Optimize Pruning and Fruit Quality in Pear Orchards

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Future Orchards™ Orchard Walks in June 2018.
Apple and Pear Australia Limited (APAL)
June 1st, 2018
11:30 am - 5:30 pm
Why we need to manipulate fruiting?

• To modify the balance between growth and fruiting, to increase yield and reduce management costs associated with large canopy tree;

• To improve flowering and fruit set;

• To reduce the numbers of fruit;

• To modify the season of flowering and fruiting or the post-harvest storage characteristic of the fruit.

• Increase fruit quality

Jackson, 1989
Tree is a collection of individual sinks all related and often in competition.

Costa et al., 1986
What we have to consider for a precise orchard management?

**Environment**
- Soil (Structure, texture, fertility, etc.)
- Weather (temperature, Humidity, light, etc.)

**Tree**
- Vigor, Productivity, Efficiency, Fruit Quality,
- Cultivar
- Rootstock
- Interaction cv/rootstock

**Technical subjects**
- Soil management
- Pruning
- Irrigation and nutrition
- Level of knowledge of the grower

**Training system**

**Planting distance**

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Factors Affecting Fruit Quality

Environmental factors
- Light
- Temperature
- Humidity
- Training system
- Wind

Genetic factors
- Variety
- PGRs
- Rootstock

Agronomic factors
- Soil
- Irrigation
- Nutrition
Pear Quality Optimization

• Pruning physiology
• Pear cultivar habit
• Rootstocks
• Nursery products
• Main training systems
• HDP pruning technique
• LDP pruning technique
• Quality (Light, Growth regulators, Nutrition, Harvest and Mechanization)
Pruning

• Pruning is a pool of practices that allow the control of growth and maximize the income in the orchard.

• Pruning modifies the tree growth and the balance between production and growth.
PRUNING ROLE IN THE BALANCE BETWEEN VEGETATIVE AND REPRODUCTIVE ACTIVITY

Vegetative activity

Reproductive activity

Hilkenbaumer, 1953
Growth capacity of buds with different orientations

Grisvard, 1957
Effect of bending

Grisvard, 1957
Mohacsy, 1957

Lespinasse, 1980
Position of a branch can change with age

Grisvard, 1957
Modification due to aging

Costa et al., 1986
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Main areas of pear production

- **Italy** > Abbe’ Fetel (41%)
- **Spain** > Conference (38%) and Blanquilla (20%)
- **Portugal** > Rocha (95%)
- **Belgium and Holland** > Conference (88% and 79%)
- **Washington USA** > Anjou (59%) and Bartlett (21%)
- **California USA** > William= Bartlett (60%)
- **South Africa** (11,431 ha) > Packham’s (29%) Forelle (26%), William Bon Chretien (16%), Early Bon Chretien (10%), Abate Fetel (5%), Rosemarie (3%)
- **Argentina** > Bartlett (44%) and Packham’s (25%)
- **Chile** (10,000 ha) > Packham’s 55%, Bosc (11%), Abbe’ Fetel (843 ha), Forelle, Carmen (120 ha), Flamingo (15 ha)
Abate Fetel produced in Russia Krasnodar
Abate Fetel produced in Argentina Mendoza
Abate Fetel produced in Uruguay
Abate Fetel produced in Brazil Santa Caterina
Abate Fetel produced in Italy
Abate Fetel produced in Argentina Mendoza
Abate Fetel produced in Uruguay

Environmental effect on fruit crop
Harvest calendar:

- Carmen* (Lucy Sweet™)
- PE2UNIBO* (Early Giulia™)
- PE1UNIBO* (Lucy Sweet™)
- PE3UNIBO* (Green Debby™)
- Bartlett
- PE4UNIBO* (Lucy Red™)
- Abate Fétel

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4 cultivars

Lucy Sweet
- Sweet and aromatic taste (low acid)

Early Giulia
- Slight acid and sweet; crispy
- Early ripening
- Good appearance and large size

Debby Green
- Melting flesh; aromatic and good balance sweet/acid
- Compact tree

Lucy Red
- Sweet taste
- Good appearance
- Red skin
Type 1 – Bartlett.
2-year-old branch with brindilla and spurs

Type 2a – Doyenné du Comice.
2-year-old branch with brindles

Type 2b - Abbè Fétel.
2-years-old branch with spurs

Type 3 – Conference.
2-years-old branch with spurs

Type IV – Beurré Bosc.
2-year-old branch with spur and short brindilla

Type V - Passe Crassane.
4-year-old branch with spur

Pear fruit-bud models

Sansavini 1966 a e b
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# MAIN PEAR ROOTSTOCKS

<table>
<thead>
<tr>
<th>VIGOUR</th>
<th>SPECIES</th>
<th>CLONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwarfing</td>
<td><em>Cydonia oblonga</em></td>
<td>EM C, Adams, MH and Sydo Pyrodwarf</td>
</tr>
<tr>
<td>Medium vigour</td>
<td><em>Cydonia oblonga</em></td>
<td>Cts 212, MA and BA29</td>
</tr>
<tr>
<td>Vigorous (Seedling)</td>
<td><em>Pyrus communis</em></td>
<td>BP1, Fox 9 and Fox11</td>
</tr>
<tr>
<td></td>
<td><em>Pyrus communis</em></td>
<td>BP2, BP3 Farold 40, 69, 87, 97</td>
</tr>
</tbody>
</table>

| Dwarfing                |                      |                                          |
| MC                      | Adams               | MH                                       |
| Sydo                    | MA                  | BA29                                     |
| Fox11                   | Seedling            |                                          |
Certified Tree Producted in the Emilia-Romagna divided by rootstocks (2009 = 2,388,899 trees)

Only the 7.9% of the total trees produced are grafted on seedling

Source: S.F.R. Emilia-Romagna
Rootstocks trend

Quince

• Sydo became more important clone than BA29 with 707,405 trees produced.

• MC this rootstock is employed only for very high density orchard (>4000 trees/ha).

• With tree of small size with few permanent branches quince MC minimise the negative effect on fruit size.

• BA29 is still largely utilised.

• The new clone MH is increasing especially for Abbé Fetel.

• Preliminary information showed that quince Adams is early bearing and characterised from a low-medium vigour.

• Interstem is widespread to overcame graft-incompatibility between quince and pear i.e. Bartlett and Abbé Fetel.
Bartlett grafted on quince MC and on seedling
Rootstock: BH/MC
Density: 13.333 alb./ha
T.S.: Vertical axis

8.0 cm²

Rootstock: BH/MC
Density: 10.821 trees/ha
T.S.: Vertical axis

11.0 cm²
Vertical cut across graft union to enhance new tissues formation in combinations with a medium level of graft-incompatibility with quinces
Rootstocks trend

Seedling

• Bartlett is grafted for the 60% on seedling genotype
• OHF 40 (Farold 40) is the most important seedling

• In some cases ownrooted cultivar like Conference are utilised as rootstock to reduce the vigour of very vigorous cultivar like Abbé Fétel.

• Own-rooted tree are utilised only in marginal area with difficult soil conditions. The main problem is the delay in bearing.

• Pyrodwarf is not propagated in Italy
• OHF 87 and 97 largely utilized in USA
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In Nursery

• Accelerate nursery cycle
• Pre-formed tree
• Feather induction
• knip tree
• Bibaum® tree
New kind on tree produced from the nursery

Biennial cycle

Knip

One-year-old tree

Tree with interstem obtained with a double graft

Y – BI-AXIS tree
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## Training systems and spacings 2016

<table>
<thead>
<tr>
<th>Training system</th>
<th>Spacing (m)</th>
<th>Density (tree/ha)</th>
<th>Density (tree/acre)</th>
<th>Cultivar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Free Palmetta</strong></td>
<td>3,6 x 1,5</td>
<td>1,850</td>
<td>749</td>
<td>Main</td>
</tr>
<tr>
<td></td>
<td>4,0 x 2,0</td>
<td>1,250</td>
<td>506</td>
<td></td>
</tr>
<tr>
<td><strong>Slender spindle</strong></td>
<td>3,5 x 1,0</td>
<td>2,850</td>
<td>1,153</td>
<td>Main</td>
</tr>
<tr>
<td></td>
<td>4,0 x 1,5</td>
<td>1,660</td>
<td>672</td>
<td></td>
</tr>
<tr>
<td><strong>Vertical axis</strong></td>
<td>3,5 x 0,7</td>
<td>4,080</td>
<td>1,651</td>
<td>Abbé Fétel, Conference, Doyenné du Comice, Bosc</td>
</tr>
<tr>
<td><strong>Y tatura</strong></td>
<td>4,0 x 0,8</td>
<td>3,125</td>
<td>1,265</td>
<td>Main</td>
</tr>
<tr>
<td></td>
<td>4,5 x 1,2</td>
<td>1,850</td>
<td>749</td>
<td></td>
</tr>
<tr>
<td><strong>Y longitudinal Bibaum®</strong></td>
<td>3,3 x 1,0</td>
<td>3,030</td>
<td>1,227</td>
<td>Main</td>
</tr>
<tr>
<td><strong>V system</strong></td>
<td>3,5 x 0,7</td>
<td>4,080</td>
<td>1,651</td>
<td>Abbé Fétel, Conference, Doyenné, Bosc</td>
</tr>
</tbody>
</table>

### Very high density

<table>
<thead>
<tr>
<th>Training system</th>
<th>Spacing (m)</th>
<th>Density (tree/ha)</th>
<th>Density (tree/acre)</th>
<th>Cultivar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>V system intensive</strong></td>
<td>3,5 x 0,50</td>
<td>6,000</td>
<td>2,429</td>
<td>Abbé Fétel, Conference, Doyenné du Comice, Bosc</td>
</tr>
<tr>
<td><strong>Vertical axis</strong></td>
<td>3,0 x 0,30</td>
<td>11,000</td>
<td>4,453</td>
<td>Abbé Fétel</td>
</tr>
<tr>
<td></td>
<td>2,5 x 0,31</td>
<td>13,000</td>
<td>5,263</td>
<td></td>
</tr>
</tbody>
</table>

Source: modified from Sansavini and Musacchi, 2000
Pear training system
Orchard Training System and Density

Main goals

• Early cropping
• High yield efficiency
• High fruit quality
Training system

High level of light interception + homogeneous distribution in the canopy leads to a **higher productivity and a more consistent product.**

**How to achieve it:**  (Corelli-Grappadelli, 2003)

- Training system with **higher area/volume ratio**

- **Narrower canopies**
  (and dwarfing rootstocks) to optimize light interception and photosynthesis → more sugars, more DM%.

(Source: Baldini, 2001)
Palmette

Abbe Fetel own-rooted 12-year-old
Abbe Fetel grafted of Conference (own-rooted) 5-year-old
V system

Abbé Fétel/BH/MC Spacing 3.8 x 0.35 - Planting density 7,518 trees/ha. Year of planting 2005
Abbé Fétel/MC - Vertical axe. Year 5. Ferrara. 2005 Density 12,121 trees/ha. Spacing 2.75 x 0.30 m
Cv Abbé Fétel/Sydo: Planting density 3,030 trees/ha (Modena)
From old to new orchards in Washington and Oregon

From a globe shape to a Bi-axis system
Comparison among orchard systems for Abbé Fétel cultivar

<table>
<thead>
<tr>
<th>Training system</th>
<th>density</th>
<th>Rootstock</th>
<th>ADAMS</th>
<th>Sydo*</th>
<th>MC</th>
<th>BH-MC</th>
<th>MH*</th>
<th>BA29</th>
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</thead>
<tbody>
<tr>
<td>Spindle</td>
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<tr>
<td>Density (tree/ha)</td>
<td>3,175</td>
<td>2,857</td>
<td>3,571</td>
<td>3,571</td>
<td>3,175</td>
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<tr>
<td>Bi-axis</td>
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<td>Density (tree/ha)</td>
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<td>2,857</td>
<td>2,857</td>
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<tr>
<td>“V” system</td>
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<tr>
<td>Density (tree/ha)</td>
<td>4,082</td>
<td>3,571</td>
<td>5,714</td>
<td>5,714</td>
<td>4,082</td>
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<tr>
<td>Vertical axis</td>
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<td></td>
</tr>
<tr>
<td>Density (tree/ha)</td>
<td>7,143</td>
<td>/</td>
<td>9,524</td>
<td>9,524</td>
<td>7,143</td>
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<tr>
<td>Intensive “V” system</td>
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<td>Density (tree/ha)</td>
<td>/</td>
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<td>7,143</td>
<td>/</td>
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</tbody>
</table>

Every combination rootstock-training system was represented by three randomized repetitions.
Comparison among orchard systems for Abbé Fétel cultivar: productive results.

Calculated Yield/ha (2008-2011)

Density: 2,857 ÷ 5,714 trees/ha
Density: 7,143 ÷ 9,524 trees/ha