Improving resource use efficiency, productivity and consistency of quality

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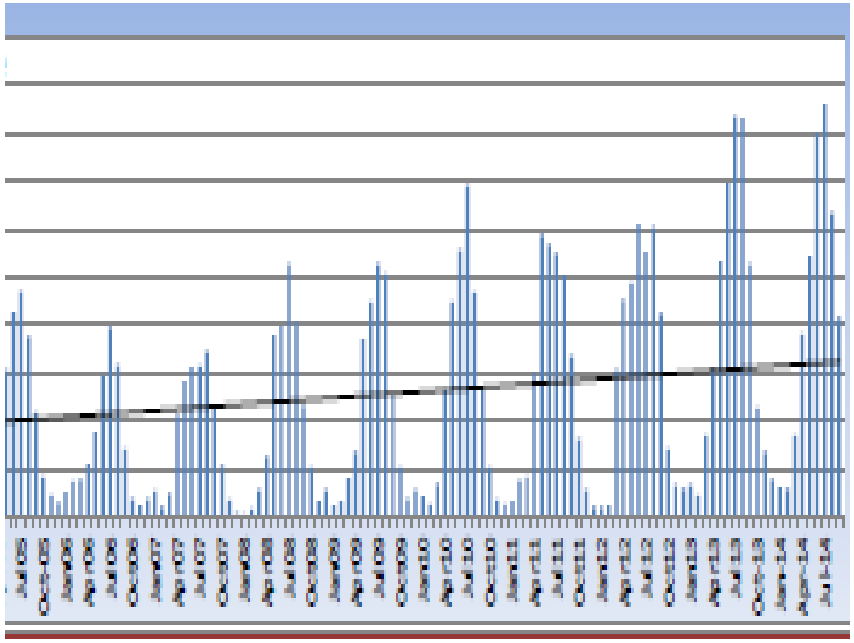
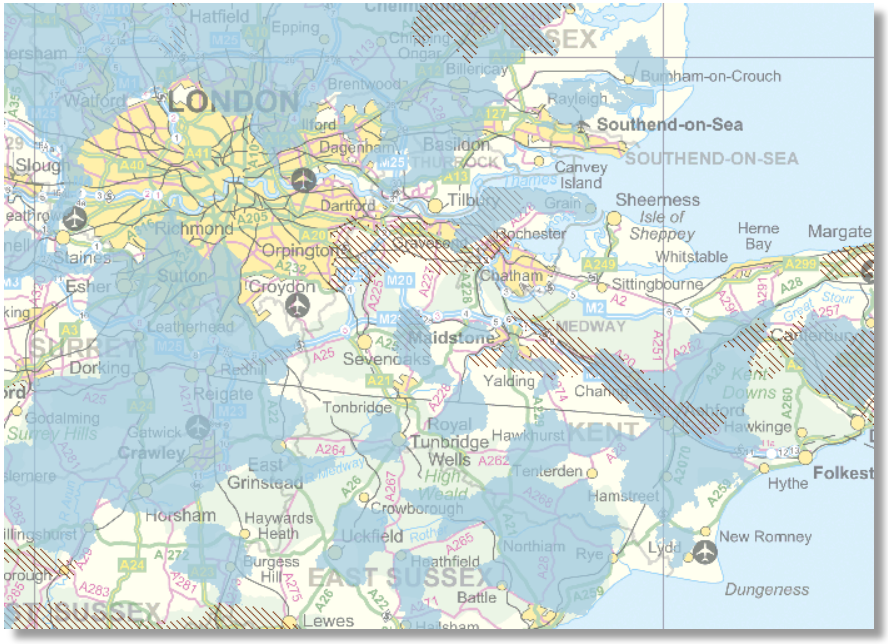
Innovate UK
Technology Strategy Board

Berry Gardens

Water availability and water quality for high value horticulture





- Exemption for trickle irrigation to be removed (Abstraction Licence Reform)
- Environment Agency to begin implementing changes in October 2015
- Only 27% of water-bodies in England are classified as being of ‘good status’ (EU WFD)

Environment Agency

Benchmarking Water Productivity in soft fruit production

Crop	Water applied		Marketable yield		Irrigation productivity	
	M^3 / hectare		Tonnes / hectare		M^3 / tonne	
	Average	Range	Average	Range	Average	Range
Raspberry						
Soil	1,080	543 - 1,523	10	7 - 17	114	87 - 134
Substrate	1,509	650 - 2,600	13	10 - 20	111	43 - 166
Strawberry						
Soil	1,437	244 - 2,400	19	5 - 34	79	58 - 99
Substrate	2,495	1,275 - 3,942	32	18 - 45	82	49 - 108

- ‘Water conscious’ growers recognise the link between irrigation and fruit quality
- Effective irrigation scheduling will improve consistency of fruit quality
- Shift to substrate production will rapidly increase demand for water

EUROPEAN UNION
Investing in Your Future
European Regional Development Fund 2007-13

'WATERR' Project
Irrigation Business Reviews

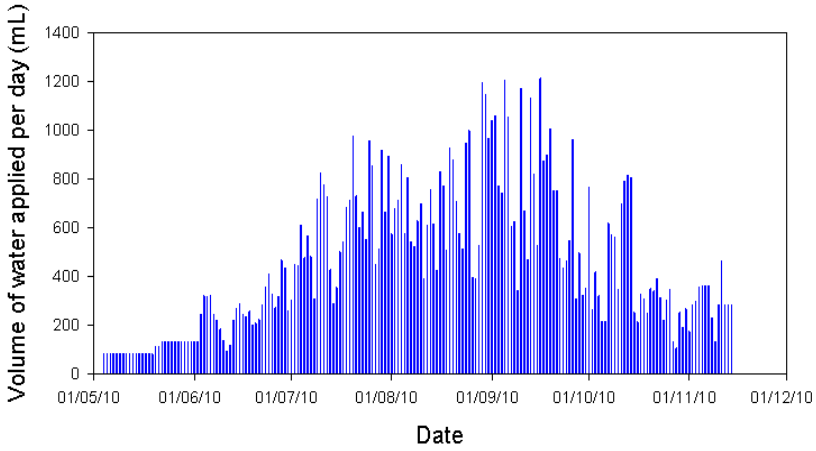
Irrigator Support Needs / Priorities

Ranking / % of Irrigators Rating Important or Very Important

1. Learning from the experiences of other irrigators (77%)
2. Learning about planned changes to Abstraction Licensing System (72%)
3. Understanding which technologies/ techniques have the most impact on irrigation water use efficiency and financial returns (67%)
4. Visits to sites which demonstrate irrigation Best Practice (67%)
5. Understanding how own water use efficiency compares with other abstractors (58%)
6. Direct 1:1 support from irrigation specialists (58%)
7. Collaborative opportunities to improve catchment management and water demand / supply balance (52%)

What do we mean by Precision Irrigation?

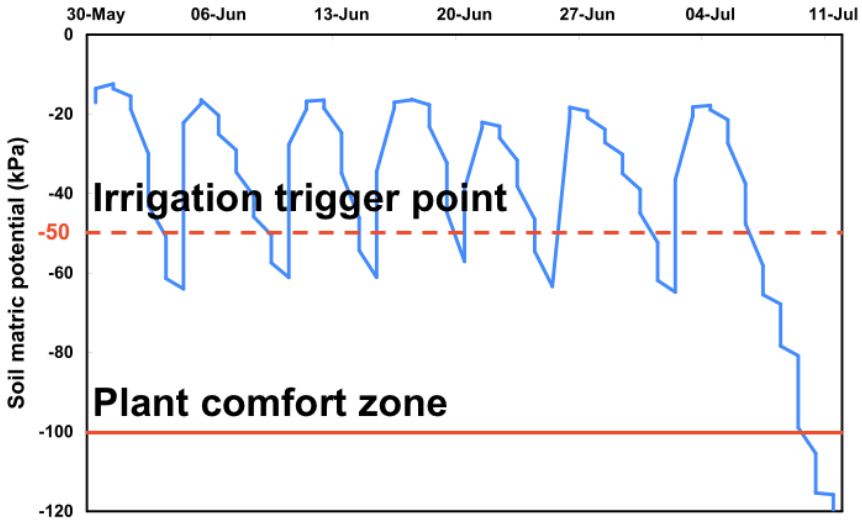
- A system that applies the target volumes of water consistently
- A system that delivers target run-off volumes consistently
- A system that matches crop demand for water with supply



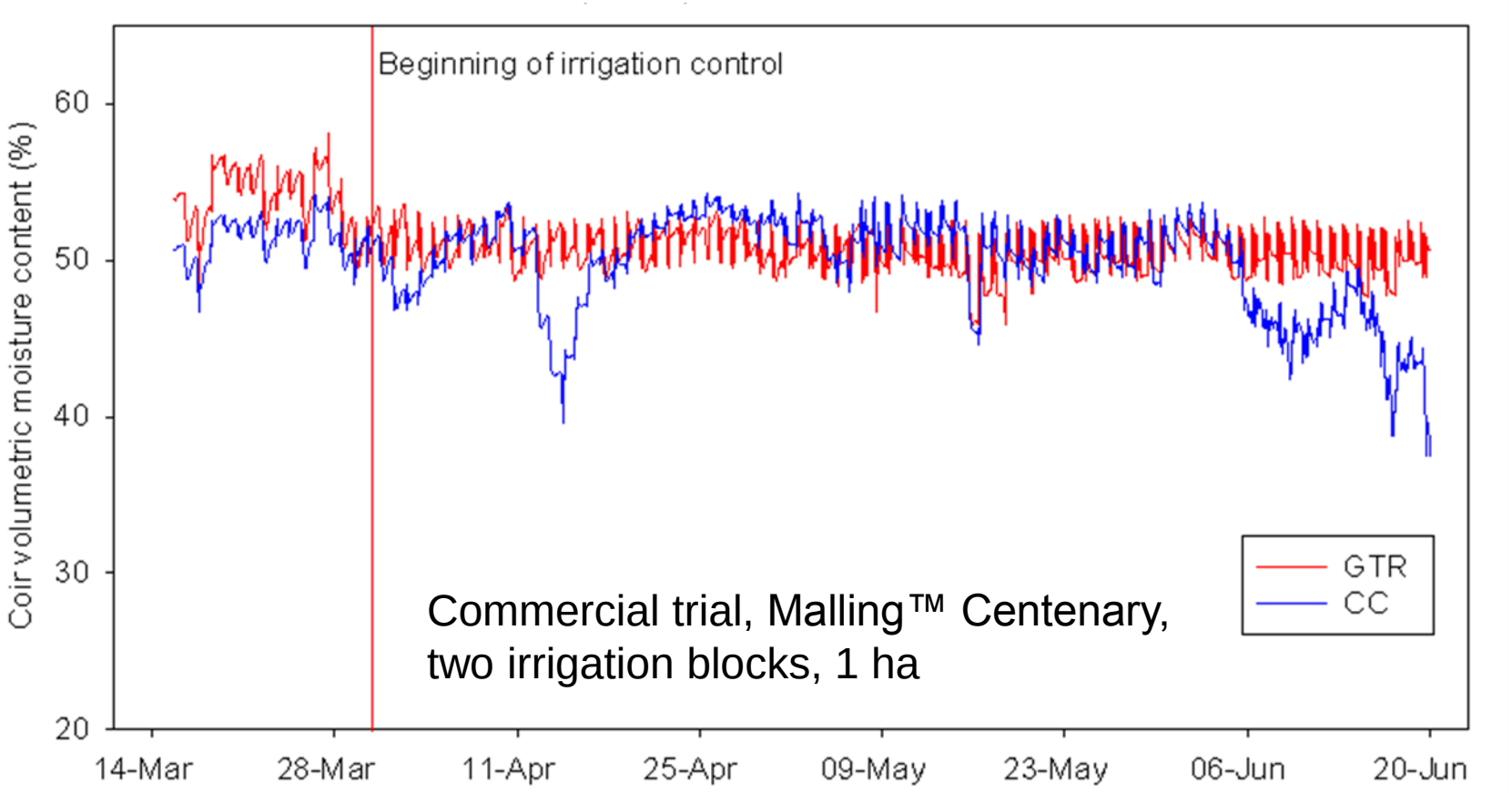
- Ensuring that irrigation is managed to optimise:
  - Plant health
  - Plant nutrition
  - Class 1 yields
  - Fruit quality
  - Canopy size and light interception

How does the Precision Irrigation system work?

- Variety-specific irrigation set points
- Sensors measure coir moisture content (CVMC)
- Sensors measure coir pore EC
- CVMC values averaged by Advanced Datalogger
- Signal sent to commercial rig once set point reached
- Duration of each irrigation event adjusted to deliver target run-off volumes
- Automated flushing based on pore EC values
- Variability in weather automatically accounted for
- Different plant sizes, varieties, crop loads, planting densities automatically accounted for
- Safety margin built in around set points
- Alarm state built in to the PI system
- Frequent monitoring of inputs, run-off, CVMC, plant health, fruit growth by NIAB EMR staff
- System can deliver the growers' usual practice with improved consistency if required

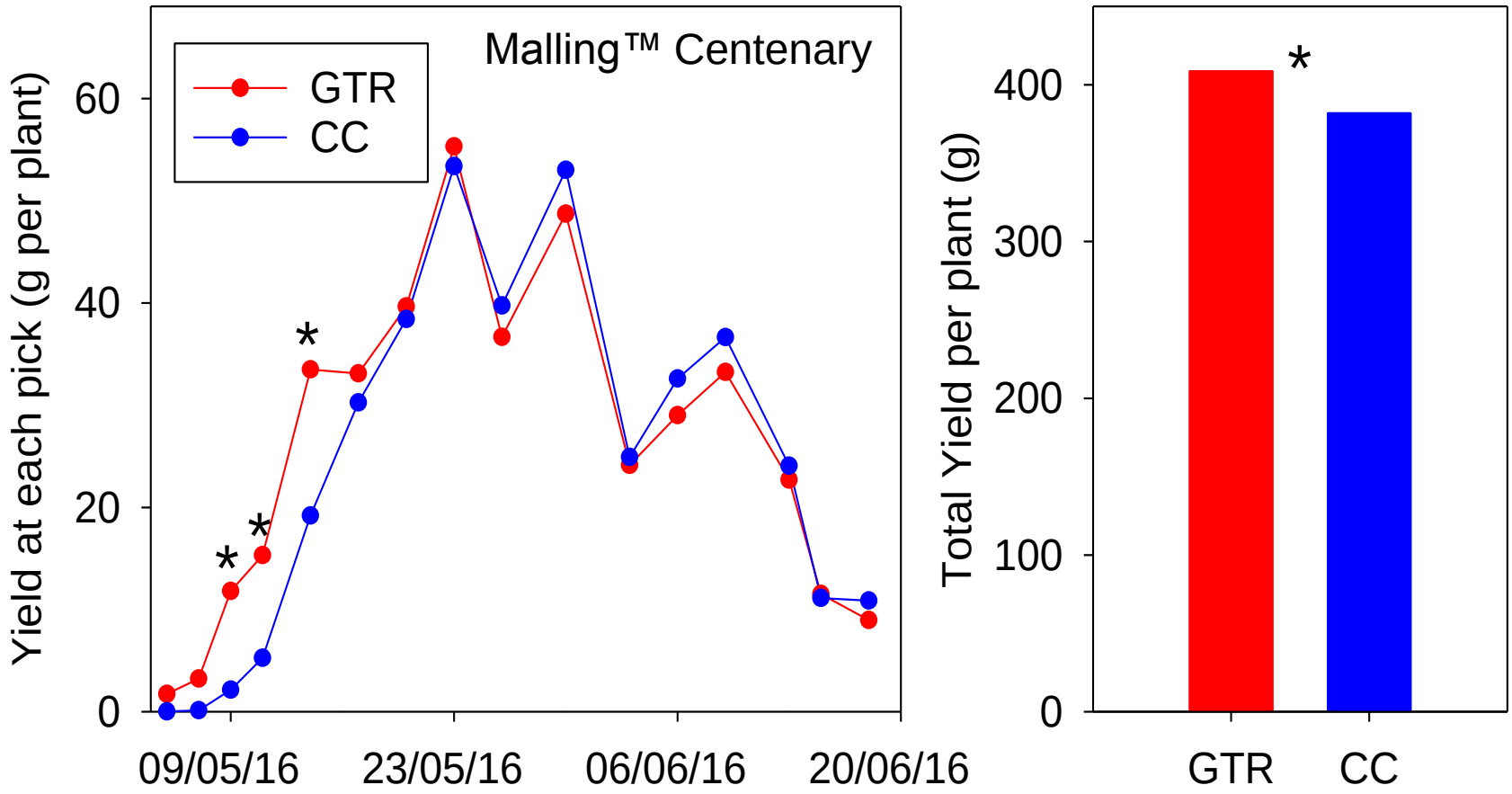


What difference does Precision Irrigation make?



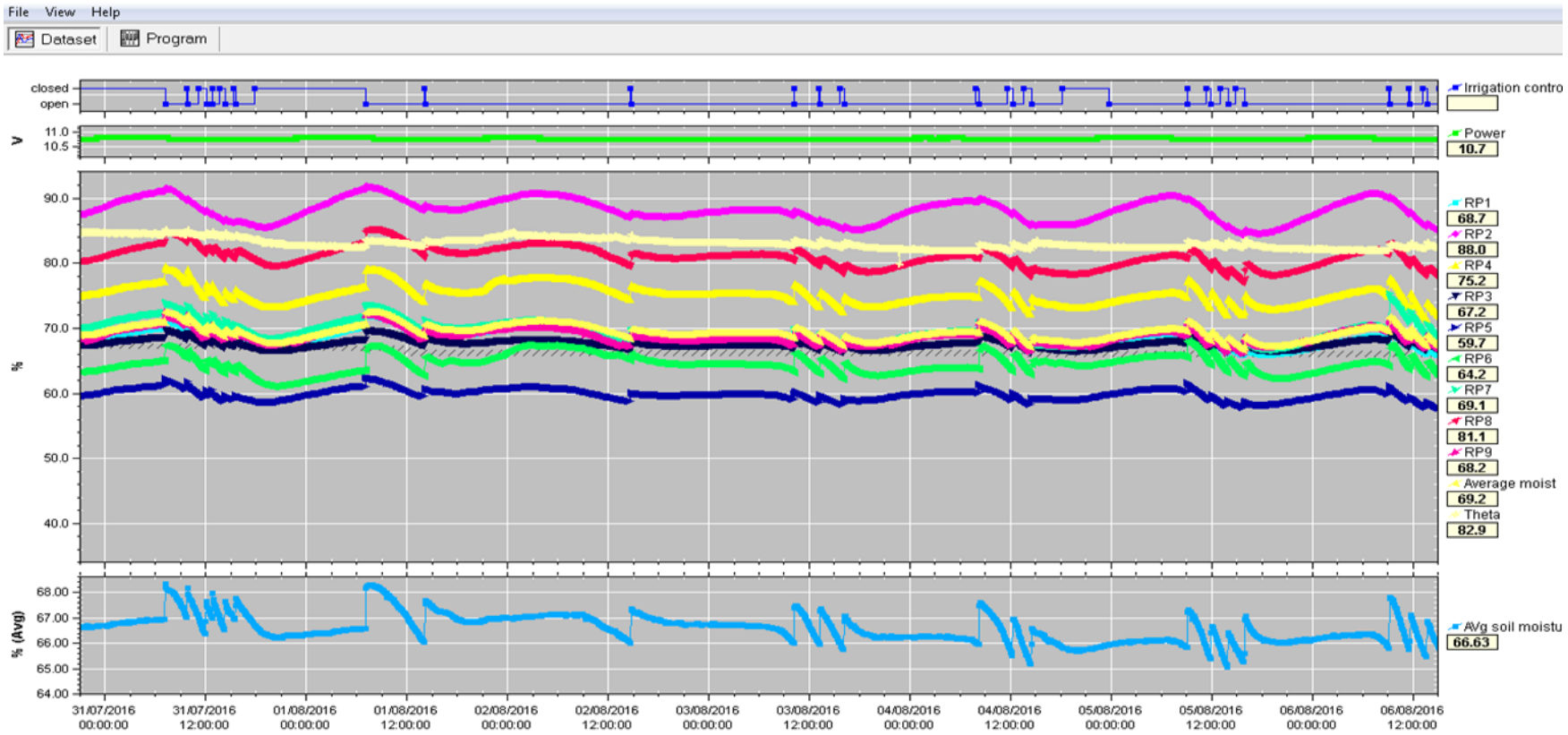
- CC: CVMC 38 – 55 %, typically maintained 47 - 54% to try to improve fruit quality
- GTR: CVMC 47 – 53 %, typically maintained 48 - 52%

… 7% higher Class 1 yields



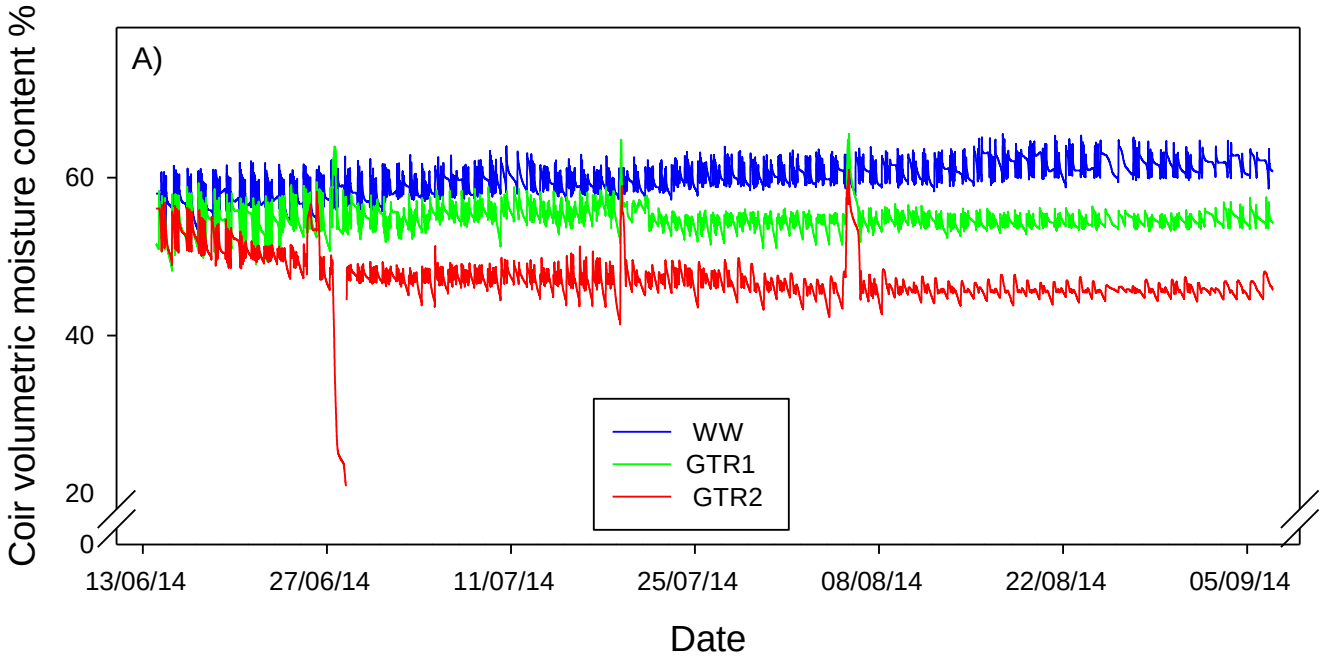
- Earlier cropping under GTR (higher ambient temperatures?)

Real time access to data 24/7



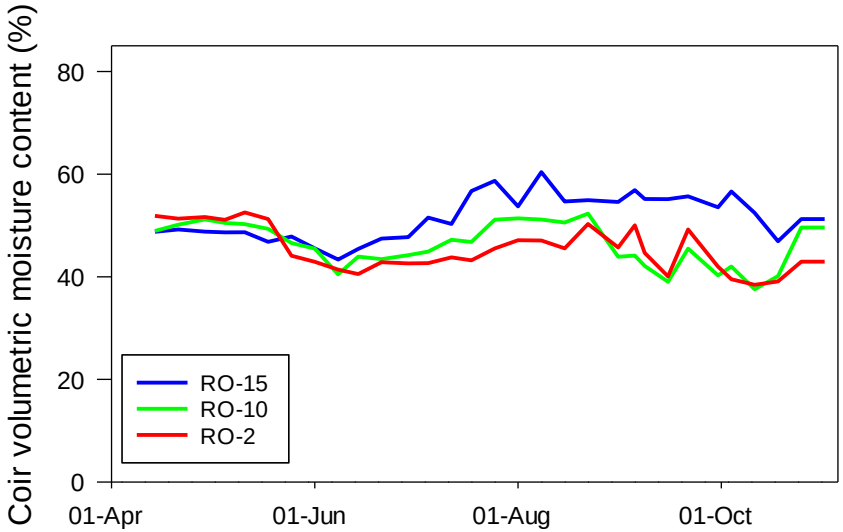
- Pore EC, air/coir temp., RH, VPD, dripper inputs, run-off volumes, light intensity
- BerryDSS - GDH, forecasts of ‘polytunnel climate’ data, remote monitoring

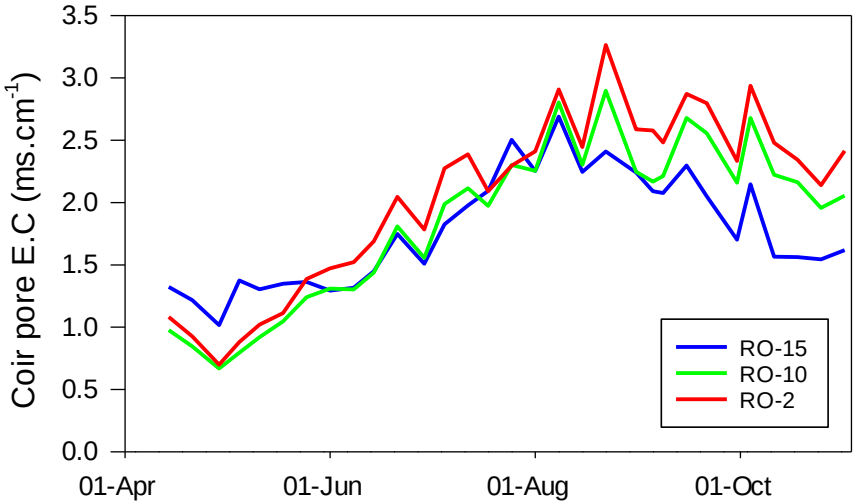
Precision irrigation of primocane and floricane raspberry

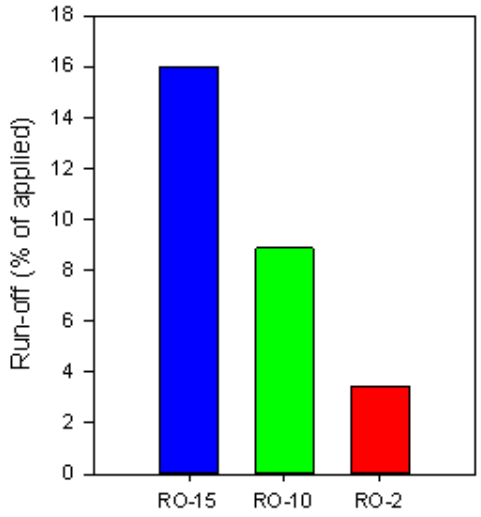


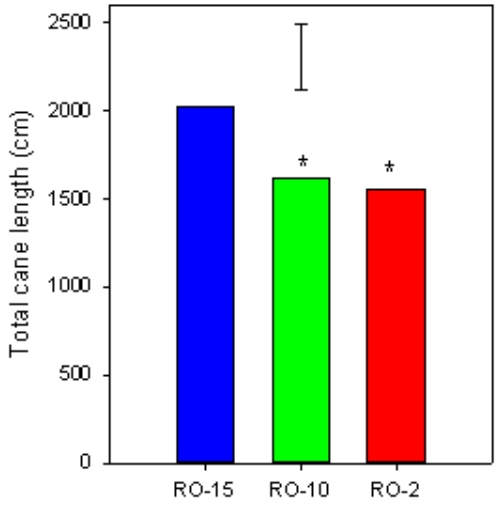
- Precision control of coir water content
- Automated coir flushing to manage coir pore EC
- Full control of percentage run-off
- Potential to control primocane vigour

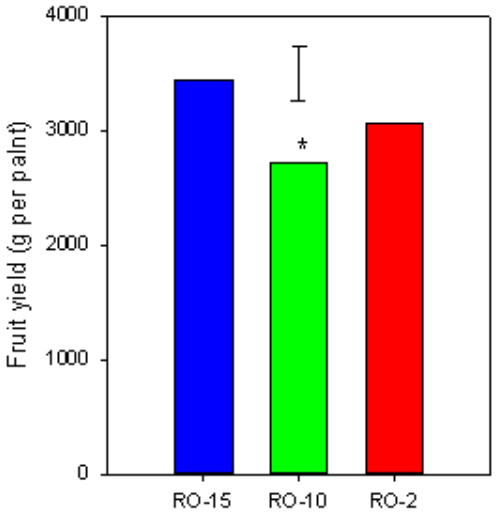
Less run-off, lower yields in Primocane crop



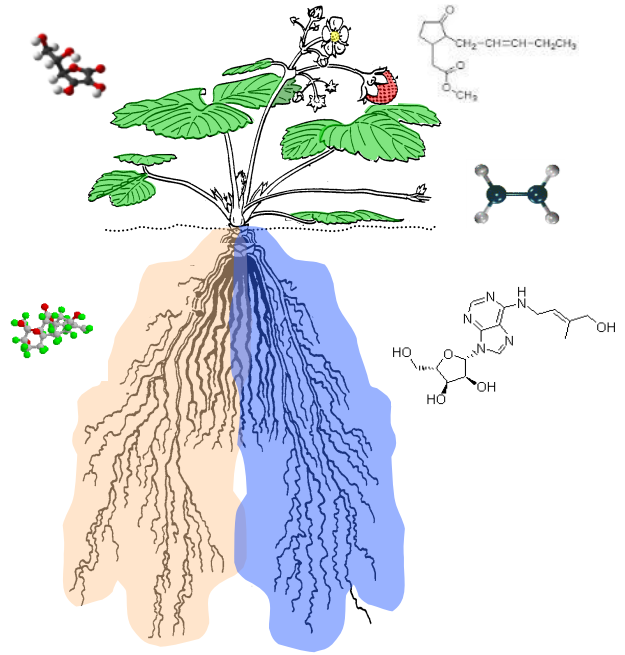


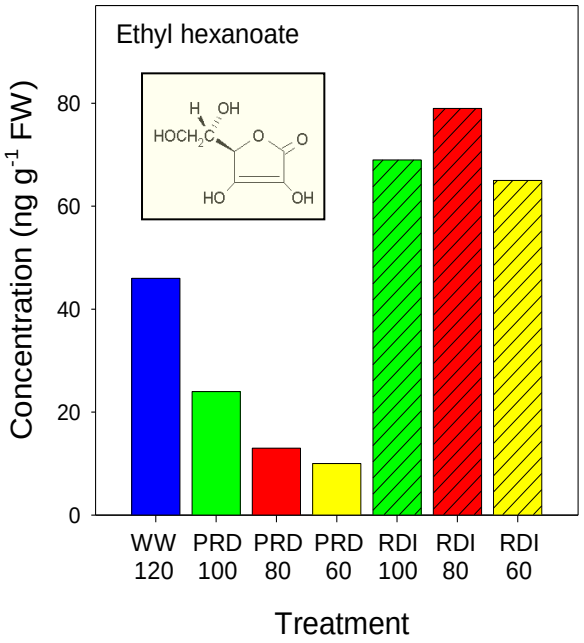


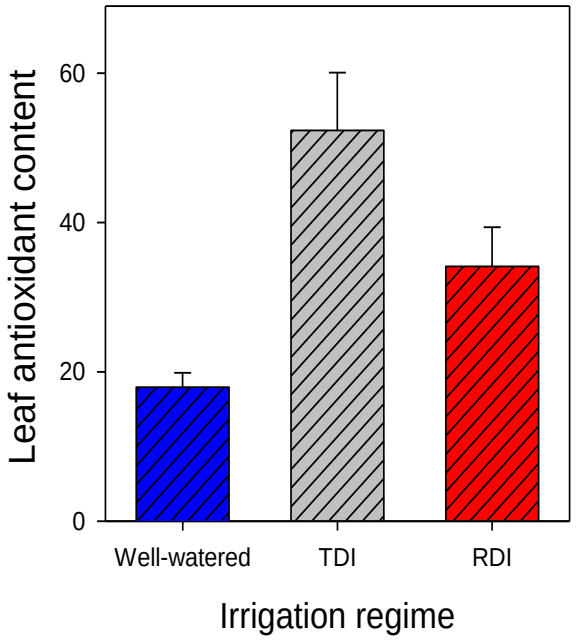




New ways to improve resource use efficiency, productivity and fruit quality





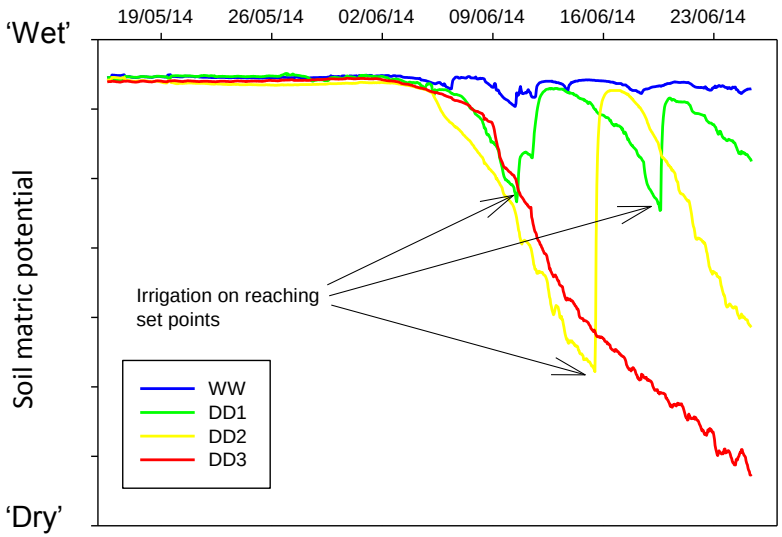


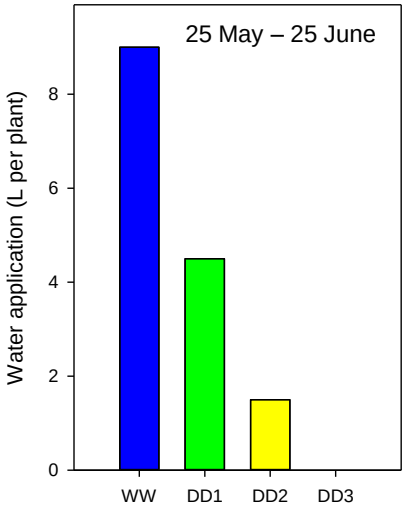
- 'Beneficial stresses' *e.g.* Transient Deficit Irrigation (TDI)
- Improved flavour, firmness, antioxidant capacity, shelf-life
- Resource partitioning – higher dry matter content
- Stress pre-conditioning to improve crop resilience

Soil grown strawberry

- Industry average WP in 2012 = 44 (m^3 per tonne Class 1)
- RDI delivered a WP of 9
- Good commercial yields, aspects of berry quality improved
- Demonstrate the potential for water savings…

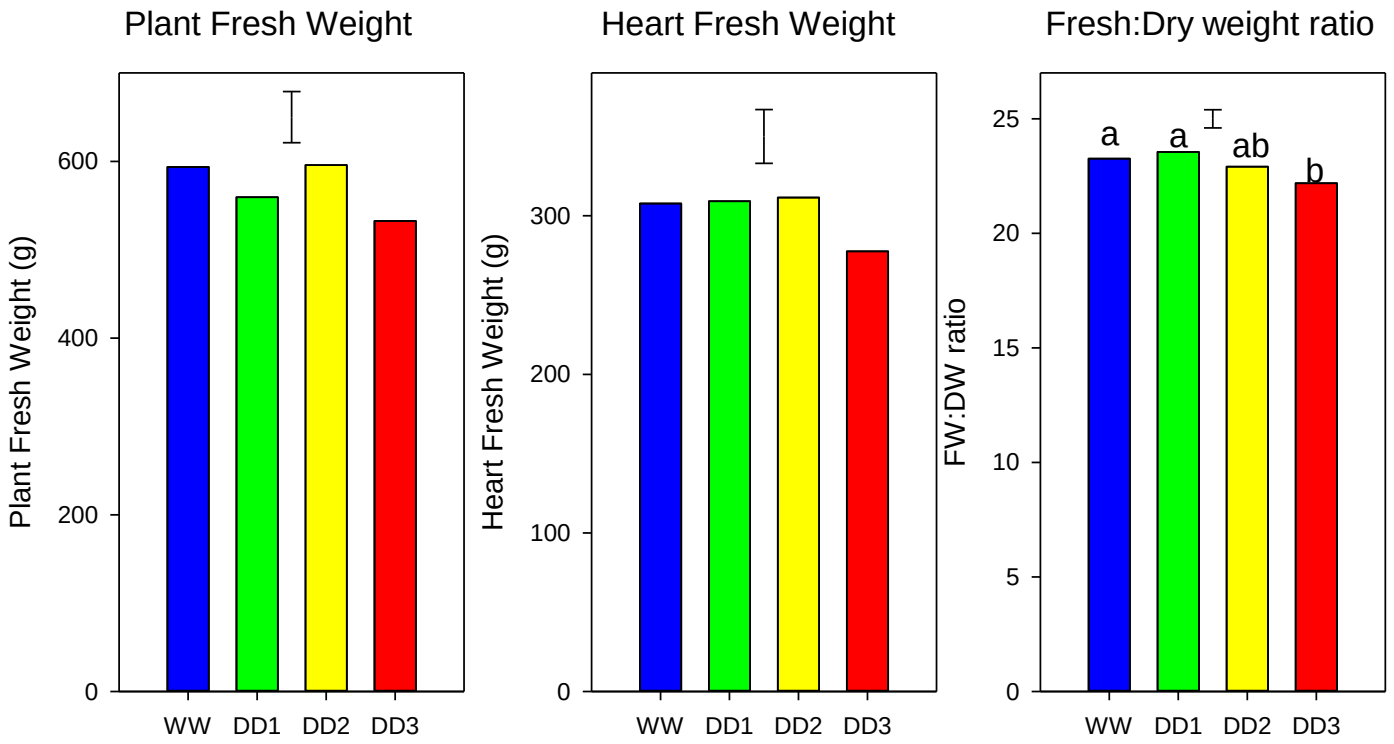
Testing the irrigation set points in field-grown lettuce





- Successfully applied irrigation at required set points
- WW irrigated on 7 occasions between 25 May and end of experiment, each plant received 9 L of water
- DD1 irrigated on 2 occasions, 4.5 L of water per plant
- DD2 irrigated once, 1.5 L of water per plant
- DD3 was not irrigated

Effect of applying irrigation at set points on lettuce marketable yield

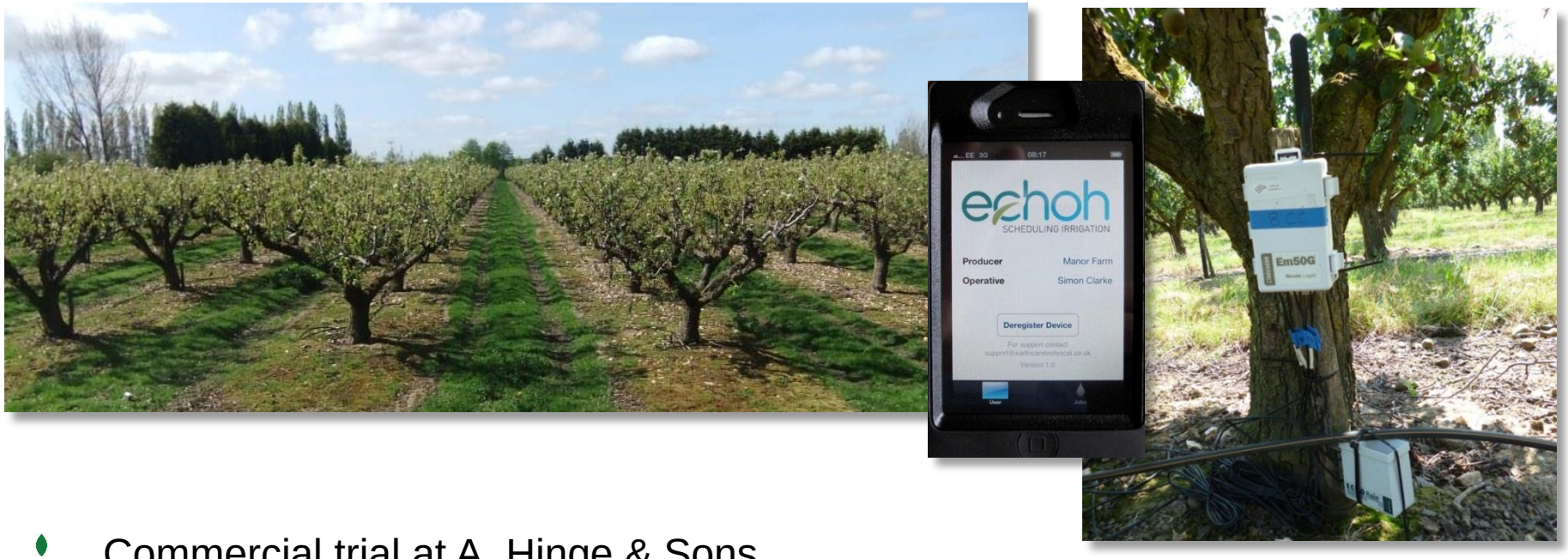


- Fresh weight did not differ significantly between the treatments
- Heart fresh weight did not differ significantly between the treatments
- Fresh:dry weight ratio was reduced significantly in DD3, compared to the WW and DD1 treatment (less water in the leaves)

Improving quality and shelf-life of lettuce crops using precision, deficit and alternate wetting and drying irrigation techniques optimised for different soils

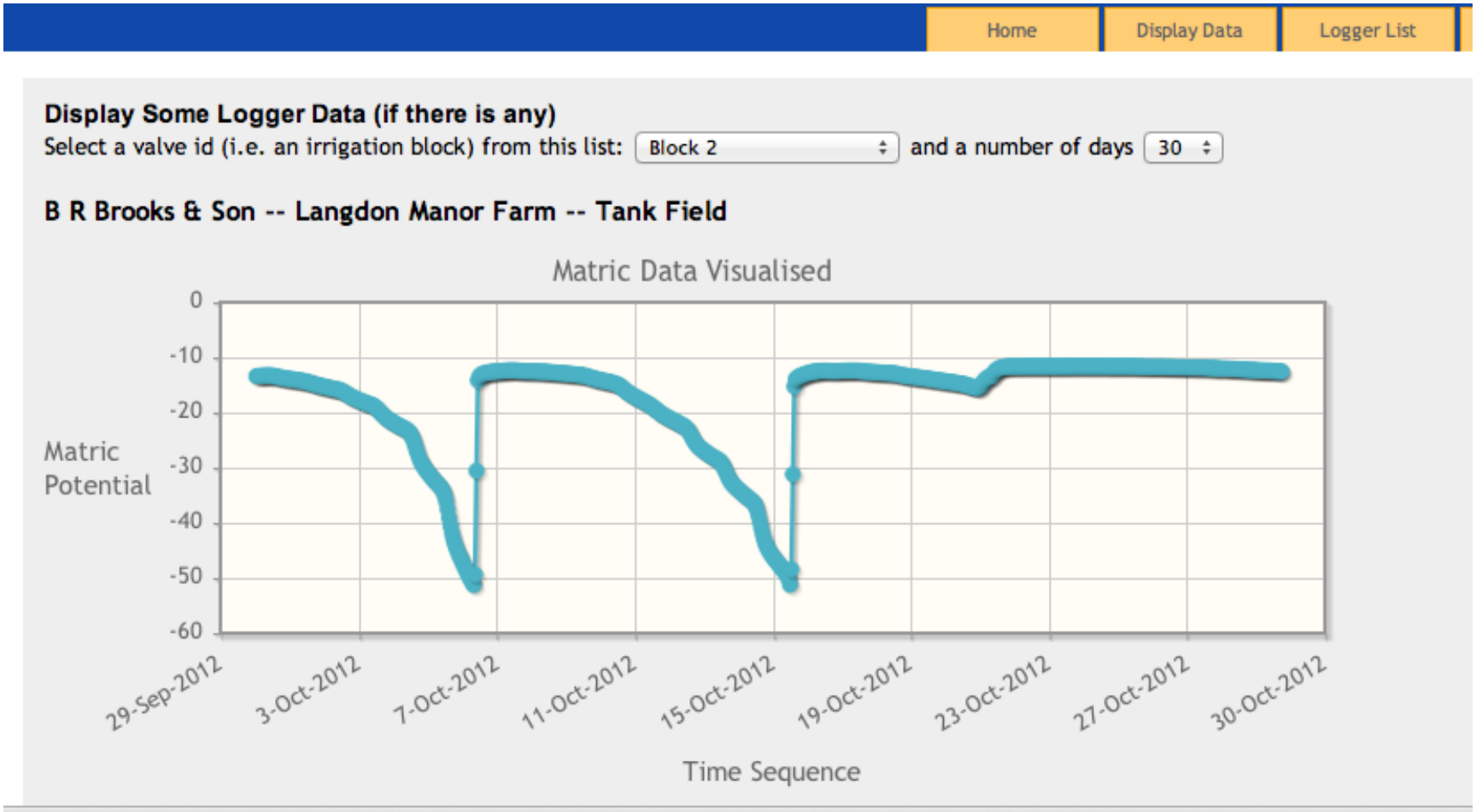
- To derive and test irrigation set points based on soil matric potentials for ‘Romaine’ and ‘Iceberg’ lettuce in different soils
- To determine the effects of precision, deficit and alternate wetting and drying irrigation treatments on consistency of lettuce leaf quality
- To quantify the potential of the irrigation treatments to improve resource use efficiency and leaf quality in high intensity leaf salad production at four commercial sites with different soils
- To develop water-saving and quality-enhancing irrigation strategies for the commercial production of high-intensity salad crops
- To communicate and demonstrate the results to the industry

Commercial pear trial



- Commercial trial at A. Hinge & Sons
- Implementing irrigation ‘best practice’ at Ham Green Farm
- Developing RDI to improve fruit quality and storage potential
- Deploying enabling technologies
- Communicate the results to the industry

Data processing via echoh server



The Gdot: a new tool to measure soil water availability

- Simple (non-technical)
- Universal (all soils)
- Root zone monitoring
- Any crop
- Low-cost

Benefits of Precision Irrigation

- To growers
  - Consistent berry yields and quality
  - Improved time management for expert staff
  - Informed decision-making
  - Less time spent on cane/canopy management
  - Lower picking costs
  - Water and fertiliser savings
- To retailers
  - Improved consistency of supply of high quality fresh fruit
  - Fruit with an assured shelf-life leading to reduced wastage in store
  - Innovative production methods to deliver sustainable intensification
- To consumers
  - High quality, phytonutritious, flavoursome fruit
  - Improved availability of locally-sourced fresh produce

Commercial risks and barriers

- Budgets based on expected yields per plant
- High value horticulture (£3,000 to £6,500 per tonne)
- Irrigation system design and performance, perceived need for ‘run-off’
- Lack of data on variable productivity within cropping blocks
- Consequences of over-fertigation on berry quality…?

Challenging our preconceptions

Commercial Control plot

Grower Test Regime plot

- ‘much drier than a grower would normally expect’…
- … but no effect on plant physiology

Summary

- Each variety has specific irrigation needs to produce the best quality fruit consistently over the season
- Transient water deficits can significantly reduce Class 1 yields
- Variable coir water content results in inconsistent fruit quality
- Berry quality is often improved under Precision Irrigation
- Controlling primocane vigour without reducing yields is challenging
- Precision Irrigation simplifies irrigation decision-making, reducing labour costs and improving time management
- The system can be used to deliver growers' current irrigation programmes with improved consistency if required
- The PI technology package is compatible with existing irrigation hardware on grower sites

On-going R&D to improve production efficiency

- Develop imaging techniques to improve yield forecasting, detection of plant stress and prediction of fruit quality
- Identify nutrient requirements of proprietary varieties and develop bespoke fertiliser regimes
- Model environmental metrics to help improve the accuracy of longer-term yield forecasts
- Use weather probability forecasting to help inform grower decision-making
- Devise beneficial stresses to improve crop resilience and canopy management
- Use mycorrhizal fungi to improve resource acquisition and Class 1 yields
- Integrate new technologies and approaches into a grower-facing decision support system