Irrigation
A key component of high quality Farming Systems Research division
Ian Goodwin, Senior research scientist

Crop Water Use > Water Supply
↓
Water Stress

The effects of water stress
• Yield

The effects of water stress
• Fruit size

The effects of water stress
• Total soluble solids
The effects of water stress

- Antioxidants

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2008/09</th>
<th>2009/10</th>
<th>2010/11</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSD (P=0.05)</td>
<td>1000</td>
<td>1500</td>
<td>2000</td>
</tr>
</tbody>
</table>

Total polyphenols (mg GAE/g FW)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2008/09</th>
<th>2009/10</th>
<th>2010/11</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSD (P=0.05)</td>
<td>38%</td>
<td>50%</td>
<td>74%</td>
</tr>
</tbody>
</table>

ORAC (micromol TE/100g FW)

<table>
<thead>
<tr>
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<th>2008/09</th>
<th>2009/10</th>
<th>2010/11</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSD (P=0.05)</td>
<td>0%</td>
<td>50%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The effects of water stress

- Sunburn

The effects of water stress

- Fruit temperature

Crop water use

Orchard water use

= Tree water use + Understorey water use

Tree water use = 1.3 x EAS x $E_T_0$

Understorey water use = $K_e$ x $E_T_0$

$E_T_0$ is reference crop evapotranspiration (water use of grass)
EAS is the effective area of shade (convert grass to tree water use)
$K_e$ is the understorey (soil evaporation) coefficient (convert grass to understorey water use)
**Reference crop evapotranspiration (ET₀)**

Solar radiation, wind speed, humidity, temperature


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**Tree water use**

**Effective area of shade (EAS)**

- the fraction of the orchard floor shaded by the tree -

\[
\text{EAS} = \frac{\text{Shade (am)} + \text{Shade (midday)} + \text{Shade (pm)}}{3}
\]

- I.e. 10 am, 1:30 pm and 5 pm summer time

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**EAS**

- tree size
- training system
- planting arrangement
- leaf area density

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**Understorey water use**

- Irrigation system

Microjet \( K_n = 0.2 \)

Drip \( K_n = 0.1 \)
Orchard water use

Example
Microjet irrigated apple orchard

\[ \text{ET}_o = 7 \text{ mm} \]
\[ \text{EAS} = 40\% \]
\[ \text{Understorey coefficient} = 0.2 \]

Tree water use \( = 1.3 \times 40\% \times 7 = 3.6 \text{ mm} \)
Understorey water use \( = 0.2 \times 7 = 1.4 \text{ mm} \)
Orchard water use \( = 3.6 + 1.4 = 5.0 \text{ mm} \)

Available soil water

(1) Total root-zone Readily Available Water

When to initiate irrigation
- Root distribution
- Soil type (i.e. RAW)

Example:
Fibrous root-zone depth = 400 mm
Lateral root distribution = 75 \%
RAW = 8 \%
Total root-zone RAW = 400 \times 75 \% \times 8 \% = 24 \text{ mm}

Available soil water

(2) Wetting pattern Readily Available Water

Optimum irrigation run time (hour)
- Fibrous root-zone depth (400 mm)
- Emitter rate and coverage
- Soil type (i.e. RAW)

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Drip</th>
<th>Microjet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy clay loam</td>
<td>1.6 l/h</td>
<td>2.3 l/h</td>
</tr>
<tr>
<td>Clay loam</td>
<td>25 l/h</td>
<td>35 l/h</td>
</tr>
<tr>
<td></td>
<td>((r = 1.4 \text{ m}))</td>
<td>((r = 1.8 \text{ m}))</td>
</tr>
</tbody>
</table>
**PIPS-ET Calculator**

**Irrigation scheduling plan**

<table>
<thead>
<tr>
<th>Location</th>
<th>Block</th>
<th>Row Spacing (m)</th>
<th>Tree Spacing (m)</th>
<th>Variety</th>
<th>Emitter Output (litre/hour)</th>
<th>Clone Emitter Spacing (m)</th>
<th>Rootstock Laterals per Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drouin</td>
<td>South east</td>
<td>5</td>
<td>2</td>
<td>Royal Gala</td>
<td>30</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

**Real-time irrigation scheduling**

**Soil moisture monitoring**

- **Fine tune:**
  - Irrigation run time
  - Crop coefficient (i.e. orchard water use)
  - When to irrigate after rainfall

**Soil moisture monitoring – sensors**

Satellite remote sensing

Orchard water use

Orchard stress monitoring

Orchard water use and stress monitoring

Thank you

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Questions