Optimize Pruning and Fruit Quality in Apple and Pear Orchards

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Apple and Pear Australia Limited (APAL)

June 4-8, 2018
11:30 am - 5:30 pm
Tree balance

ORGANS
- Leaves
- Fruits

FUNCTION
- Carbohydrate production
- Attractor, hormone producer
- Transportation
- Water and nutrient uptake

FUNCTION ORGANS
- Vascular system

- Adsorbing roots
- Root pruning

Pruning
- Nutrition
- Rootstock
- Growth regulator
- Training system

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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.

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**
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
Bending shoot can change the balance between vegetative and reproductive activity
Growth capacity of buds with different orientations

Grisvard, 1957
Effect of bending

Grisvard, 1957
Mohacsy, 1957

Lespinasse, 1980
Quality Optimization

- Pruning physiology
- Cultivar habit
- Rootstocks
- Nursery products
- Main training systems
- HDP pruning technique
- Quality (Light, crop load, Harvest and Mechanization)
Different apple needs different training system

- **GALDEN DELICIOUS**
- **RED DELICIOUS**
- **GRANNY SMITH**
- **GALA (bicolor)**
Fruit exposure to the light and effect of leaves shadow
Apple habit

Spur type= Starkrimson

Red Delicious

Golden Delicious

Rome Beauty
WA 38: main productive characteristics

• Type IV habit
• Blind wood
• Bearing wood characteristics
• Yield and Fruit size
• Bi-axis and mechanization
Blind wood
Pruning techniques:
(applied to both V-system and Spindle training system)

“Bending”

- Trees were pruned minimally, retaining long branches, removing competitive vertical shoots, and concentrating mainly on the bending of the lowest-middle branches.

“Click”

- The “click” focuses mainly on removing crowded branches, choosing always the most horizontal branches and trying to develop more buds close to the stem to avoid the “blind wood” issue that characterizes the “type IV habitus” apple varieties.
Click pruning effects on buds swelling
Quality Optimization

• Pruning physiology
• Cultivar habit
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• Quality (Light, crop load, Harvest and Mechanization)
New rootstocks are under evaluation in Europe. M9 337 is the most important rootstock utilized.
Geneva® Apple Rootstocks by Tree Size

- **Mark B.9**
  - 15-30%
  - G.11
  - G.41*

- **M.9 (Small)**
  - 30-35%
  - T337
  - Pajam 2, EMLA Nic29

- **M.9 (Large)**
  - 35-40%
  - G.16
  - G.210*
  - G.214*
  - G.222
  - G.935

- **M.26**
  - 40-50%
  - M.26 MM106

- **M.7**
  - 50-75%

- **Bud 118 Seedling**
  - >75%
  - Fire blight resistant
  - Replant tolerant
  - * Wooly apple aphid resistant

Quality Optimization

- Pruning physiology
- Cultivar habit
- Rootstocks
- Nursery products
- Main training systems
- HDP pruning technique
- LDP pruning technique
- Quality (Light, crop load, Harvest and Mechanization)
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
Quality Optimization

• Pruning physiology
• Cultivar habit
• Rootstocks
• Nursery products
• Main training systems
• HDP pruning technique
• Quality (Light, crop load, Harvest and Mechanization)
Apple training system
Apple orchard design

The last decade has seen pronounced innovation in apple orchard design marked by the success of new training systems developed as function of planting density.

Orchard density can range between 1,500 (Solaxe) trees/ha up to 10,000 trees/ha (Super spindle).

High density orchard trained at Super spindle induces early bearing starting from the second year.

Its weaknesses are:

• need of high level of technology;

• excess of vigor especially in fertile soil (high organic matter);

• lifespan less than 15 years.
### Planting density:

<table>
<thead>
<tr>
<th>Training system</th>
<th>Spacing (m)</th>
<th>Spacing (feet)</th>
<th>Planting density (trees/ha)</th>
<th>Planting density (trees/acre)</th>
<th>Cultivar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spindle intensive</td>
<td>3.3 x 0.9</td>
<td>(11 x 3)</td>
<td>3,367</td>
<td>1,367</td>
<td>Gala, Rosy Glow Fuji</td>
</tr>
<tr>
<td>Spindle standard</td>
<td>3.6 x 0.9</td>
<td>(12 x 3)</td>
<td>3,086</td>
<td>1,249</td>
<td>Gala, Fuji and Rosy Glow</td>
</tr>
<tr>
<td>Bi-axis</td>
<td>3.3 x 0.9-1.2</td>
<td>(11 x 3-4)</td>
<td>2,525-3,367</td>
<td>1,022-1,367</td>
<td>Gala, Fuji and Rosy Glow</td>
</tr>
</tbody>
</table>
Canopy shape Bi-axis vs Spindle and V-system
The solaxe is the combination of two training systems; the “Solen” (Lespinasse, 1989) and the “Axe vertical” (Lauri and Lespinasse, 2000).

This training system is based on the progressive formation of the tree structure, to establish an equilibrium between vegetative and fruiting activity.

This situation can be obtained with the use of permanent fruiting branches.

Central axis and the fruiting branches grow freely, whereas competing vegetative shoots are removed.

As the branch ages, secondary fruiting formations like brindles and fruiting spurs will develop.
CRIPPS PINK/M9 - FERRARA  PLANTING YEAR 2003. YEAR 2007
CRIPPS PINK: COMPARISON BETWEEN SOLAXE (CENTRIFUGE) AND SLENDER SPINDLE IN THE PO VALLEY (FERRARA)
Cripps Pink: effect of fruit position in the canopy
SpindleFuji/M9 2nd leaf  3.3 x 0.9 m (10.8’ x 2.95’)

FUJI/PAJAM2 – SPINDLE 2nd leaf
3.3 x 0.9 m (10.8’ x 2.95’)

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Cripps Pink/M9 2nd year
After planting
After pruning
V TRELLIS – ANGLE CANOPY
New ideas regarding tree shape include plants with 2 or 3 axes so as to divide the vigor over more branches.

The innovative ‘Bibaum®’ system is a in nursery -pre-formed split-branches tree that obviates the delay of canopy formation.
New ideas regarding tree shape include plants with 2 or 3 axis so as to divide the vigor over more branches.
Bi-axis trees can be created in three possible ways:

1) **Nursery.**

2) **Heading back the tree in the field** (however, one more year is necessary to develop the canopy structure if the bi-axis is created in the field).

3) **Top graft** an existing orchard.

The nursery technique to produce bi-axis trees utilizes a double chip budding or a bench-graft and has been patented as "Bibaum®".  
(Musacchi, 2008; Musacchi et al., 2009)
The innovative ‘Bibaum®’ system is a pre-formed, split-branch trees in nursery that obviate the delay of canopy formation.
Heading back the tree in the field

Heading back at planting

1\textsuperscript{st} Head back
50 cm or 1.5 feet

2\textsuperscript{nd} Head back
Just above the selected axis 20-30cm 0.6-1 feet

End of the first year at least 2 m (7 feet) of new growth.
Heading back the tree in the field
Heading back the tree in the field

Possible mistakes:
• Head back to high
• Use existing lateral to build the axis
Bi-axis system - Planting

• This system requires a trellis structure with posts and 4 wires equally spaced at a distance of 70 cm (2.5 feet) between wires.

• Trees are planted with the double axis oriented in the direction of the row which results in a flat and narrow canopy with a depth of 70 cm (2.5 feet).

• At planting, the two axes will bend in opposite directions and with a crotch angle of 30-40 degrees to make the basal angle of insertion wider.

• When vegetative growth starts, the two axes will be oriented vertically to build a “double axis” tree.