Precision Growing root zone management

Australian webinar 16th March 2017
Andrew Lee, Grodan
Today’s speaker:

**Andrew Lee** - *Technical Services Manager for the Grodan organisation*

The world’s leading substrate supplier to the professional hi-tech horticultural industry. He has worked within the greenhouse industry for 18 years and is recognised as one of Grodan’s leading authorities on root zone management.

Andy’s work takes him to Grodan’s customers in North America, Asia, Central & East Europe and of course Holland. As such Andy has experience of a wide range of cultural environments. He is a regular speaker at industry conferences and has published numerous crop technical articles for horticultural trade magazines throughout the world. Andy chairs the “Green Expert Platform”, a group consisting of crop consultants and researchers who come together to exchange knowledge on crop technical issues related to hi-tech production of greenhouse vegetable crops.

**Sonny Moerenhout** - *Area Sales Manager Australia, New Zealand and United Kingdom*

will be answering your question on chat
Agenda:

- Precision Growing

- Substrate design
  - Uniformity
  - Irrigation efficiency
  - Control range

- Substrate management
  - Effect of RZM on plant growth
  - System configuration
  - Drain hole configuration
  - WC & EC behaviour in the substrate
  - Case studies & fine tuning
Precision Growing root zone management

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Growing

The basis for growth

• $\text{CO}_2$ enters the plant through stomatal pores

• $\text{H}_2\text{O}$ enters the plant through the roots and moves to the leaves via the transpiration stream
Growing

The basis for growth

• \( \text{CO}_2 \) enters the plant through stomatal pores

• \( \text{H}_2\text{O} \) enters the plant through the roots and moves to the leaves via the transpiration stream

• Add sunlight for energy & photosynthesis takes place

\[
6\text{H}_2\text{O} + 6\text{CO}_2 \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2
\]

• Our goal is to maximise fruit production & quality

keeping eye on costs

with consideration for the environmental consequences of our actions
Precision Growing

Giving a plant exactly what it needs

Doing more
By using less

Performance
Costs
Environment

Doing more by using less results in improved performance, reduced costs, and a healthier, more environmentally friendly environment.
Precision Growing

Integrated approach to growing
Benefits of root zone management

Chance Areas in Precision Growing root zone management
Performance

- **Yield** increases measured in terms of an overall Kg/m² and a higher average fruit weight:
  
  Early production
  Total production
  Resilient plants
Benefits of root zone management

Chance Areas in Precision Growing root zone management
Performance

• **Yield** increases measured in terms of an overall Kg/m² and a higher average fruit weight:
  - Early production
  - Total production
  - Resilient plants

• **Fruit quality** is greatly improved.
  - blossom-end rot in tomato and pepper
  - *Mycosphaerella* (gummy stem blight) in cucumber
  - *Fusarium* (internal fruit rot) of peppers
Benefits of root zone management

Chance Areas in Precision Growing root zone management

Minimal inputs

• **Energy** is a significant input cost. Adjustments in climate steering can be made, yet strong generative growth & fruit quality maintained using a structured irrigation strategy

• **Labour:** Consistent fruit quality especially in dark or periods of changeable weather. Equals greater harvesting speed and limits the degree of quality grading in the pack-house

• **Accurate application** of water and fertiliser combined with drain water recycling lowers costs
Benefits of root zone management

Chance Areas in Precision Growing
root zone management
Environment / sustainability performance of the business

• Water and fertilizer use is reduced via a precise irrigation strategy. This is one strategy which can help growers comply with stricter environmental legislation relating to the emission of fertilisers and plant protection products from the greenhouse
Benefits of root zone management

Chance Areas in Precision Growing
root zone management

Environment / sustainability performance of the business

• **Water and fertilizer use** is reduced via a precise irrigation strategy. This is one strategy which can help growers comply with stricter environmental legislation relating to the emission of fertilisers and plant protection products from the greenhouse

• **Lowering energy** input per kilo fruit significantly improves sustainable performance. With accurate RZM controlled generative steering with lower energy inputs is possible
Benefits of root zone management

Chance Areas in Precision Growing
root zone management

Environment / sustainability performance of the business

• **Water and fertilizer use** is reduced via a precise irrigation strategy. This is one strategy which can help growers comply with stricter environmental legislation relating to the emission of fertilisers and plant protection products from the greenhouse

• **Lowering energy** input per kilo fruit significantly improves sustainable performance. With accurate RZM controlled generative steering with lower energy inputs is possible

• **Shelf life** of fruit is consistent with sell-by-dates, reducing supermarket waste concerns
Open field with drip irrigation: 60L

Greenhouse hydroponic system without recycling: 22L

Greenhouse hydroponic system with recycling: 15L

High Tech closed greenhouse hydroponic system: 4L

WATER USAGE per kg tomato
Best Practice Guidelines for Greenhouse Water Management
Substrate design
Substrate functionality for global challenges

Key focus → functionality → benefit to growers in practice

- Grodan are interested in the interaction between water and EC behaviour and how these can be controlled by the grower with root zone management to address the challenges he/she faces.

- 4 key features incorporated into the design of Grodan stone wool substrates
  - Inert “NG 2.0” stone wool fibres (unique surface chemistry)
  - Irrigation efficiency
  - Uniformity over the height
  - Steering range WC
Substrate management
Effect on plant growth
### Steering between seasons & days

<table>
<thead>
<tr>
<th>Irrigation strategy</th>
<th>Influence on crop development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease WC</td>
<td>= Generative effect</td>
</tr>
<tr>
<td>Increase EC</td>
<td>= Generative effect</td>
</tr>
<tr>
<td>Increase WC</td>
<td>= Vegetative effect</td>
</tr>
<tr>
<td>Decrease EC</td>
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</tr>
</tbody>
</table>
## Control possibilities for manipulating substrate WC

<table>
<thead>
<tr>
<th></th>
<th>Influence on the slab WC</th>
<th>WC DECREASE (Generative)</th>
<th>WC INCREASE (Vegetative)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Start time</strong></td>
<td>Large</td>
<td>Later</td>
<td>Earlier</td>
</tr>
<tr>
<td><strong>Stop time</strong></td>
<td>Large</td>
<td>Earlier</td>
<td>Later</td>
</tr>
<tr>
<td><strong>Irrigation length</strong></td>
<td>Small</td>
<td>Longer</td>
<td>Shorter</td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>Medium</td>
<td>Lower</td>
<td>Higher</td>
</tr>
</tbody>
</table>
WC & EC steering in relation to light

Vegetative steering
Plant help & survival

Generative steering
Invest in plant & stimulate

800 W/m²
600 W/m²
400 W/m²
200 W/m²

EC
WC

EC
WC
Substrate management
System configuration
Substrate volume l/m²

Optimum substrate volume = 7.5 – 9.0 l/m²
Substrate volume l/m²

Optimum substrate volume = 7.5 – 9.0 l/m²

Irrigation capacity l/m²/hr

Optimum irrigation capacity 1.2 – 1.5 l/m²/hr

Steerable in WC% and EC whilst managing generative & vegetative growth
Impact of substrate volume for generative – vegetative steering

Example Grotop Master

<table>
<thead>
<tr>
<th></th>
<th>Grotop Master 7 l/m² with 1.25 drippers /m²</th>
<th>Grotop Master 9l/m² with 1.25 drippers /m²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume ml/m²</td>
<td>Volume (ml) per dripper</td>
</tr>
<tr>
<td>Small cycle (3%)</td>
<td>210</td>
<td>168</td>
</tr>
<tr>
<td>Standard cycle (4%)</td>
<td>280</td>
<td>224</td>
</tr>
<tr>
<td>Large cycle (6%)</td>
<td>420</td>
<td>336</td>
</tr>
</tbody>
</table>

More generative steering due to larger irrigation sessions
Substrate management
Drain hole configuration
Cutting drain hole

- Slabs fully saturated with full nutrient solution before drain hole(s) cut.
  - Before planting (slab contact)
- One drain hole per 133 cm at lowest point*.
- Cut from under slab in upwards direction.
  - never directly under block
  - prevent differences in staff.
    - Good instruction & supervision
    - Number of people allocated to task
- Number & size of drain holes will influence ability to manage the substrate.
Positioning of the drain hole

Number of drain holes & drain hole positioning – consequence for irrigation efficiency* & EC management

![Graph showing the effect of drain hole positioning on drain EC.](image)

Drain EC

<table>
<thead>
<tr>
<th>Drain EC (mS/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.3</td>
</tr>
<tr>
<td>4.9</td>
</tr>
<tr>
<td>4.5</td>
</tr>
<tr>
<td>4.1</td>
</tr>
<tr>
<td>3.7</td>
</tr>
</tbody>
</table>

Irrigated volume

- Yellow line: drain hole at optimal position
- Blue line: drain hole close to dripper

20 cm

10 cm

Grodan Group | 16-03-2017
Substrate management
WC & EC behaviour in the substrate
**General principles when considering irrigation strategy**

Transpiration then irrigation

Irrigations around 1\textsuperscript{st} drain greatest effect on levelling EC

Large volumes in the morning

Radiation highest EC lowest
General principles when considering irrigation strategy

Irrigations around 1st drain greatest effect on levelling EC

Large volumes in the morning

Smaller more frequent volumes in the afternoon

Radiation highest EC lowest

Stable decrease in WC% between darks days and bright days

Remember session size is a function of grower’s substrate volume (l/m²)

Transpiration then irrigation
Especially drain volumes <20%
Especially drain volumes <20%
Substrate management

Rules-of-thumb when starting the cultivation
Plant activity and climate steering tomato

Minimal decrease WC% over night

To first harvest (esp 1st 5-6 clusters)
• 2% then add this to the number of the flowering truss
• i.e. flowering truss 4
  • 4 + 2 = 6% decrease overnight

Minimal water uptake sunrise to sunset

• For each flowering truss uptake x100ml/m²
  • i.e. flowering truss 4
    • 4 x 100ml/m² = 0.4 ml/m
Plant activity  & climate steering cucumber

Minimal decrease WC% overnight

• Plant height 50 cm = 2%
  • Then x1% for every additional 25 cm of growth

• i.e. plant height 175 cm
  • 2% + (5 x 1%) = 7% decrease overnight

Minimal water uptake sun rise to sun set

• For every 25 cm growth x100 ml/m²/day
  • i.e. 50 cm = 200 ml/m²/day
Plant activity & climate steering pepper

Minimal decrease WC% over night

- 2% starting from where stem breaks to produce the final growing shoots
- Then for every 20 cm growth x1 %
  i.e. Plant height 130 cm with stem break @ 30 cm = 2% + (5 x 1%) = 7% decrease overnight

- **Minimal water uptake sun rise to sun set**

- Plant height every 20 cm = x100 ml/m²/day
  - 40 cm = 200 ml/m²/day
Substrate management
General rules-of-thumb for starting & stopping irrigation
Start irrigation

Transpiration then irrigation

• Why important to start on time?

  • EC control in time.
  • Maintain plant, root & fruit quality.

<table>
<thead>
<tr>
<th>Irrigation start time in relation to sunrise</th>
<th>Start time in relation to sunrise and increasing plant activity</th>
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<tr>
<td>0 – 1 hour</td>
<td>Early</td>
</tr>
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<td>1 – 2 hours</td>
<td>Standard</td>
</tr>
<tr>
<td>2 – 4 hours</td>
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Typical start conditions
Start irrigation

Transpiration then irrigation

• Why important to start on time?
  • EC control in time.
  • Maintain plant, root & fruit quality.

• Factors which affect rate of resaturation to point of drain
  • Size* of irrigation session /m²
    • *relation to substrate volume

• Frequency of irrigation sessions.

Typical start conditions

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Drain period

Radiation highest substrate EC lowest

• Why important for EC control in time?
  • Stability of EC in a particular growing phase.
  • Maintain plant and fruit quality.

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Typical drain conditions
Drain period

Radiation highest substrate EC lowest

- Why important for EC control in time?
  - Stability of EC in a particular growing phase.
  - Maintain plant and fruit quality.
- Factors which affect stability of EC and WC.
  - Frequency of irrigation (ml/J)
  - Minimum rest time (summer)

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Typical drain conditions
Stop irrigation

Stable decrease substrate WC

• Why important to stop in time?
• Maintain plant, root & fruit quality
• Aim for 8 – 12% decrease in WC over night depending on balance and stage of plant development

<table>
<thead>
<tr>
<th>Irrigation stop to relative to sunset</th>
<th>Stop time in relation to sunset and decreasing plant activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 2 hours</td>
<td>Early</td>
</tr>
<tr>
<td>1 – 3 hours</td>
<td>Standard</td>
</tr>
<tr>
<td>3 – 6 hours</td>
<td>Late</td>
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</table>
Relationship between decrease WC% overnight & [summer] yield of tomato
Substrate management
Fine tuning start and stop times
Starting irrigation

Bright day

- 100-200 W/m² or 50-100 J/cm²
- Look for 1.5-2.0% decrease WC from sunrise

Dark day

- Depending plant development
  irrigation yes or no?
- Look for 1.5-2.0% decrease WC from sunrise
- ‘No’ maximum rest time setting

Start time optimised in relation to sunrise and increasing plant activity. Protects plant & fruit quality.
EC stability in the afternoon

• Correct start time

• Wrong strategy employed in Period. Small irrigation sessions are used. Consequently drain is not realised on time

• EC increases in the afternoon & the following day

• Sometimes incorrect actions are taken
  • lower drip EC
  • stop recycling drain water
  • or in this case night irrigation session

General rule: EC lowest radiation highest!
EC stability in the afternoon

• Watch minimum rest time is not restricting irrigation!

• Ensure your irrigation capacity is not restricting irrigation
  • Starting irrigation early & stopping late will not help EC control in the afternoon

• Look to the relation ml/J
Stopping irrigation

I like to use ‘2 conditions’

80-100 J/cm² & 250-350 W/m² outside radiation.

Bright day

- Aim to leave 150-200 J/cm² to sunset

Dark day

- 3-4 hours before sunset
- EC stable?
- Decrease WC over night?

<table>
<thead>
<tr>
<th>Percent decrease in WC</th>
<th>Effect of decision to stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 2%</td>
<td>Stopped too late</td>
</tr>
<tr>
<td>2 – 4%</td>
<td>OK</td>
</tr>
<tr>
<td>&gt;4 %</td>
<td>Stopped too soon</td>
</tr>
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</table>

![Graph showing radiation over time](image)

Radiation (W/m²)

<table>
<thead>
<tr>
<th>Time</th>
<th>06:45</th>
<th>18:50</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:00</td>
<td>699</td>
<td>699</td>
</tr>
<tr>
<td>06:00</td>
<td>559</td>
<td>559</td>
</tr>
<tr>
<td>12:00</td>
<td>419</td>
<td>419</td>
</tr>
<tr>
<td>18:00</td>
<td>279</td>
<td>279</td>
</tr>
<tr>
<td>00:00</td>
<td>189</td>
<td>189</td>
</tr>
</tbody>
</table>

0 – 2% Stopped too late
2 – 4% OK
>4% Stopped too soon
Getting it right with a steerable substrate

- No need to “chase a certain drain volume or EC value”.
- Structure leads to stability in the root zone despite variable outside weather conditions.

Low stable WC and high stable EC: winter

High stable WC and low stable EC: summer
Summary

• Precision Growing is the most efficient and effective way of growing and is focused on the use of minimum inputs to generate maximum output

• Precision Growing in respect substrate management will help:
  • Improve performance yield & quality
  • Optimise inputs, energy, labour & fertiliser
  • Form basis of a sustainable cultivation

• Remember the importance of the substrate system & use of steerable stone wool substrates to manage WC% & EC

• Mantra: start on time, drain on time, EC lowest radiation highest, stop on time
Q&A:

- With dry substrates do I have the ability to steer my crop more generative?
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• You mentioned that I should use large irrigation sessions in the morning. Another manufacture of stone wool recommends I should use small sessions. What’s the reason for the difference in advice?
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• You said the importance of decrease in WC% over night and the relationship to yield in the summer. Can you explain that again?
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• With dry substrates do I have the ability to steer my crop more generative?

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• You said the importance of decrease in WC% over night and the relationship to yield in the summer. Can you explain that again?

• How does high density effect the general rule of 3cc/jouI? Eg. truss at 3.9 plant/m2, say LAI 3
Contact us

Sonny Moerenhout

Area Sales Manager Australia, New Zealand and United Kingdom

- M +31 (0)6 12 14 69 95

sonny.moerenhout@grodan.com
Passionate about Precision Growing