Future Orchards Trial: Interim Report

<table>
<thead>
<tr>
<th>Project title:</th>
<th>Investigating Envy apple eating quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region:</td>
<td>Tasmania</td>
</tr>
<tr>
<td>Contact:</td>
<td>Sophie Folder (Tas FLA, Pear Consulting), Craig Hornblow (AgFirst), Dean Rainham (Agfirst) and Ryan Hankin (Hansen Orchards)</td>
</tr>
<tr>
<td>Projective Objective:</td>
<td>To investigate the effect of crop load and dry matter on Envy apple eating quality.</td>
</tr>
</tbody>
</table>

Outline and method

**Background:**
Envy apple is marketed on its superior and unique taste. A consistently excellent eating experience is important for this variety to deliver on the marketing promise of “taste the difference”.

Envy apples are considered to be one of the best tasting apples on the market, although growers have expressed concern over variability in Envy eating quality. As a new variety to the Tasmanian region the COG were interested to find out if this variability is related to crop load, maturity or dry matter differences. A demonstration trial was established in the 2018-19 season to investigate this issue.

**Aims:**
- To determine the effect of crop load on Envy apple eating quality
- To investigate the relationship between fruit dry matter, crop load and eating quality of Envy apples

**Method:**
- The trial area was selected and Trunk Cross sectional Area (TCA) of trees measured (5/12/2018) at time of commercial hand thinning. Crop load was allocated to the trees according to the tree TCA. Twelve trial trees were hand thinned to set the desired crop load.
- Three weeks prior to harvest (1/04/2019) the crop load on trees was re-counted and TCA re-measured. Due to differences in crop load to what was set initially in December the trial trees were re-assigned to a crop load treatment grouping based on their TCA and crop load. Samples for dry matter assessment were collected by taking a sample of 5 fruit per tree and group with the other trees from the same treatment (= 20 fruit per treatment). The 20 fruit were analysed for dry matter using a drying oven at the University of Tasmania.
- At harvest (23/04/2019) a sub samples of 20 fruit were collected per tree and grouped with other trees from the same treatment (to equal 80 fruit per treatment. At harvest 20 fruit from each treatment were assessed for maturity (starch, foreground colour,
background colour, brix, pressure and fruit weight. The remaining 60 fruit were put into cool storage.

- Fruit were stored in an Envy cool storage for 10 weeks. Fruit was removed the cool store (28/06/2019) and the fruit was then stored at ambient temperature for 1 week prior to the taste panel to simulate a retail environment. Fruit maturity was re-assessed post storage on 4/07/2019 including background colour (BGC), Pressure (kg), Brix (TSS) and Greasiness.
- Fruit eating quality was assessed using a sensory taste panel. Fruit was tasted by participants at the winter orchard walk and rated for texture, juiciness, sweetness, flavour and chance of purchasing again. An assessment of the incidence of internal browning was undertaken on fruit remaining after the taste panel.

Treatments:
1. 2-3 fruit per TCA
2. 5-6 fruit per TCA
3. 9-11 fruit per TCA
4. 13-17 fruit per TCA
5. 16-19 fruit per TCA (Unthinned control)

Measurements:
- Initial TCA and crop load at trial set up
- Crop load, TCA and fruit dry matter 3 weeks prior to harvest
- Maturity assessments at harvest including Background colour (BGC), Pressure (kg), Brix (TSS), Starch Pattern Index (SPI), Greasiness and Fruit Weight (g).
- Maturity assessments for BGC, Brix, Pressure & Greasiness post-storage.
- Sensory taste panel assessment after 10 weeks in storage including texture, juiciness, sweetness, flavour and chance of purchasing again.

Activities undertaken

<table>
<thead>
<tr>
<th>Milestones</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial defined</td>
<td>August 2018</td>
</tr>
<tr>
<td>Trial setup.TCA, crop load measured. Trees hand thinned to set crop loads.</td>
<td>5 December 2018</td>
</tr>
<tr>
<td>Trial visit, photographs taken.</td>
<td>4 March 2019</td>
</tr>
<tr>
<td>Crop load re-counted and TCA re-measured.</td>
<td>1 April 2019</td>
</tr>
<tr>
<td>Fruit dry matter assessments.</td>
<td></td>
</tr>
<tr>
<td>Harvest, maturity assessments, fruit into cool store.</td>
<td>23 April 2019</td>
</tr>
<tr>
<td>Fruit removed from storage.</td>
<td>28 June 2019</td>
</tr>
<tr>
<td>Post storage maturity assessments.</td>
<td>4 July 2019</td>
</tr>
<tr>
<td>Taste panel assessment at Future Orchards walk.</td>
<td>5 July 2019</td>
</tr>
<tr>
<td>Report prepared.</td>
<td>August 2019</td>
</tr>
<tr>
<td>Presentation growers at Future Orchards walk.</td>
<td>22 November 2019</td>
</tr>
</tbody>
</table>
Results

Trunk cross sectional area, crop load and yield

The trial trees were re-assigned to a crop load treatment grouping based on their TCA and crop load 3 weeks prior to harvest (Table 1) as it was discovered there were differences in crop load to what was initially set at hand thinning in December.

Crop load and TCA: Average crop load ranged from 63 to 257 fruit per tree. The lower crop loads per TCA occurred in the larger trees with higher TCA (21 cm²) compared to the higher crop loads which were on the smaller trees (15 – 17 cm² TCA), (Table 1).

Table 1: Trunk Cross sectional area (TCA) and crop load per tree 3 weeks pre harvest (1/04/2019)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Trunk diameter (mm)</th>
<th>TCA (cm²)</th>
<th>Crop load on tree pre harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3 fruit / TCA</td>
<td>52</td>
<td>21</td>
<td>63</td>
</tr>
<tr>
<td>5-6 fruit per TCA</td>
<td>50</td>
<td>21</td>
<td>115</td>
</tr>
<tr>
<td>9-11 fruit per TCA</td>
<td>47</td>
<td>17</td>
<td>164</td>
</tr>
<tr>
<td>13-17 fruit per TCA</td>
<td>43</td>
<td>15</td>
<td>220</td>
</tr>
<tr>
<td>Control (16-19) fruit per TCA</td>
<td>43</td>
<td>15</td>
<td>257</td>
</tr>
</tbody>
</table>

Fruit weight: Average fruit weight at harvest ranged from 186g (2-3 fruit / TCA) to 286g (Control 16-19 fruit / TCA). There was a strong relationship between crop load and fruit weight with decreased fruit weight as crop load per TCA increased (Table 2).

Yield: The average crop load per tree was used with the average fruit weight at harvest to calculate the fruit yield on a per tree and per hectare basis (Table 2). The yield per tree was calculated by multiplying crop load by average fruit weight and was converted to kg (Table 2). These yields ranged from 17.9 kg per tree (2-3 fruit / TCA) through to 47.9 kg per tree (Control 16-19 fruit / TCA). The yield per hectare was calculated using the number of trees in the block (20,961) divided by the block size (5.87ha). The yield per hectare ranged from 64 tonnes per ha (2-3 fruit /TCA) to 171 tonnes per hectare (Control, 16-19 fruit /TCA).

Table 2: Crop load per tree, fruit weight and calculated yield

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Crop load on tree pre harvest</th>
<th>Fruit weight at harvest (g)</th>
<th>Calculated Yield per tree (kg) *</th>
<th>Calculated Yield per ha (t/ha)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3 fruit / TCA</td>
<td>63</td>
<td>286</td>
<td>17.9</td>
<td>64</td>
</tr>
<tr>
<td>5-6 fruit per TCA</td>
<td>115</td>
<td>251</td>
<td>28.8</td>
<td>103</td>
</tr>
<tr>
<td>9-11 fruit per TCA</td>
<td>164</td>
<td>218</td>
<td>35.8</td>
<td>128</td>
</tr>
<tr>
<td>13-17 fruit per TCA</td>
<td>220</td>
<td>186</td>
<td>40.9</td>
<td>146</td>
</tr>
<tr>
<td>Control (16-19) fruit per TCA</td>
<td>257</td>
<td>187</td>
<td>47.9</td>
<td>171</td>
</tr>
</tbody>
</table>
Fruit dry matter harvest maturity

Dry Matter %: The fruit with the lowest crop load (2-3 fruit / TCA) measured the highest fruit dry matter percentage of 17.4% (Figure 1) and had larger / heavier fruit at harvest (286g) than the other treatments (Table 2). There was little difference between the other treatments in dry matter percentage which ranged between 15.2% and 16%.

![Figure 1: Fruit dry matter % 3 weeks pre harvest (1/04/2019)](image)

Pressure: Fruit firmness (pressure) was measured at harvest and post storage. The fruit from the lowest crop load trees (2-3 fruit per TCA) had firmer fruit at harvest (10.2kg) than the other crop load treatments ranging between 8.8 and 9.1 kg (Figure 2). Fruit was firmer post storage although there was little difference in pressure between the treatments which ranged from 10.1 to 10.9 kg.

![Figure 2: Fruit pressure (kg) at harvest (1/04/2019) and post storage (4/07/2019)](image)

Brix: Fruit brix (Total Soluble Sugars) increased in the fruit during storage (Figure 3). The 5-6 fruit per TCA had the highest Brix at harvest (14.5 TSS) compared to the other treatments. The lower crop load treatments 2-3 fruit / TCA and 5-6 fruit / TCA had the highest brix readings post storage of...
15.9 TSS and 15.5 TSS, which supports the findings from the sensory taste panel where these treatments were ranked higher for sweetness and flavour (Figure 4). The fruit with 13-17 fruit per TCA consistently recorded the lowest brix readings at harvest (13.1 TSS) and post storage (14.3 TSS).

**Figure 3: Fruit brix (TSS) at harvest (1/04/2019) and post storage (4/07/2019)**

**Sensory Taste Panel**

Growers were invited to rank fruit from each treatment on a scale of 1 -5, where 1 is a poor experience and 5 an excellent experience. Four categories were assessed; texture, juiciness, sweetness and flavour (Figure 4).

**Figure 4: Sensory taste panels results for flavour, sweetness, juiciness and texture (5/07/2019)**

The treatment with the crop load of 5 -6 fruit per TCA was consistently higher across all four categories. The treatments with the higher crop loads was much more variable across the taste categories with juiciness performing well but Sweetness and Flavour coming much lower.

The taste panel was then asked to vote for their favourite apple. Again and overwhelmingly the 5-6 fruit per TCA treatment came in top receiving 41.6% of the votes followed by the lowest crop load...
treatment (29.2%). The high crop load treatments again were considered the least favourable with only 4% of the vote (Figure 5).

![Figure 5: Votes for favourite apple (5/07/2019)](image)

Participants were asked to list words that described their favourite and worst pieces of fruit from the tasting selection. The results are displayed as Wordle pictures (Figures 6 & 7) and the most frequently used words are displayed as larger text. The best piece of fruit was selected due to its favour, sweetness, juiciness, balance and crispness (Figure 6). The worst piece of fruit was described as lacking flavour, sweetness, sugar and taste (Figure 7).

**Figure 6: words describing the favourite apple**

**Figure 7: Words describing the worst apple**

**Internal Browning:** Internal browning was noted in some fruit in the lower crop load treatments at the sensory taste panel (Photo 10) and was mentioned as a reason for some treatment being selected as the worst piece of fruit (Figure 7). An assessment of 10 remaining fruit per treatment following the sensory taste panel was made per treatment (Photos 13 - 17). Internal browning was found in 2 of the 10 fruit assessed in the 2-3 fruit per TCA crop load treatment (Photo 13) and no browning was found fruit assessed in the other treatments.

**Chance of purchasing fruit again:** Participants were asked to rank their likelihood of purchasing each piece of fruit again based on their sensory taste experience. The 5-6 fruit per TCA treatment really stood out as having the highest incidence of repeat purchasing above the other treatments (Figure 8). The high crop load treatments came in much lower and reflected the inconsistent experience they had in terms of flavour, sweetness, texture and juiciness.
Implications

The demonstration trial has showed that crop load is linked to fruit maturity and harvest assessments including fruit dry matter percentage, fruit weight, firmness and brix as well as sensory taste experience for the end consumer. The lower crop load treatments scored highly and were favoured for their eating experiences, suggesting that over cropping Envy will have detrimental effects for the end consumer. Internal browning was detected in the lowest crop load treatment (2-3 fruit /TCA) suggesting that under cropping Envy may lead to fruit quality issues. There will be a crop-load sweet spot where the tree is neither under or over cropped . Reducing variability across the orchard with the appropriate crop load strategy will be important to consistently deliver an excellent taste experience of Envy.

The trees with 5-6 fruit / TCA crop load treatment was most favoured across the sensory taste panel indicators as well as having high brix at harvest and post storage. This crop load equated to a calculated yield of 103 tonnes of fruit per hectare. This result supports the current industry recommendation to target an optimum crop load of 90-100 tonnes per hectare for Envy. This demonstration trial has shown that this recommendation is still valid to achieve good eating quality outcomes for Envy.

Conclusions

The following conclusions can be drawn from this demonstration trial;

- Crop load does influence the eating quality and dry matter of Envy apples.
- A crop load of 5-6 fruit per TCA (103 t/ha) was the preferred fruit by taste panellists and had high brix levels at harvest and post storage.
- High crop loads treatments 13-17 fruit per TCA (146 t/ha) and 16-19 fruit per TCA (171 t/ha) were the least preferred fruit by taste panellists.
- The industry recommendation for a target yield 90-100 tonnes per hectare for Envy is relevant and supports the eating quality findings of this demonstration trial.
- The risk of internal browning is higher at low crop loads (2-3 fruit / TCA or 64 t/ha).
Acknowledgements

We would like to thank the following people for their assistance in undertaking this trial:

- Hansen Orchards for providing the trial site and cool storage of the trial fruit.
- Ryan Hankin and Renee Trengrove (Hansen Orchards) for their assistance in setting up, hand thinning and undertaking counts of crop loads.
- Sally Bound (Tasmanian Institute of Agriculture) and Ramdeep Sidhu (University of Tasmania) for their assistance in undertaking fruit dry matter assessments at the University of Tasmania Laboratory.
- Nigel Bartels (Serve-Ag) for undertaking the harvest and harvest maturity assessments.
- To the Tasmanian growers and industry personnel who participated in the sensory taste panel of the trial fruit at the winter Future Orchards walk in July 2019.

Photos

Crop load photos in orchard

Photos 1 & 2: Crop load on trial trees pre harvest (1/04/2019)

Photos 3 & 4: Crop load on trial trees at harvest (23/04/2019)
Fruit samples at sensory tasting panel (5/07/2019)

Photo 5: 2-3 fruit per TCA
Photo 6: 5-6 fruit per TCA
Photo 7: 9-11 fruit per TCA

Photo 8: 13-17 fruit per TCA
Photo 9: 16-19 fruit per TCA
Photo 10: Internal browning

Photo 11: Fruit prepared for taste panel
Photo 12: Participants at sensory taste panel
Internal browning assessment (5/07/2019)

Photo 13: 2-3 fruit per TCA

Photo 14: 5-6 fruit per TCA

Photo 15: 9-11 fruit per TCA

Photo 16: 13-17 fruit per TCA

Photo 17: 16-19 fruit per TCA