's Chairman and Darlington Point grower, Bruce Gowrie-Smith, organise the guest speakers and the IDO coordinated the locations and advertising for the field day. 33 growers and industry representatives attended the field day. Most prune growers now use the information shared at the field day to thin their orchards before pit hardening to maximise size and sugar levels.

Figure 1 Joe Turkocvich from California identifying the reference date of prunes

- *Variety Trial Field Walk*

The Variety Trial Field Walk was held on Friday 15th January 2016 at the Yenda Variety Trial Site on Peter and Sue Raccanello's farm. The IDO had only been monitoring the fruit since 1st January 2016 so shared existing knowledge of the fruit. The field walk allowed growers to see the fruit and sample it

prior to harvest. 20 growers attended this field walk.

Figure 2 Ausprune growers at the variety trial site in Yenda

- *Dehydration Meeting – Sunsweet Representatives from California*

The IDO helped to organise dehydrators to attend an information session where guest speakers, Jeff Wilson and Melvin Ward, from Sunsweet shared their knowledge of California and Chile. 20 dehydrators attended the information session representing 15 families that dry prunes. The information session was held just prior to harvest on 10th March 2017. Production and dehydration technology was discussed.

Objective 5 Reporting to APIA National Executive Committee on industry R&D issues and capacity building strategies

The IDO attended APIA's Executive and Prune IAC meetings, AGM's and Prune Conferences. Growers and the Executive were informed of the IDO's activities. From these meetings, extra activities for the IDO were discussed with the industry reference group and added to the work plan.

Objective 6 Networking with other horticulture IDO's and Prune Industry stakeholders

- *Californian Prune Industry Study Tour*

In March 2014, the IDO submitted a funding application to HAL for a study tour (DP13701) to take place later in the year. The funding application was accepted and the IDO started to plan the trip. With suggestions from growers who were attending the trip and those who had been to California previously, the IDO put together a busy itinerary.
All sectors of the Californian Prune Industry were considered when planning the trip. To learn the most about the Californian Prune Industry, participants visited processors, researchers, dryers, growers, machinery manufacturers and industry representatives.
The study tour group consisted of eight growers, one horticultural consultant and one observer. The study tour took place in July between 14th and 22nd.
Valuable experience was gained by the IDO when planning the trip and will be used again when planning the next overseas study tour.
The study tour was reported on via several media outlets.

- Two articles were printed in The Vine Magazine
- Two articles were printed in the Area News newspaper. Griffith local paper.
- A travel blog was put together and posted on APIA's social media pages.

The final report for project DP13701 was submitted in December 2014.

Figure 3 The tour group on their first day of the Californaina Study Tour

- *Attendance at the IPA Congress*

The IDO attended the IPA Congress in Italy (May 2015) and the IPA Congress in Chile (Nov 2016). These were reported on and information was shared via final reports, *The Vine* magazine, newspapers, radio, industry newsletters, field days and APIA's Annual Conferences. Articles from *The Vine* can be seen in the appendix. Final reports were submitted for each of these congresses. DP14700 for Italy and DP16700 for Chile.

Figure 4 Michael Zalunardo, APIA Chairman Grant Delves, IDO Ann Furner, Angas Park's David Swain, Frank DeRossi and Del Zalunardo in an orchard in Argentina

- *Updated Contact List*

The contact list in continually updated. At all field days or workshops growers are ask to supply their email address and phone number. This reminds growers to keep the IDO informed of changes to their details. Updating the grower contact list continues to be a part of the IDO's role.

- *Grower visits and enquires*

Where possible, the IDO has visited several growers on farm to discuss a range of topics. Time doesn't allow for all growers to be visited individually however the IDO takes phone calls regularly from growers to discuss topic such as:

- Disease and pest identification and their management
- Pruning and thinning techniques
- Providing new growers with details of harvest and drying contractors
- Many other requests

- *Visit to Young, NSW*

The IDO travelled to Young, NSW on Tuesday 20th September to talk to growers and processors. It was clear that some Growers in Young use their fruit for purposes other than drying. The Young region has the potential to increase Australia's prune production however with the proximity of Young to large centres it appears the growers receive better returns when selling their fruit on the fresh market.

- *Visit to Mildura, Vic*

The IDO travelled to Mildura, Victoria on 1st September 2016 to visit Angas Park. The IDO could see the variety trial fruit being processed and was able to assess the fruits ability to pit.

This information was shared with growers at the annual conference. Samples were provided for tasting and evaluation forms were completed.

Outputs

- New knowledge on thinning prune trees prior to pit hardening.
- New knowledge of solar drying in a solar tunnel
- Combining technology to test if an ultrasonic pre-treatment of fresh plums reduces the time of drying through a traditional drying shed.
- Evaluation of cultivars and rootstocks
- Introducing the “Dry Right” Quality Assurance Program
- Increasing the Australian Prune Industry knowledge of international prune industries.

Evaluation and Discussion

The IDO collects feedback from all those who attend seminars, workshops and field days. From this the IDO can tailor the delivery of information to the growers and share information that is relevant and information that is interesting to APIA's members.

The IDO is delivering information that growers want to hear as attendance to field days and seminars are extremely high.

Positive feedback is provided to the IDO and with the continued support and guidance of the Project Management Committee the IDO has reengaged growers interest and is helping to provide growers with a platform to improve quality and grower returns.

Recommendations

It is recommended that the IDO:

- continues delivering high quality material to the Australian Prune Industry and listens to the concerns of the industry so information can be tailored to cater for changing demands from processors and consumers.
- continues evaluating the variety trials with a focus on fruit quality parameters.
- engages the whole supply chain in introducing innovation, or any form of change.
- is persistent and patience when working on new research and development implementation.
- recognises the value of collaboration among industry participants at an early stage in any project.
- continues to build international relationships to share new technology and innovations
- and industry participants learn from other industries and understand that many industry share the similar issues.

Intellectual Property/Commercialisation

'No commercial IP generated'

Acknowledgements

This project has been funded by Horticulture Innovation Australia Limited using the research and development prune levy and funds from the Australian Government.

Appendices

1. Solar Drying and Ultrasonic Treatment Trial

February & March 2016

Ann Furner, Industry Development Officer.

Summary

Dehydration accounts for approximately 50% the cost of production of prune. Increasing cost of energy is a huge concern for growers. To combat this, the Australian Prune Industry (APIA) tested solar tunnel drying and ultrasonic pre-treatment of prunes during harvest 2016.

During harvest ideal environmental conditions proved solar drying to be a success however we cannot rely on these conditions all the time. Adverse conditions would make solar drying a very difficult process to master and would be very challenging. Further investigations about solar drying would be recommended before investing in a commercial setup.

Ultrasonic pre-treatment provided mixed results. As suggested, ultrasonic pre-treatment may be used to intensify low temperature drying of food materials. Results were positive through the solar tunnels but not through the commercial dryers. Investing in ultrasonic technology to attached to existing commercial

dehydrators would not be recommended. Commercial dehydrators would have to lower temperatures to see benefits from ultrasonic technology.

Introduction

The largest expense in dehydrating prunes is the cost of energy to power the dehydrators.

Rising energy prices in Australia and global pressure to be more environmentally friendly continue to be at the forefront of prune growers. The industry is searching for an energy efficient and cost effective solution that will reduce energy consumption (and costs) without compromising the quality of the final product. This would not only lower the environmental footprint of the Australian prune industry, but may also improve its sustainability for years to come.

The enormous energy potential of solar radiation from the sun has been used to dry fruit for many centuries. This free resource has been well utilised by the Chilean prune industry and at the IPA Congress in Italy, May 2015, they shared information about changes they have made to automate the process, increasing throughput and decreasing labour costs.

Perhaps there could be an opportunity for solar drying in Australia? The Australian Prune Industry Association was eager to learn more and in January 2016 two small-scale solar drying tunnels were built in the Riverina.

APIA was also keen to follow up the results from Dr Henry Sabarez of CSIRO Division of Animal, Food and Health Sciences. He led a Horticulture Australia project (DP12001) which found that ultrasound-based pretreatment is a highly effective means of enhancing low temperature drying of plums resulting in shorter drying time and better retention of product quality attributes.

After positive laboratory results in DP12001, APIA wanted to see if the ultrasonic technology could be implemented into a commercial setting as a means of reducing drying times, and thus energy consumption.

Materials and Methods

Location and Time

The solar drying tunnels were designed and built by Prune Industry Development Officer Ann Furner at Farm 2747 Marchinton Rd, Yenda. The tunnels were 6m long by 0.915m wide. They were designed to use a 2ft x 3ft tray. There were 10 trays per tunnel which could hold approximately 100kg of fresh fruit. This design allowed for many different samples to be tested throughout harvest.

Del and Michael Zalunardo's commercial dehydrators were used in this trial to dry fruit that was pre-treated through the ultrasonic unit.

The Ultrasonic unit was hired from Unisonics Australian Pty Limited and was used from 12th February to 29th February, 18 days in total.

The solar trial was conducted for 29 days from 5th February to 4th March 2016 using fruit from several locations including Darlington Point and Yenda.

A total of 1069.2kg of fresh fruit was used for these trials.

Treatments

All varieties were weighed prior to entering the solar tunnel and during the drying process, weights were recorded. Two Hastings Data loggers were used to record Temperature and Humidity. They were placed inside and outside the tunnels to record the daily minimum and maximum temperatures and relative humidity.

	Name:	**Treatment**
1.	Solar Tunnel Drying	Fresh plums were placed into the tunnel – White Plastic and Clear Plastic
2.	Solar Tunnel Drying + Ultrasonic	Fresh plums were pre-treated in the ultrasonic unit and then placed in the solar tunnel
3.	Ultrasonic + Commercial Dehydrator	Fresh plums were pre-treated in the ultrasonic unit and dried in a commercial dehydrator

Results and Discussion

Table 1 outlines how many kilograms of fruit were used during this trial.

Name:	Kg
Solar Tunnel Drying	893.7
Commercial dryer	175.5
Total:	**1069.2**

Table 1: Total fresh fruit weight used in this trial.

1. **Solar Tunnel Drying**

At the start of the trial two different types of plastics were used. Duratough 4.05m width clear and Duratough 9m width white light.

It was very clear after the first 24hours that the clear plastic was superior. Photo 1 shows the solar tunnels covered in both white and clear plastic. Photo 2 shows fruit after 24hrs under clear plastic. The fruit had changed colour and had started to shrivel. The smell of the fruit was very similar to a commercial dehydrator.

Photo 3 shows the fresh fruit after 96 hours under white plastic. The fruit had not changed colour or started to shrivel. It had softened as though the inside was stewed. This fruit was placed under clear plastic to finish dehydrating and it became very leathery and the flavour was unpleasant like burnt caramel.

Photo 1: Solar Drying Tunnels with white and clear plastic

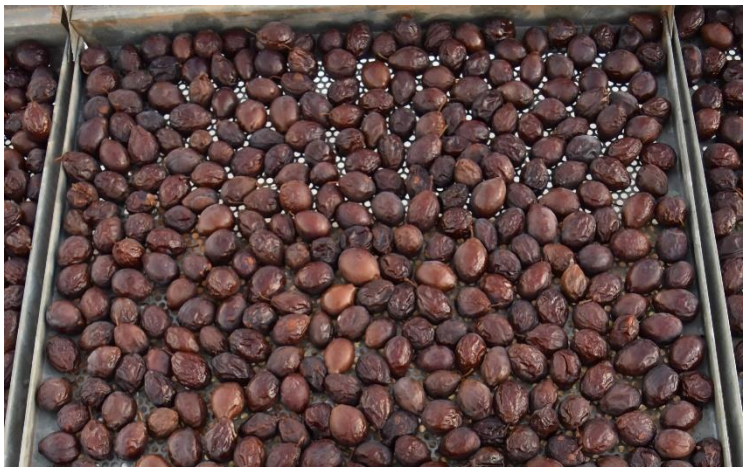


Photo 2: Fruit after 24hrs under clear plastic

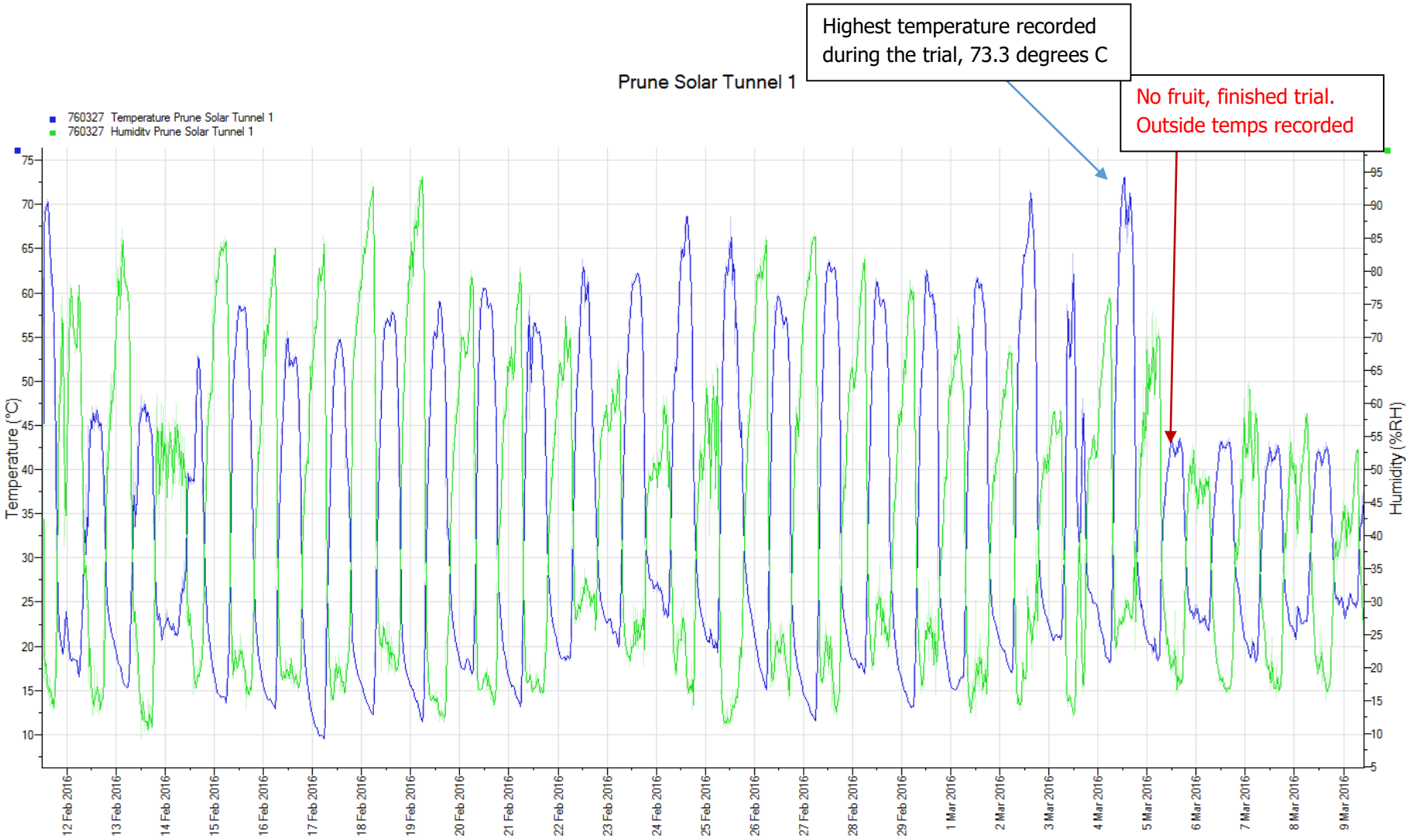
Photo 3: Muir Beauty (foreground) and Sutter (background) after 96hrs under white plastic.

The inside temperature of the tunnel covered in white plastic was 46°C, 8°C cooler then the temperature inside the clear plastic tunnel. This clearly demonstrated that white plastic is not suitable for solar drying prunes.

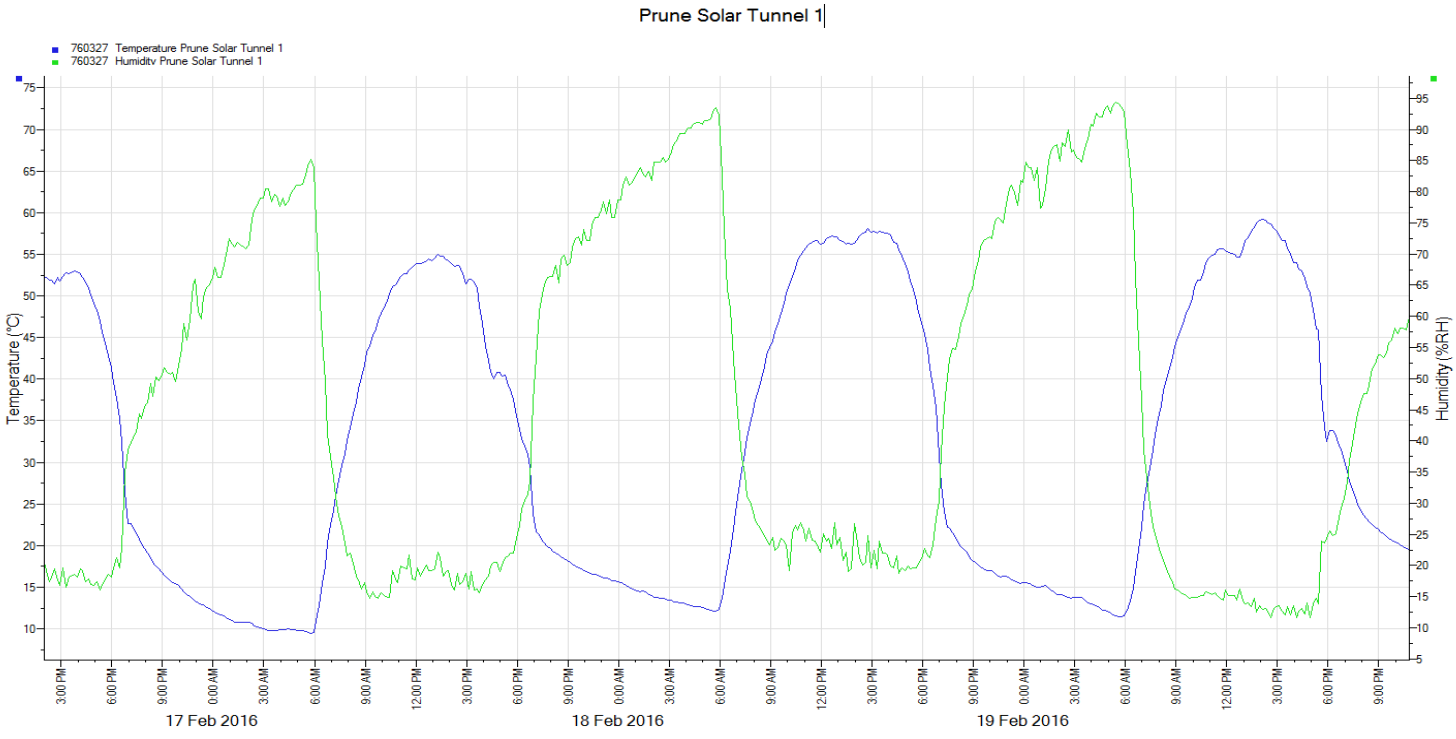
8th February 2016	**Ambient air**	**Clear plastic inside**	**White plastic inside**
Temperature °C @ 4pm	38	54	46

Table 2: Temperatures inside and outside of both tunnels.

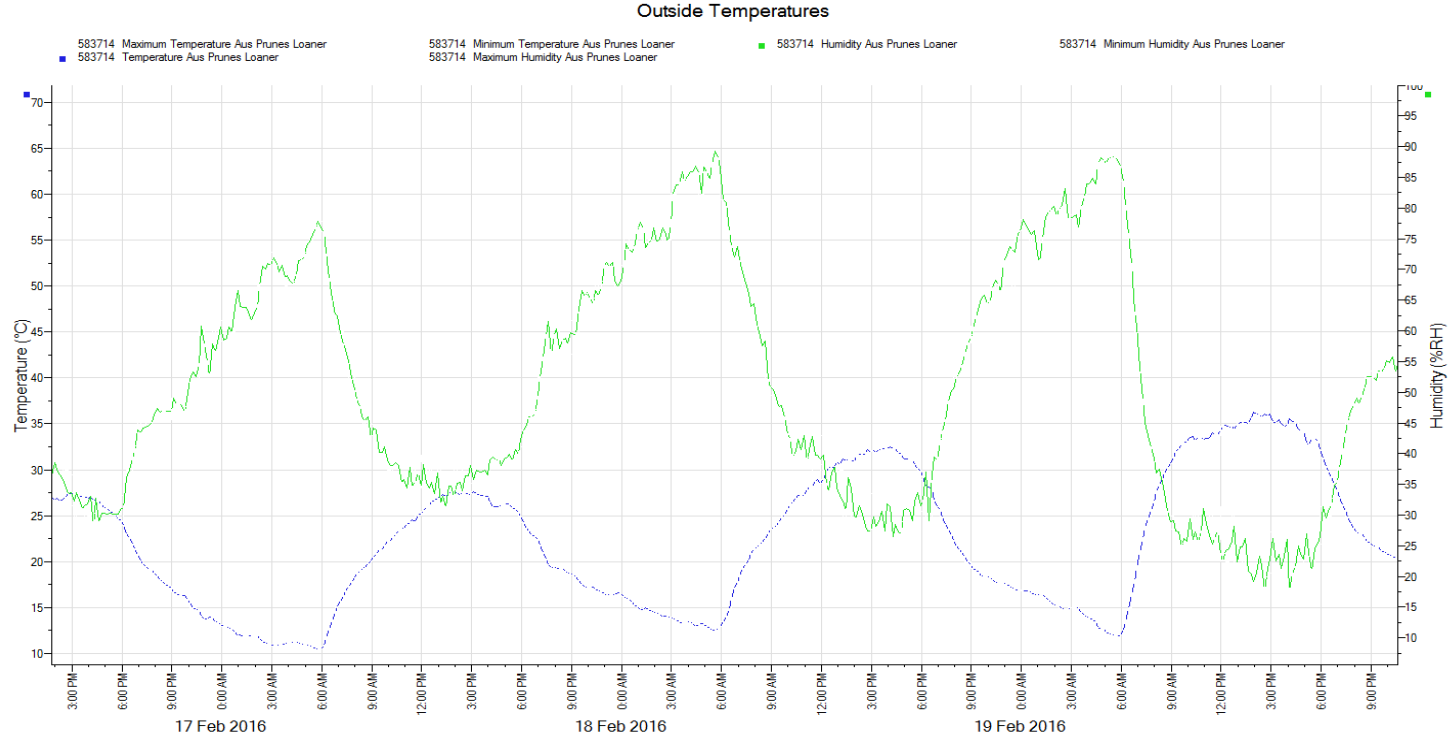
Minimum and maximum temperatures and relative humidity were recorded inside the solar tunnels. Tiny Tag data loggers were set to record data every 10 minute. Graph 1 maps the temperature and humidity inside tunnel 1 using a Tiny Tag Data Logger. The weather during the trial period was extremely favourable for solar drying. High temperatures, full sun and no rain are ideal conditions and they were the conditions during the trial period.



Graph 1: Temperature and humidity data inside the solar drying tunnels.



Graph 2: Temperature and humidity inside the solar tunnel



Graph 3: Temperature and humidity captured outside (ambient conditions).

Comparing temperatures at 12pm on 17th Feb 2016 inside and outside the tunnel in Graph 2 and 3 it was clear that the temperature was higher under the plastic cover. The temperature was 54°C inside the tunnel compared to 30°C outside the tunnel. That is 24°C warmer under the clear plastic. The temperature under the plastic raises very quickly in the morning but also drops very rapidly once the sun was no longer hitting the plastic.

The humidity inside the tunnel at 12pm on 17th Feb 2016 was 16%, outside the tunnel it was 35%. Once the temperature rises in the morning humidity drops rapidly but in the evenings when the temperature drops the humidity rises very quickly.

The humidity during the night was very similar inside and outside the tunnels, with a slight increase inside the tunnel. A fan was placed at one end of the tunnel and the other end was left open, blowing air through the tunnel. During this period, there were little differences in humidity inside or outside the tunnels. Fans could be used to remove excess humidity first thing in the morning, around 6am when it was at its highest.

During the solar tunnel drying trial weeds and ants were a problem. Prior to building the tunnels the ground was levelled and free of weeds however as the trial proceeded, weeds began to grow inside and around the tunnels. These had to be controlled during the trial as left uncontrolled the weeds could increase humidity in the tunnels.

Ants were another issue experienced during the trial. They were attracted to the fruit due to its high sugar content. These would have to be controlled during the solar drying process.

2. Ultrasonic Pre-treatment and Solar Drying

The ultrasonic unit that was used in this trial could hold a maximum of 2kg of fruit and 9L of water. Photo 4 shows the unit. The silver dial on the front of the unit was a timer, there was no dials to adjust the levels of ultrasound waves. It could be used for 30 minutes and then needed to be turned off and cooled down. The water in the unit had to be kept clean so the base of the unit was not covered in debris. The water was refreshed every 30 mins and the fresh water was primed for 5 mins prior to dipping a new batch of fruit.

Photo 4: Ultrasonic unit

Photo 5: Aluminium foil test strip

To test whether the unit was working, a strip of aluminium foil was placed in the unit for 30 secs. Photo 5 demonstrates that when the foil is placed in the unit holes appear in the foil, indicating that the unit is working correctly.

Photo 6 shows the effect of the ultrasound waves on the water when the unit is turned on. The water surface seemed to vibrate creating ripples on the surface. Photo 7 shows paraffin oil on the surface when the fruit is being treated.

Photo 6: Ripples on the water surface

Photo 7: Fruit inside the ultrasonic unit.

To set the treatment times, the first batches of fruit were dipped in the unit for 1 min, 3 min or 6 min and compared with the control that had no treatment. The fruit was dried for four days, weighed and then the moisture content was tested. Table 3 shows the results of the first trial. The 3 min treatment was the stand out as after 96hrs in the solar tunnel the moisture content was less than the other treatments.

From this pre-treatment, times were set at less than 3 minutes. Pre-treatment times had to be realistic so they could be implemented in a commercial setting.

Date	Variety	Ultrasonic Treatment (Min)	Start Weight (kg)	End Weight (kg)	Time (Hrs)	Days	Moisture Content (%)
12/02/2016	698	Control	11	4.5	96	4	25
		1	10	3.7	96	4	24
		3	10	3.3	96	4	19.5
		6	10	3.9	96	4	25

Table 3: Ultrasonic pre-treatment results from solar drying, in the first trial.

Several other trials were performed but several of them were inconclusive showing that there is no difference in treated versus the untreated.

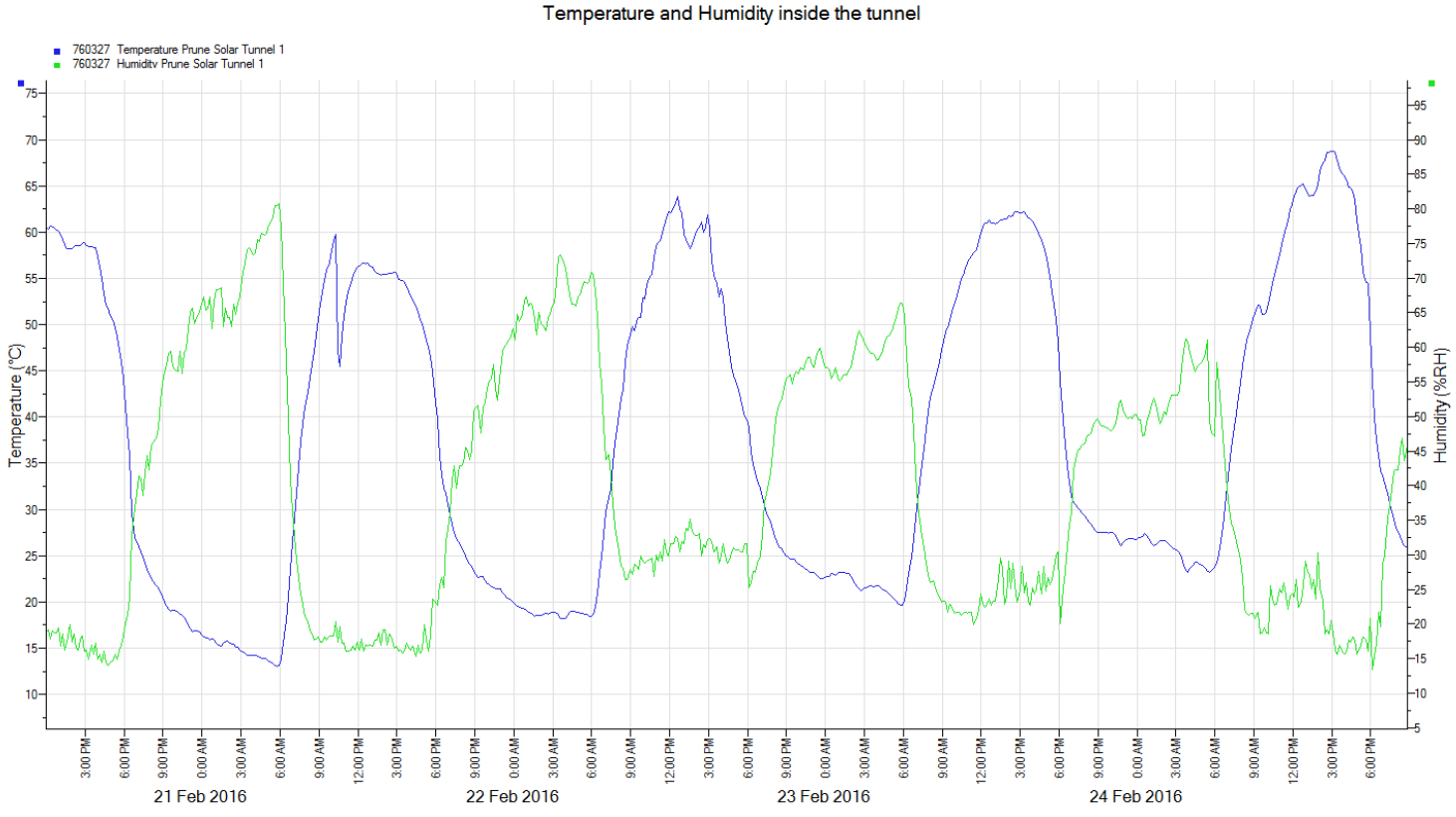
The best result however was an ultrasonic pre-treatment of 1min 30sec using D'Agen plums. These

Date	Variety	Ultrasonic Treatment (min)	Start Weight (kg)	End Weight (kg)	Time (Hrs)	Days	Moisture Content %
21/02/2016	D'Agen	Control	10	3.8	72	3	24
		1	10	3.7	72	3	22.5
		1 min 30 secs	10	3.4	72	3	19

results can be seen in table 4. This batch of fruit was dried in 72hrs with the fruit treated for 1min 30sec recording a moisture content of 19%.

Table 4: Ultrasonic pre-treatment results from solar drying, in second trial.

The fruit entered the dryer at 6pm 21st February and was removed at 6pm on 24th February. Graph 4 shows the temperature and humidity inside the solar tunnel during this period. As stated previously, the dehydration of ultrasonic pre-treatment of plums should dry quicker at lower temperatures. During the 72hrs that the D'Agen plums were dried, temperatures remained below 70°C and the majority of the time they remained below 65°C.



Graph 4: Conditions inside the solar tunnel when the D'Agen plums were dried.

3. Ultrasonic and commercial dehydrator

A total of 175.5kg of fresh fruit was dried through Zalunadro's commercial dehydrator. This fruit was pre-treated for various times in the ultrasonic unit and the moisture content of the fruit was recorded to compare the level of water loss. The fruit was all dried for the same amount of time, approximately 15hrs. Photo 8 and 9 show the fruit prior to dehydrating and the placement of fruit in the dehydrating tunnels.

Photo 8: Ultrasonic treated fruit prior to drying in a commercial dehydrator. Photo 9: The placement of the fruit in the drying tunnels.

This first trial was conducted on 17th February where 40kg of fresh fruit was dried. 20kg as a control and 20 kg which was treated for 1 min 30 secs in the ultrasonic unit. Table 5 shows the moisture content of the control was lower at 17.5%, than the treated fruit at 19.5%. This is indicating that the control dried quicker than the treated fruit.

Date	Variety	Ultrasonic Treatment (min)	Start Weight (kg)	End Weight (kg)	Time (Hrs)	Moisture Content (%)
17/02/2016	Californian French Improved	Control – no treatment	20	7.53	15	17.5
		1 min 30 secs	20	7.73	15	19.5

Table 5: First trial of ultrasonic pre-treatment through commercial dehydrator.

From the same batch of fruit, 46kg, 10kg not treated and 36kg or treated, was solar dried in the solar tunnels. Table 6 shows that the moisture content of the pre-treated fruit was lower than the control, after

120hrs of drying time. This was an indication that drying times can be decreased using the combination of solar and ultrasonic pre-treatment.

Date	Variety	Ultrasonic Treatment (min)	Start Weight (kg)	End Weight	Time (Hrs)	Moisture Content (%)
17/02/2016	Californian French Improved	Control	10	4.2	120	25
		1 min 30 secs	36	14.9	120	19

Table 6: Solar dried Californian French Improved using the ultrasonic pre-treatment.

Photo 10: Californian French Improved 96hrs after entering the solar drying tunnel.

Photo 10 clearly shows a difference in the fruit drying times required for treated and non-treated fruit. This photo was taken 96hrs after the fruit was placed in the solar drying tunnels. It shows the treated fruit was darker in colour and more shrivelled. The non-treated fruit was still plump, soft to touch and lighter in colour.

The second trial conducted on 19th February 55.5kg of fresh fruit was dried. Fruit was placed in the ultrasonic unit for 1 min, 1 min 30 secs and 2 min. 10kg of untreated fruit was also dried.

These results in table 7 demonstrate that the 1 min 30sec and the 2-minute treatment moisture content was slightly lower than the control. The trays used to dry the 1min treatment would have had more fruit on them, slowing the drying process. It is hard to draw a conclusion with these results.

Date	Variety	Ultrasonic Treatment	Start Weight (kg)	End Weight (kg)	Time (Hrs)	Moisture Content (%)
19/02/2016	CFI	Control – no treatment	10	3.03	15	19
		1 min	26	9.23	15	22
		1 min 30 secs	9.5	3.19	15	18
		2 mins	10	3.33	15	17

Table 7: Second trial through commercial dehydrator

The third trial conducted on 22nd February 80kg of fresh fruit was dried. These results are shown in table 8.

During the first two trials there was no significant difference in the moisture contents using treatments less than 2 mins. A longer treatment of 3 minutes was used using to different basket capacities. The ultrasonic unit could fit a maximum of 2kg of fruit at anytime so 2 treatments were tested with a single layer of fruit, 1kg per basket and a double layer of fruit, 2kg per basket.

The shorter treatment of 1 min 30 secs and the control had a very similar moisture content at the end of drying. The 3 min treatment dried slower than the control and 1 min 30 sec treatments. The 2kg basket capacity had a positive effect on drying time. This may mean the throughput can be increased and not limited by the exposure to the ultrasounds.

Date	Variety	Ultrasonic Treatment	Start Weight (kg)	End Weight (kg)	Time (Hrs)	Moisture Content (%)	Basket capacity
22/02/2016	Van Der Merwe	Control – no treatment	20	7.8	15	16.5	
		3 mins	20	8.5	15	22	1kg
		3 mins	20	8.2	15	19	2kg
		1 min 30 secs	20	7.8	15	16	2kg

Table 8: Third trial through the commercial dehydrator.

Conclusion

Clear plastic would be the preferred plastic for solar drying.

The combination of solar drying and ultrasonic pre-treatment showed positive results.

The ultrasonic pre-treated fruit dried in a commercial dehydrator showed no significant difference between treated and non-treated. A conclusion can be draw that modifications would have to be made to lower temperatures in the tunnels to, if ultrasonic pre-treatment was to prove viable.

Recommendations

This research demonstrated that using existing commercial drying tunnels with ultrasonic pretreatment would not provide any benefits.

The research demonstrated that it is effective in low temperature solar drying tunnels however more research should be carried out prior to investing in this combination on a commercial scale.

If time and funding allows for more work to be carried out on this trial, parameters set from harvest 2016 will allow for less time to be spent on working out how to use the equipment and more time will be used to develop a proper testing procedure.

If possible, advise from Dr Henry Sabarez prior to the commencement of a new trial would be advisable.

The quality attributes of the solar dried and pre-treated fruit will be assessed and the shelf life of solar dried product will be evaluated. This will take place over the next 12 months as all the fruit dried from this trial is still available.

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Without the continued support from individuals in the industry this trial would not have been possible.

2. Variety Evaluation 2015 -2016

Varieties:

d'Agen
- The Australian industry standard
- Derived from Prune d'Ente (France)

California French Improved
- Developed in California from d'Agen for warmer climates
- The predominant variety used in California
- Vigorous upright tree

Van der Merwe
- Developed in South Africa (released 1954)
- Bud mutation of d'Agen
- Early flowering
- Good fruit set

Sutter
- Released by breeding program at UC Davis in 2000
- Earlier ripening
- Large fruit with high sugar
- Matures earlier than French Improved
- Lower pitting efficiency with certain pitting machines

Muir Beauty
- Developed at UC Davis from a cross between California French Improved and Tulare Giant
- (released in 2004)
- Blossoms and ripens early
- Large fruit with high sucrose and superior flavour

Rootstocks:

Both the rootstocks used were developed in California.

Myrobalan H29C
- Resistant to Armillaria and Crown Gall
- Moderate tree size
- Good tolerance to dry summer conditions
- Good yields with good fruit quality

Marianna 26-24
- Good yields with good quality fruit
- Less tolerant of heavy soils
- Resistant to Crown Gall

Blossom

Variety	2012/13	2013/14	2014/15	2015/2016 September 17	2016/2017 September 6
D'Agen	October 4	September 24	September 26	80% Flowers	50% Green tip – no flowers
Van der Merwe	September 17	September 1	September 15	Full Flower	40% Flowers
Sutter	October 1	September 28	September 24	30% Flowers	10% Flowers
California French Improved	October 1	September 20	September 26	30% Flowers	80% Green tip, no flowers
Muir Beauty	September 20	September 9	September 13	50% Flowers	80% Green tip, no flowers

Table 1 Dates for full bloom (NSW Riverina, Yenda and Darlington Point)

Crop load

Variety	Darlington Point		Yenda	
	November 2014	**January 2015**	**November 2014**	**January 2015**
D'Agen				
Myrobalan	2	No fruit	3	5
Marianna	3	3	3	5
Van der Merwe				
Myrobalan	3	No Fruit	3	5
Marianna	4	4	3	4
Sutter				
Myrobalan	2	4	1	2
Marianna	1	5	1	3
California French				
Improved				
Myrobalan	2	3	1	3
Marianna	1	4	1	4
Muir Beauty				
Myrobalan	4	4	2	5
Marianna	4	5	3	5

Table 2 Crop load rating (1=very light crop, 5= very heavy crop)

Tree growth

Variety/ rootstock	Darlington Point				Yenda			
D'Agen	**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2012/13**	**2013/14**	**2014/15**	**2015/16**
Myobalan	45.1	95.2	110.2	126.5	31.5	75.1	87.3	108
Marianna	49.3	97.2	112.3	130.8	40.8	75.2	96.9	117
Van der Merwe								
Myrobalan	44.2	91.5	106.3	123.5	41.8	81.2	94.6	112.5
Marianna	40	92.9	107.5	126.0	35.7	78.3	98.5	114
Sutter								
Myrobalan	45.4	98.3	112.8	128.9	40.2	81.8	99.5	120
Marianna	42.3	93.3	109.1	130.8	41.8	81.7	104	130
California French Improved								
Myrobalan	24	84.5	106.4	135.5	28	75.5	92.2	120.3
Marianna	41	70.5	92.5	106.8	24	70.2	94.8	119.7
Muir Beauty								
Myrobalan	51.7	96.4	104.5	125.1	40.1	66.7	78.8	115
Marianna	49.8	83.4	89.8	91.2	36.2	67.4	84.3	96

Table 3 Mean tree butt diameter (mm)

Harvest Parameters		2014/15			2015/16			
Variety	**Block**	**Brix**	**Density**	**Dry-out ratio**	**Harvest Dates**	**Brix**	**Density**	**Dry-out ratio**
California French Improved	Darlington Point	24.1	2.7	2.3	16/02	24.6	1.5	2.3
	Yenda	24.4	2.3		22/02	24.8	1.14	2.88
Van der Merwe	Darlington Point	21.6	3.2	3.3	16/02	24.6	1.36	3.1
	Yenda	21.9	3.2	1.9	22/02	24.6	1.33	4.1
d'Agen	Darlington Point	21.7	2.1	2.6	16/02	22.6	1.7	2.9
	Yenda	23.6	1.9	2.5	22/02	21.1	1.52	3.32
Muir Beauty	Darlington Point	26.1	0.7	4.1	05/02	26.4	0.78	2.7
	Yenda	26.7	1.4	3.9	05/02	24.5	0.75	4.4
Sutter	Darlington Point	26	2.6	3.3	05/02	25.8	2.8	3.5
	Yenda	26.3	2.9	2.8	05/02	24.5	1.32	3.6

Table 7 Harvest Parameters (2015/16 Muir Beauties were solar dried)