Adding precision to precise irrigation

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Methods and technologies to improve efficiency of water use (yield per irrigation unit)

Robert G. Evans, E. John Sadler, 2008

• Agricultural advances will include:
  – Conversion to crops with higher productivity per unit of water consumed,
  – Development of precision irrigation technologies for sprinklers and micro-irrigation systems
Water use efficiency in Israel

Index growth in relation to 1960s

Production

Water use
Precision agriculture

A management strategy that uses information technologies to bring data from multiple sources to bear on decisions associated with crop production (1997)
Data Collection

Spatial decision support systems

Variable-rate application

Data and information Processing
From data collection to VRI

1. Data collection to map the in-field variability
   – Mostly indirect measurements like NDVI and plant temperature
2. Data processing
   – Transformation into meaningful measures
3. Spatial DSS
   – Strategies for variable rate irrigation
4. Variable rate application technologies
Thermal imagery for irrigation

• Detection of irrigation malfunctions

• Water status mapping and Irrigation management
Thermal imagery for irrigation

- Detection of irrigation malfunctions

- Water status mapping and Irrigation management
Map of irrigation malfunctions

Red – clogs; Blue- leaks
‘Waze’ for the farmers: the monitoring routs

Seasonal monitoring of irrigation malfunctions requires 5–7.5 days per hectare of olives and grapevines. The thermal-based detection system can reduce this to 3–4 days.
Thermal imagery for irrigation

- Detection of irrigation malfunctions
- Water status mapping and Irrigation management
CWSI – Crop Water Stress Index

• The index based on canopy temperature (Tcanopy) and extreme reference temperatures:

\[ CWSI = \frac{(T_{\text{canopy}} - T_{\text{min}})}{(T_{\text{max}} - T_{\text{min}})} \]  

(Idso et al., 1981)

– \( T_{\text{max}} \) – Heavy Water Stress, Closed Stomata, low transpiration.

– \( T_{\text{min}} \) – Full Transpiration, Open Stomata, high transpiration.

Min = 0 = well-irrigated  
1 = Max = heavy water stress
Precise and Precision Irrigation

- The use of thermal remote-sensing to map the in-field variability has the potential to increase WUE without decreasing yield
- Adding precision to precise irrigation systems

### Water use efficiency in cotton field

<table>
<thead>
<tr>
<th>Irrigation</th>
<th>Water use efficiency (Kg/cube)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation based on point plant monitoring</td>
<td>8.5</td>
</tr>
<tr>
<td>Irrigation based on thermal-imaging</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Legend:
- b
- a
RGB (regular) imaging - UAV
RGB (regular) imaging - UAV
Thermal imaging - UAV
LWP Maps Givat Brener – 11/08/2013

Whole-field – 90%

Irrigation units – 95%

management zones – 100%

- Over Irrigated
- Well Irrigated
- Low water stress
- Medium water stress
- Severe water stress
Summary

• VRI systems are already commercial for pivot and linear move irrigation systems
• Initial non-commercial systems were developed for drip irrigation
• These commercial systems are currently fed simply by static IMZ ignoring the in-season-change in their borders.
• To improve their performance these systems should be fed also by in-season prescription maps
Summary

• Methodologies are continuously developed to create high level irrigation prescription maps by including in-season thermal imaging.

• These technologies and methodologies have a great potential in increasing water use efficiency in the 21st century.
Summary

• Thermal images are becoming more available to the farmers yet, care should be taken to ensure using thermal cameras with high accuracy.

• The current challenge is to develop methodologies to decrease the costs involved in using thermal imaging in order to urge the adoption of thermal-based irrigation approach by the farmers.
Thank you for your attention

Questions?

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