Sustainable irrigation of high-intensity tree fruit orchards

TF 210 (apple, cherry) 2013-2016

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HDC TF 210: Project aims

- To develop irrigation set points based on soil matric potentials for
  - Gala/M.9
  - Braeburn/M.9
  - Merchant/Gisela 5
  - Kordia/Gisela 5

- To schedule irrigation to improve irrigation water use efficiency and productivity in high intensity apple and sweet cherry orchards
### ‘WATERR’ Project

#### Irrigation Business Reviews

#### Irrigator Performance Summary - Water Use Efficiency: 2011–13

<table>
<thead>
<tr>
<th>Crop</th>
<th>Water Applied (M3 / Hectare)</th>
<th>Crop Yields (Tonnes / Hectare.)</th>
<th>Irrigation Productivity (M3 / Tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Range</td>
<td>Average</td>
</tr>
<tr>
<td>Potatoes</td>
<td>886</td>
<td>115 - 1,775</td>
<td>41</td>
</tr>
<tr>
<td>Lettuce</td>
<td>784</td>
<td>281 - 2,142</td>
<td>20</td>
</tr>
<tr>
<td>Strawberries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Field</td>
<td>1,437</td>
<td>244 - 2,400</td>
<td>19</td>
</tr>
<tr>
<td>- Substrate</td>
<td>2,495</td>
<td>1,275 - 3,942</td>
<td>32</td>
</tr>
<tr>
<td>Raspberries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Field</td>
<td>1,080</td>
<td>543 - 1,523</td>
<td>10</td>
</tr>
<tr>
<td>- Substrate</td>
<td>1,509</td>
<td>650 - 2,600</td>
<td>13</td>
</tr>
<tr>
<td>Apples / Pears</td>
<td>197</td>
<td>22 - 860</td>
<td>25</td>
</tr>
<tr>
<td>Cherries</td>
<td>315</td>
<td>104 - 771</td>
<td>7</td>
</tr>
</tbody>
</table>

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#### Measuring soil moisture availability (and temperature)

- **Field capacity**
- **Permanent wilting point**

- Availability of water is indicated by **soil matric potential**
- Direct relationship to plant water stress
**Linking water content to water potential**

- Soil matric potential is independent of soil texture and soil bulk density
- Irrigation set points derived using soil matric potential should be relevant to all soil types

**Methods to derive irrigation set points**
Improving water (and fertiliser) use efficiency in intensive orchards

Derive irrigation set points for sweet cherries (2014)

- Stage I: Cell division
- Stage II: Pit hardening
- Stage III: Cell enlargement

Kordia

Fruit Diameter (mm)
Effects of limited soil water availability on yield (2014)

- Total and Class I fruit yields were not affected by irrigation treatments in either variety
- Merchant fruit number was reduced when soil moisture deficits were allowed to develop during Stage I

Effects of limited soil water availability on return bloom and yield (2015)

- Return bloom and marketable yield were not significantly affected by the irrigation treatments
- Severe water deficits (-900 kPa) during the flower initiation phase did not affect return bloom, yields or quality
Average soil matric potential in the irrigation treatments (2015)

- **WW**: soil maintained around field capacity
- **ITR1**: average soil matric potentials maintained above -60 kPa during Stages I and II, irrigated at -200 kPa during Stage III
- **ITR2**: maintained above -60 kPa during Stages I and II, irrigation withheld during Stage III and post-harvest until shoot stress responses detected

Tree physiological responses to limited soil water availability

- **ITR1**: mild and transient shoot water stress detected at an average soil matric potential of -200 kPa
- **ITR2**: stress-induced shoot physiological responses detected during Stage III
Tree physiological responses to limited soil water availability

- ITR1: mild and transient water stress was detected at -200 kPa
- ITR2: physiological responses detected post-harvest

Effects of limited soil water availability on yield

- Total and Class I fruit yields were not affected by irrigation treatments in either variety
- Fruit firmness and total soluble sugar content (%BRIX) were not affected by irrigation treatment
Irrigation water applied during the 2015 growing season

- Kordia trees under the ITR1 treatment were irrigated on 22 occasions (6 times pre-harvest)
- Merchant trees under the ITR1 treatment were irrigated on 10 occasions (2 pre-harvest)

Compared to the WW treatment (Commercial Control), a water saving of 72% was achieved for Kordia
A water saving of 88% was achieved for Merchant

Project summary

**Apples**
- Frequent irrigation to maintain soil near to field capacity is not necessary to deliver good commercial yields in Gala and Braeburn
- Irrigating when average soil matric potential reaches -200 kPa will maintain yields and quality and reduce N leaching (TF 214)
- Irrigation should be applied during dry seasons to maintain soil matric potential above -400 kPa, to avoid losses in yield and quality

**Sweet cherries**
- Mild soil drying imposed during Stage I reduced total fruit number in Merchant
- Irrigating to maintain soil above -60 kPa during Stages I and II will improve resource use efficiency without reducing yields and quality
- Irrigating when the average soil matric potential reaches -200 kPa in Stage III will maintain Class I yields and reduce post-harvest losses
FERTINNOWA: Transfer of INNOvative techniques for sustainable WAter use in FERtigated crops

Objectives
To collect, exchange, showcase and transfer innovative water management solutions and best practices for fertigated crops in order to:
- Improve input water quality
- Improve water use efficiency
- Reduce environmental impact

Final aim
- Translation of knowledge into use at different levels (growers, industry, legislation, consumers, ngo’s,…)
- Outcomes will have to be tailored to the specific situation (crops, region, socio-economic, legislation, …)

FERTINNOWA’s Consortium
- 23 partners (Research stations, Advisors, Universities, SME, Industry)
- 1 linked third party (EUFRAS)
- Bringing together all technologies and experiences, bottlenecks, … from all over Europe.
- Coming from the growers, advisors, industry, …
Want to be involved?

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Or visit: www.fertinnowa.com

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