The Avocado Tree

Flowering occurs on last seasons growth
(the most recent summer flush)
The Avocado Tree

Ineffective root system
The Avocado Tree

Energy Distribution
Tree Physiology

Energy distribution

Non bearing tree

Fruit - 0%
Shoot system - 55%
Root system - 45%
Tree Physiology

Energy distribution

*Bearing tree*

- Fruit: 55%
- Shoot system: 40%
- Root system: 5%
Without roots:

No moisture absorbed

No nutrition
Damage

Unwatered

Blocked xylem vessels

Well-watered

David Turner UWA
The water contained a red fluorescent dye – so red means water can flow through the vessels.

David Turner UWA
A temperamental tree

A reason that avocado has remained economically viable for so long.
Floral Initiation

Temperature

A period of cool temperatures is required
Floral Initiation

Day/Night Temperatures

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Fuerte</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 / 20°C</td>
<td>- No Flowers</td>
</tr>
<tr>
<td>30 / 10°C</td>
<td>- No Flowers</td>
</tr>
<tr>
<td>20 / 10 &amp; 20 / 5°C</td>
<td>- Flowered</td>
</tr>
</tbody>
</table>
# Floral Initiation

<table>
<thead>
<tr>
<th>Day/Night Temperatures</th>
<th>Hass</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 / 25°C</td>
<td>- No flowers</td>
</tr>
<tr>
<td>25 / 20°C</td>
<td>- No flowers</td>
</tr>
<tr>
<td>24 / 19°C</td>
<td>- No flowers</td>
</tr>
</tbody>
</table>
Floral Initiation

Day/Night Temperatures  Hass

15 / 10°C  - Flowered

18 / 15°C  - Flowered

20 / 15°C  - Flowered but delayed

23 / 18°C  - Flowered but delayed
Floral Initiation

Day Length

Will flower under short or long days 9 – 15 hours

Flowering time hastened by short days
Floral Initiation

Water Stress

“Water stress did not induce flowering”

“Flowering was delayed”
Floral Initiation

Gibberellins

Natural plant hormone

Can be artificially applied

Produced during vegetative growth phases

Produced by the seed coat
Floral Initiation

Carbohydrate reserves

“Flower bud formation does not proceed in shoots with inadequate carbohydrate levels”
Floral Initiation

Carbohydrate reserves

“In Hass, starch levels were directly related to subsequent yield and had potential for use in crop prediction”

Dr. A.W. Whiley
Floral Initiation

Carbohydrate reserves

“Very low carbohydrate levels at fruit set and development affected the ability of the tree to retain its fruit load”

Davie, 1995
Rootstock effect

Incompatibility will inhibit carbohydrate flow
Rootstock effect

kg/tree

High-yielding

Low-yielding


GLT Horticultural Services Pty. Ltd.
Floral Initiation

Temperature
Carbohydrate level
Rootstock
Day length & water stress

Gibberellins
Direct sunlight

have no effect
What initiates biennial bearing?

Weather

Hail

Cold / Frost

Heat wave
Cold Temperature at flowering

Minimum temp 11°C

Flowering over a period

Large number flowers
What initiates biennial bearing?

Management

Moisture Stress

Poor nutrition

Late hanging of crop
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average yield over 6 years (t/ha)</th>
<th>Effect on biennial bearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early harvest (21-24% DM)</td>
<td>21.5</td>
<td>-</td>
</tr>
<tr>
<td>Split harvest ½ early, ½ late</td>
<td>18.8</td>
<td>Minimal effect</td>
</tr>
<tr>
<td>Late harvest (30% DM)</td>
<td>15.9</td>
<td>Strong pattern developed</td>
</tr>
</tbody>
</table>
Biennial Bearing
The Process

Heavy Crop

Lack of vegetative growth
Biennial Bearing
The Process
Heavy Crop
Low carbohydrate (Energy) reserves

GLT Horticultural Services Pty. Ltd.
Biennial Bearing
The Process
Heavy Crop
High Gibberellin level
Biennial Bearing

The Process

Heavy Crop

Limited growth

Poor flowering
Biennial Bearing

The Process

Following season

Poor crop

Good to excessive growth
Biennial Bearing
The Process
Following season
Large carbohydrate buildup
Large flowering

GLT Horticultural Services Pty. Ltd.
Biennial Bearing
The Solution
Phytophthora Control
Biennial Bearing
The Solution
Ideal moisture management for the tree

GLT Horticultural Services Pty. Ltd.
Biennial Bearing
The Solution

Nutrition program sufficient to produce good summer growth
Biennial Bearing
The Solution
Absolute attention to detail
Detailed overall management

GLT Horticultural Services Pty. Ltd.
Yields

Tonnes / ha

Trees planted at 10m x 5m = 200 / ha.

7 tonnes / ha = 6.4 trays / tree

20 tonnes / ha = 18.2 trays / tree

40 tonnes / ha = 36.4 trays / tree
Yields

Tonnes / ha

Trees planted at 10m x 10m = 100 / Ha.

7 tonnes / ha = 12.8 trays / tree

20 tonnes / ha = 36.4 trays / tree

40 tonnes / ha = 72.8 trays / tree
Can it be prevented?

Orchard SW West Aust.

<table>
<thead>
<tr>
<th>Age</th>
<th>Yields (t / ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2.7</td>
</tr>
<tr>
<td>4</td>
<td>7.4</td>
</tr>
<tr>
<td>5</td>
<td>17.6</td>
</tr>
<tr>
<td>Age</td>
<td>Yields (t / ha)</td>
</tr>
<tr>
<td>-----</td>
<td>----------------</td>
</tr>
<tr>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>4</td>
<td>1.6</td>
</tr>
<tr>
<td>5</td>
<td>12.4</td>
</tr>
<tr>
<td>6</td>
<td>9.3</td>
</tr>
<tr>
<td>7</td>
<td>30.0</td>
</tr>
<tr>
<td>8</td>
<td>16.5</td>
</tr>
<tr>
<td>Age</td>
<td>Yields (t / ha)</td>
</tr>
<tr>
<td>-----</td>
<td>----------------</td>
</tr>
<tr>
<td>9</td>
<td>26.5</td>
</tr>
<tr>
<td>10</td>
<td>18.0</td>
</tr>
<tr>
<td>11</td>
<td>34.9</td>
</tr>
<tr>
<td>12</td>
<td>22.6</td>
</tr>
<tr>
<td>13</td>
<td>40.3</td>
</tr>
</tbody>
</table>
## Orchard SE Qld.

**Trees planted** 2000 - 2002

<table>
<thead>
<tr>
<th>Age</th>
<th>Frosted 2002</th>
<th>Yields – t / ha.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td></td>
<td>14.3</td>
</tr>
<tr>
<td>2007</td>
<td></td>
<td>16.6</td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td>27.9</td>
</tr>
</tbody>
</table>

Trees planted 2000 - 2002

Trees Frosted 2002

GLT Horticultural Services Pty. Ltd.
Orchard SE Qld.
Trees planted 2000 - 2002

<table>
<thead>
<tr>
<th>Age</th>
<th>Yield (t/ha)</th>
<th>Cost/tray to harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>14.3</td>
<td>$1.09</td>
</tr>
<tr>
<td>2007</td>
<td>16.6</td>
<td>$1.07</td>
</tr>
<tr>
<td>2008</td>
<td>27.9</td>
<td>$0.69</td>
</tr>
</tbody>
</table>

GLT Horticultural Services Pty. Ltd.
How to minimise biennial bearing

Best possible root rot control

Best possible water management

Fertilise to the crop load
What will you need to see every season?

Significant vegetative growth over fruit.
Rootstock effect on Nutrition

Rootstock Trial

Cloned

Same watering program

Same fertiliser program
<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Nitrogen</th>
<th>Calcium</th>
</tr>
</thead>
<tbody>
<tr>
<td>A10</td>
<td>2.45</td>
<td>1.10</td>
</tr>
<tr>
<td>Duke 7</td>
<td>2.93</td>
<td>1.02</td>
</tr>
<tr>
<td>Hass</td>
<td>2.85</td>
<td>0.94</td>
</tr>
<tr>
<td>Reed</td>
<td>2.58</td>
<td>0.98</td>
</tr>
<tr>
<td>Smerdon</td>
<td>2.52</td>
<td>1.28</td>
</tr>
<tr>
<td>Velvick</td>
<td>2.53</td>
<td>1.32</td>
</tr>
<tr>
<td>Zutano</td>
<td>2.88</td>
<td>1.01</td>
</tr>
</tbody>
</table>