Innovation of Current Orchard Systems to Produce High Quality

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WSU-TFREC, Wenatchee, WA
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Pear

The problems observed:
• absence of new cultivar;
• absence of dwarfing rootstock;
• high level of vigor in the existing orchard;
• old orchard design;
• difficult environmental condition during bloom;
• poor fruit quality due to shadow effect;
• lack of homogeneity in the fruit distribution in the canopy;
• difficult to mechanize old orchard;
• high cost of labor for picking.
Situation of Training system in North West Pacific area

- Old orchard with big canopy are difficult to mechanize
- Need to improve quality and fruit distribution in the canopy (reflective fabric)
- New innovative grower try different training system
- Possible solution trees with two or three axis
NEW ORCHARDS

Two-axis

Three-axis

Palmette Abbé Fétel Own-rooted. Planting distance 4.0 x 2.0m. Density 1,250 trees/ha
SPINDLE

Abbé Fétel/MH. Spacing 3.3 x 0.80. Planting density 3,787 trees/ha. Year of planting 2005

V SYSTEM

Abbé Fétel/BH/MC Spacing 3.8 x 0.35. Planting density 7,518 trees/ha. Year of planting 2005
VERTICAL AXIS

Abbè Fétel/BH/MC. Spacing 2.5 x 0.30- Planting density 13,333 trees/ha. Year of planting 2005
Comparison among orchard systems for Abbé Fétel cultivar: productive results.
Fruit size: % over 70 mm

fruit % > 70mm (aver. 2008-'11)

Comparison among orchard systems for Abbé Fétel cultivar:
productive results.
Fruit size: % over 70 mm

Density: 2,857 ÷ 4,082 trees/ha
7,143 trees/ha

Abbé Fétel – Correlation between planting density and Yield per ha in three training systems

Source: Musacchi et al. 2006
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Planting density (tree/ha)

y = 0.0185x – 7.3297
R² = 0.9779

Source: Musacchi et al. 2006
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Correlation between densities and average fruit weights

- Vertical axis
- Very intensive V system
- V system
- Spindle
- Bi-axis

R² = 0.8071
R² = 0.7376

average fruit weight (g)

average densities (trees/ha) per training system

Correlation between densities and average fruit weights

Comparison among orchard systems for Abbé Fétel cultivar

- Vigor reduction
- Early fruit bearing
- Increase of yield per hectare
- Fruit size reduction
- Slow fruit bearing
- Good fruit size

Equilibrium between production and fruit size

MC - BH/MC - ADAMS - MH® - Sydo® - BA29

“V” system 80% of fruits located in the low part of the canopy

Gross income

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Pear

High level of vigor in the existing orchard

Cashmere: Pruning trial: Winter vs Fall and Summer

Summer and Fall pruned plots: 180 trees

Winter pruned plots: 180 trees

Tree spacing

13.8 ft (4.2 m)

7.9 ft (2.4 m)
Three rootstocks were included in the trial

<table>
<thead>
<tr>
<th>Name</th>
<th>Vigor</th>
<th>Other characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>OHF87</td>
<td>Semi-vigorous</td>
<td>Good production and yield efficiency, good fruit quality. For calcareous and marginal soils. Resistant to fire blight and tolerant to pear decline. Is the currently most in demand of the series in the PNW.</td>
</tr>
<tr>
<td>OHF97</td>
<td>Vigorous</td>
<td>Standard size, but more precocious and productive than seedling stocks. Appears to be especially valuable for Asian pears.</td>
</tr>
<tr>
<td>OHF69</td>
<td>Semi-vigorous</td>
<td>Provides less vigor than OHF40, similar to OHF87. Crop efficiency lower than OHF87. Good graft compatibility with the main cv. Suitable for areas unfavorable for quince or for medium-low density planting.</td>
</tr>
</tbody>
</table>

*Webster, 1997; Weirtheim, 1998; Fideghelli et al., 2009*
Anjou pruning – pruning intensity in 2014 (metric)

<table>
<thead>
<tr>
<th>Winter pruned Feb/March 2014</th>
<th>Summer and fall pruned 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kilograms of material removed</td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>Summer and Fall</td>
</tr>
<tr>
<td>15.6</td>
<td>9.9</td>
</tr>
<tr>
<td>5.5</td>
<td></td>
</tr>
</tbody>
</table>

Tree appearance, Nov. 2014

no significant difference
Anjou pruning – winter and summer+fall pruning intensity in 2014 by rootstock (kilograms)

- Winter - kg removed by pruning
  - OHF87
  - OHF97
  - OHF69

- Summer and Fall - kg removed by pruning
  - Fall
  - Summer

No significant difference

Quantity of material removed during summer pruning for each rootstock (metric)

Anjou summer pruning 2014 by rootstock

- OHF87
- OHF97
- OHF69

No significant differences among materials
Anjou pruning: canopy removed volume (m²) in summer pruning

- OHF 87 (semi-vigorous) 15.18 m²
- OHF 97 (vigorous) 17.78 m²
- OHF 69 (semi-vigorous) 18.39 m²

Anjou pruning trial - yield 2014: comparison between combinations

<table>
<thead>
<tr>
<th>Season</th>
<th>OHF 87</th>
<th>OHF 97</th>
<th>OHF 69</th>
<th>Average Fruit Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall-Summer</td>
<td>210 b</td>
<td>214 b</td>
<td>231 a</td>
<td>90.2 g</td>
</tr>
<tr>
<td>Winter</td>
<td>237 a</td>
<td>243 a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Cork spot visible on outside of fruit at harvest
Pre-harvest: Fall+summer fruit from OHF97 rootstock are less ripe than winter ones (-7.7% in classes <1.80 and have +5.7% in the un-ripest class >2.00).
Pre-harvest: Fall+summer fruit from OHF69 rootstock are less ripe than winter ones (-7.8% in classes <1.80 and have +15% in the un-ripest class >2.00).

Those differences are maintained similarly at harvest.

Comparison between whole tree DA distribution pre harvest (27 August) and the DA distribution of fruit collected in boxes at harvest (2-3 Sept 2014). Choosing samples for boxes we affected the distribution in some ways....
Midday light measures for Anjou pruning trials

Canopy light penetration (LP) at summer pruning – June 2014
Fruit ripening distribution in the open vase tree (Low density planting)
Improving quality and maturity consistency of ‘D’Anjou’

Training system: open vase

up to 17’ height

Justification:

- Large canopy volume
- Fruit mostly in upper-medium portion
- High variability among fruits depending on light exposure
- No mechanization and no fruit sorting

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Picking fruit per position: external of canopy vs internal of canopy

Improving quality and maturity consistency of ‘D’Anjou’

Color parameters External Internal

<table>
<thead>
<tr>
<th></th>
<th>External</th>
<th>Internal</th>
</tr>
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<tbody>
<tr>
<td>(L^*) (black-white)</td>
<td>66.10</td>
<td>62.02</td>
</tr>
<tr>
<td>(a^*) (green-red)</td>
<td>-9.67</td>
<td>-16.85</td>
</tr>
<tr>
<td>(b^*) (blue-yellow)</td>
<td>40.97</td>
<td>40.05</td>
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</table>

D’Anjou fruit ripening via DA meter (2013): comparison between external and internal part of the canopy at room temperature

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<tbody>
<tr>
<td>DA index</td>
<td>1.95</td>
<td>1.72</td>
<td>1.89</td>
<td>1.80</td>
<td>1.85</td>
<td>1.83</td>
<td>1.77</td>
</tr>
<tr>
<td>DA index</td>
<td>1.60</td>
<td>1.60</td>
<td>1.56</td>
<td>1.54</td>
<td>1.47</td>
<td>1.40</td>
<td>1.30</td>
</tr>
</tbody>
</table>

Da index decrease in 24 days:

- Internal fruit: 0.18
- External fruit: 0.39
Improving quality and maturity consistency of ‘D’Anjou’

D’Anjou fruit ripening: weight (g) decrease in 18 and 24 days at RT

- Weight loss: -12.8% (18 days) and -7.4% (24 days)

Internal fruits ripen more slowly (DA index), but lose weight more rapidly after 3 weeks at RT than external ones.

Biochemical changes associated with maturity…..

…..development tools and protocols to improve uniformity of fruit maturity and quality at harvest.

Whole tree open vase: fruit distribution per $I_{DA}$ (26 aug 2014).

- $I_{AD}$ classes (= ripening classes)
Open vase: picking per canopy position (2014)

- internal
- external

Open vase, picking per canopy position:
fruit distribution in I_{AD} classes at harvest (Sept 10th)
Open vase canopy light measurement system

Data acquisition system: data acquisition card + conditioning circuit

Photosensor: light-bar (ceptometer)

Open vase canopy light intensity map at different heights

Upper level: ~ 3.5 m
Lower level: ~ 2.0 m

- Internal: light intensity < 30%
- External: light intensity > 70%
Open vase canopy light intensity measurements

Fall and summer pruning to control vigor and psylla in Anjou pear

- Stefano Musacchi (WSU TFRC)
- Elizabeth H. Beers (WSU TFREC)
- Jim Mattheis (USDA, ARS)
- David Rudell (USDA, ARS)
- Sara Serra (WSU TFREC)
- Rachel Leisson (WSU TFREC)
- Jingjin Zhang (WSU TFREC)
- Chris Sater (WSU TFREC)
- Adam Grubb (WSU TFREC)
- Nate Sullivan (USDA, ARS)
- Janie Countryman (USDA, ARS)
- Karen Blaedow (USDA, ARS)
- Bruce Greenfield (WSU TFREC)

Improving quality and maturity consistency of ‘D’Anjou’

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Thank you for your attention