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Effects of over-irrigation on plant growth and hormone balance

Lancaster University

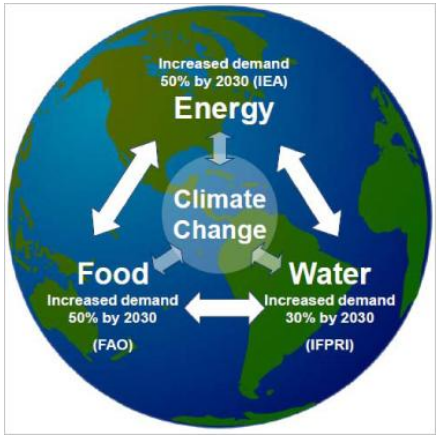
The Lancaster Environment Centre

HDC Horticultural Development Council

Perfect storm scenario

"…by 2030 the world will need to produce around **50 % more food and energy**, together with **30 % more fresh water**, whilst **adapting to climate change**." (John Beddington, 2009)

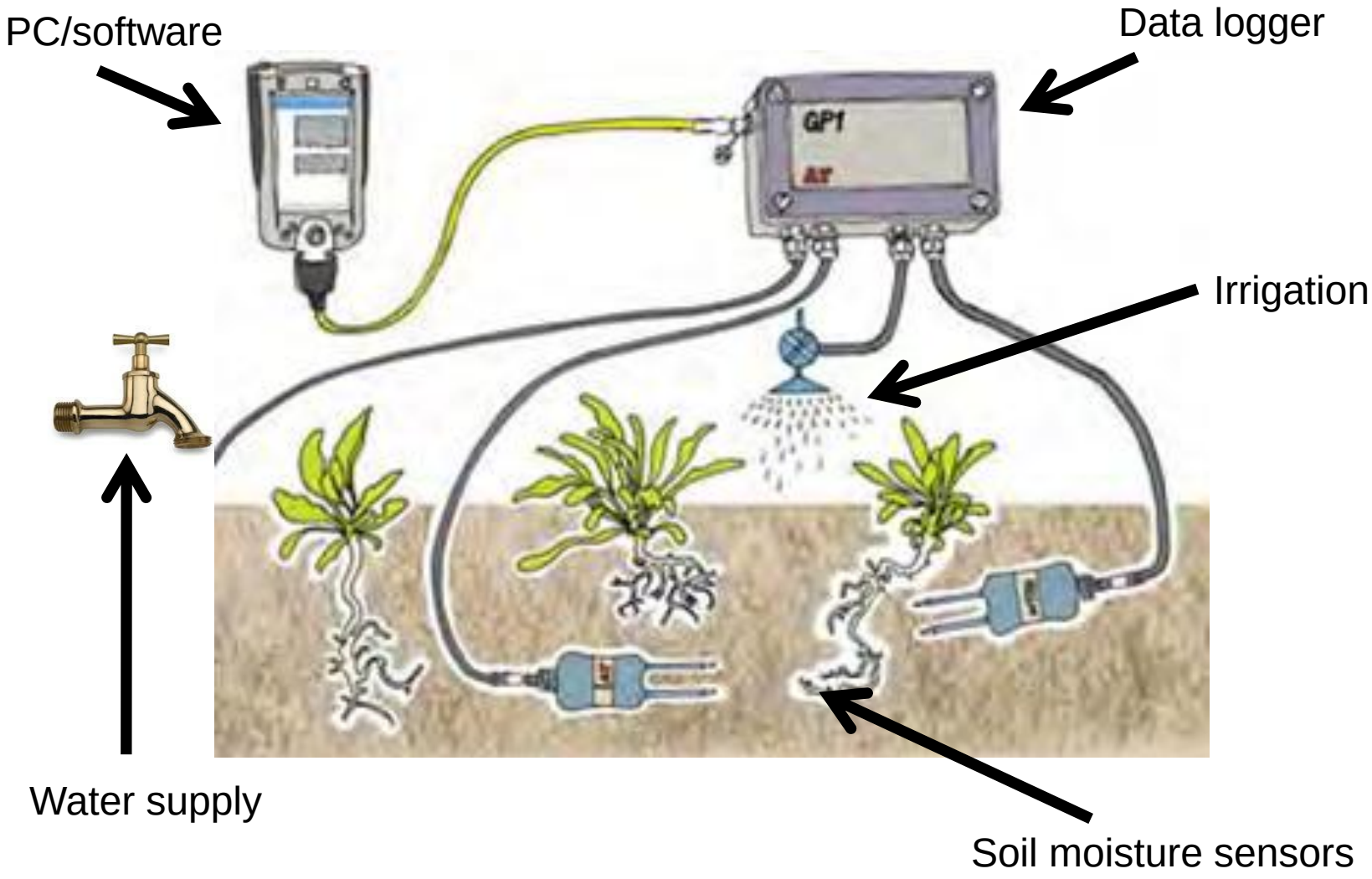
→ Agriculture accounts for 70 % of the increased fresh water demand



Challenge for global agriculture

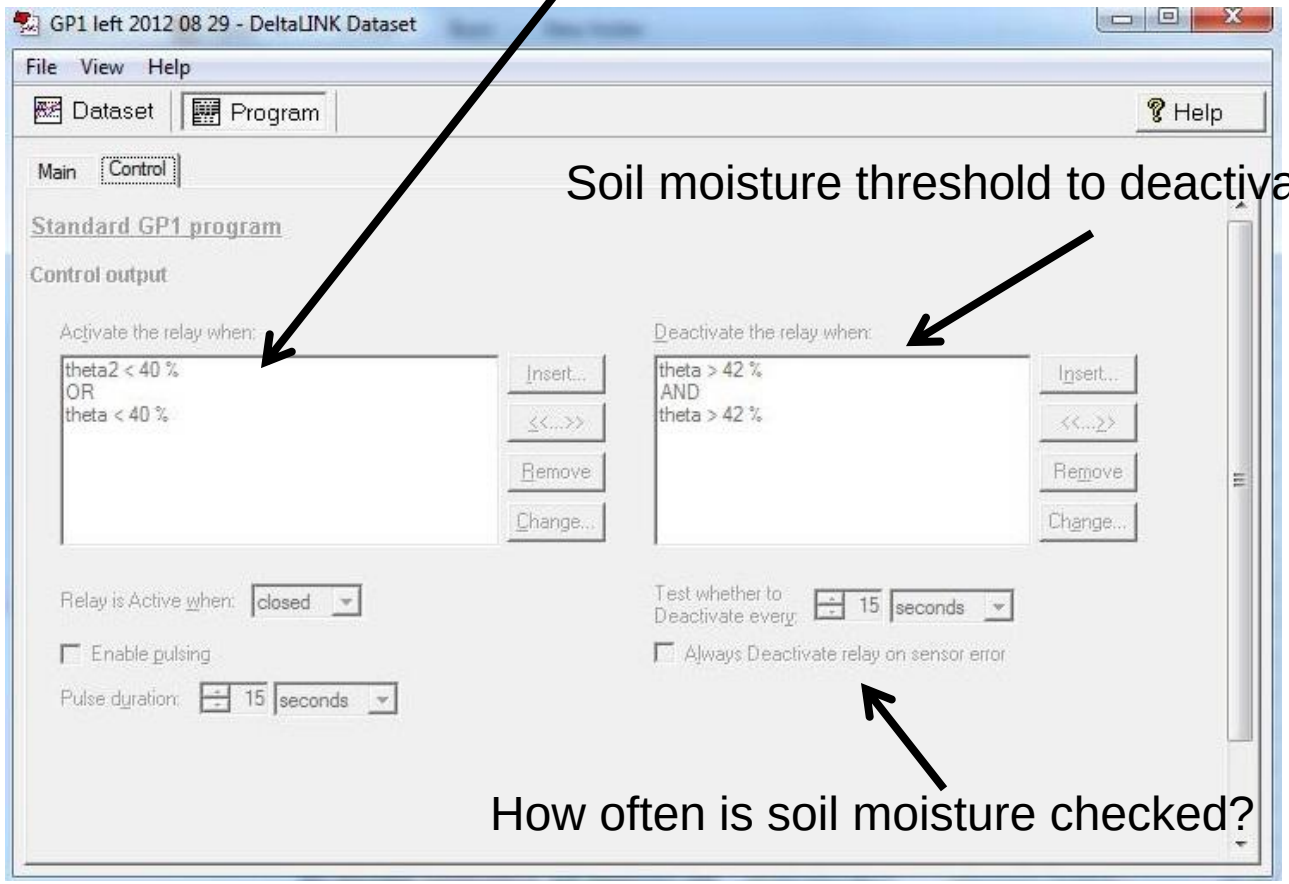
- Managing and balancing supply and demand for water
- Grow more food on not much more land
- Use less water, fertiliser and pesticides
- Use low-cost and efficient drip irrigation systems

Soil moisture based irrigation



Irrigation control

Soil moisture threshold to activate irrigation

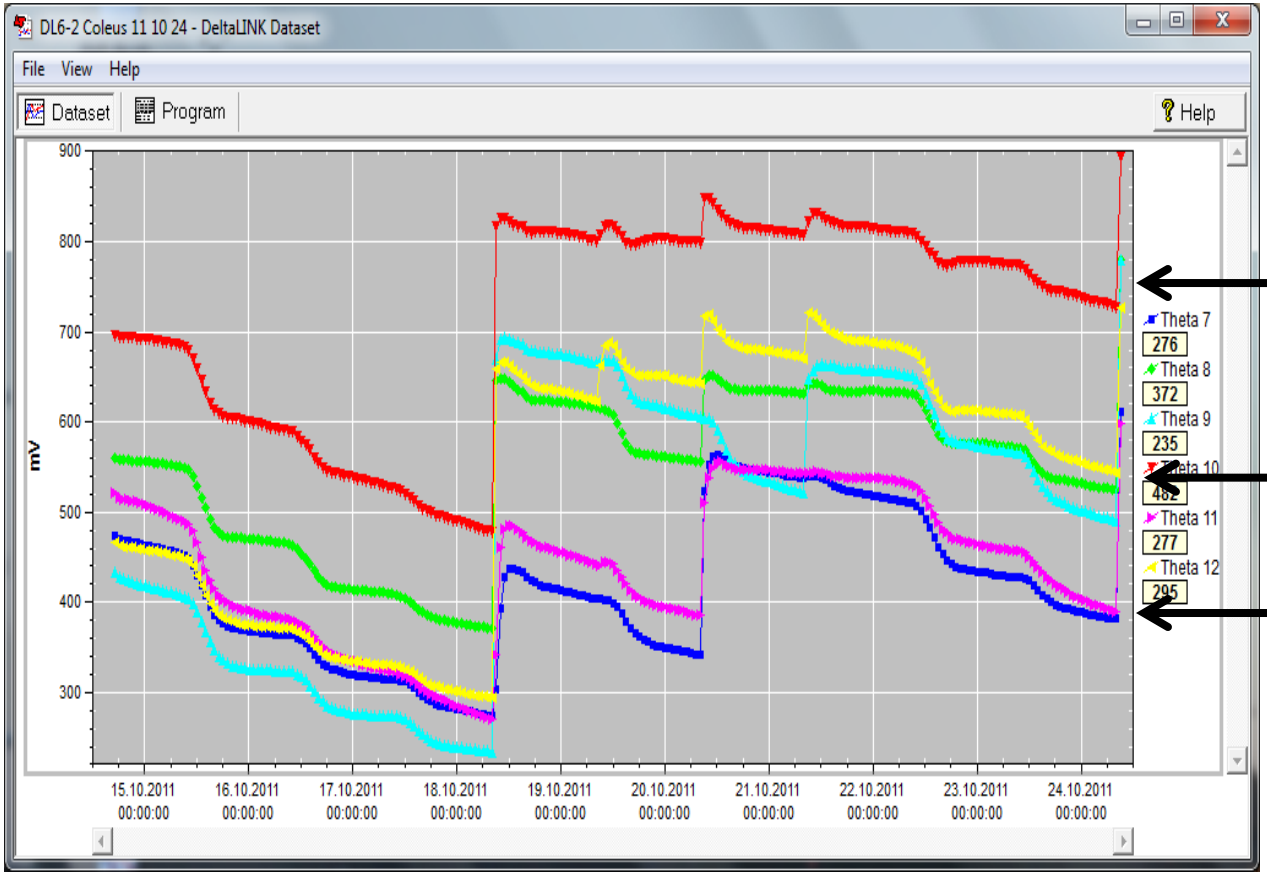


Soil moisture threshold to deactivate irrigation

How often is soil moisture checked?

Practical application

Soil moisture sensors in a “typical” nursery



over-irrigated

well-watered

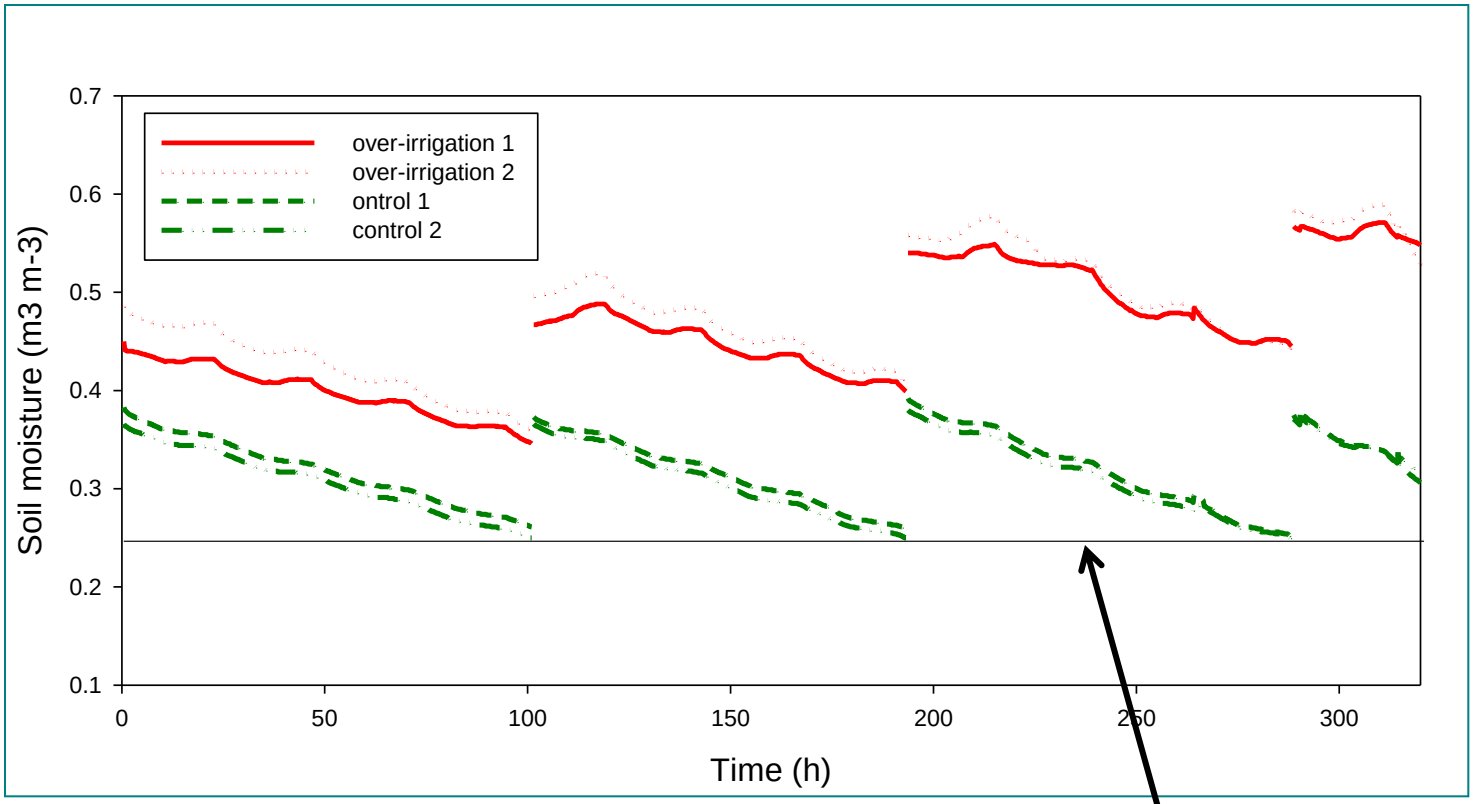
water-stressed

PhD project

Aims

- Study effects of over-irrigation on tomato plant growth and physiology
- Understand what acts as a key signal
- Ameliorate possible growth inhibition

Soil moisture controlled by automatic irrigation scheduling



control: 2 drippers

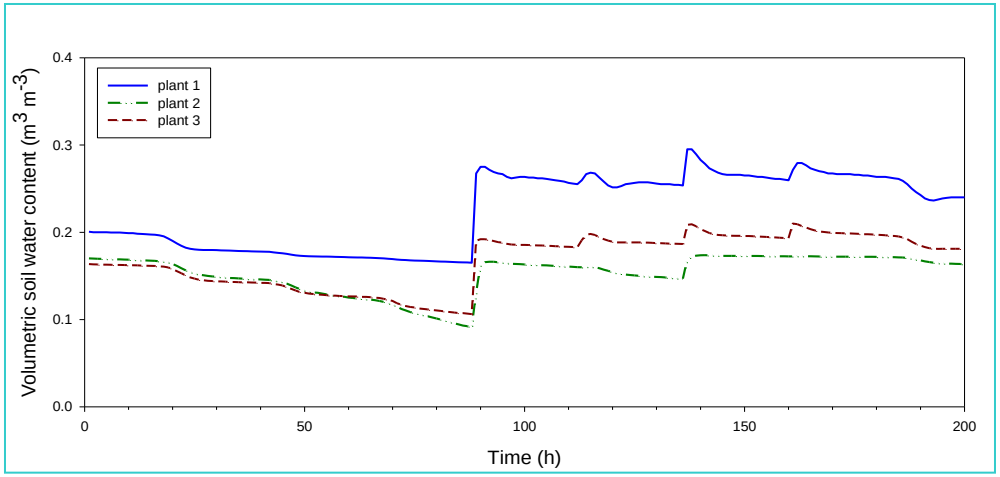
over-irrigation: 3 drippers

Watering threshold

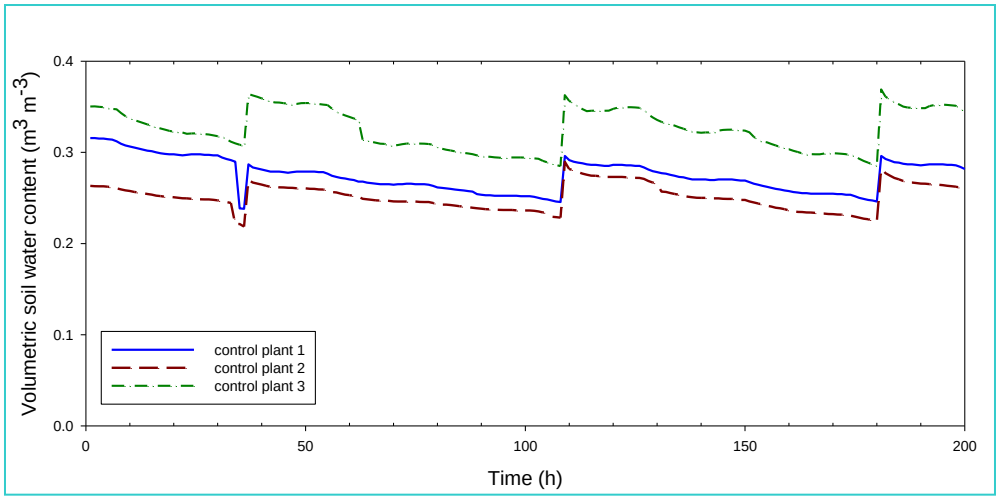
(drained capacity after 24 h)

Comparison of manual and automatic irrigation

Manual



Automatic



Coefficient of variation

Manual: 24.9 %

Automatic: 12.7 %

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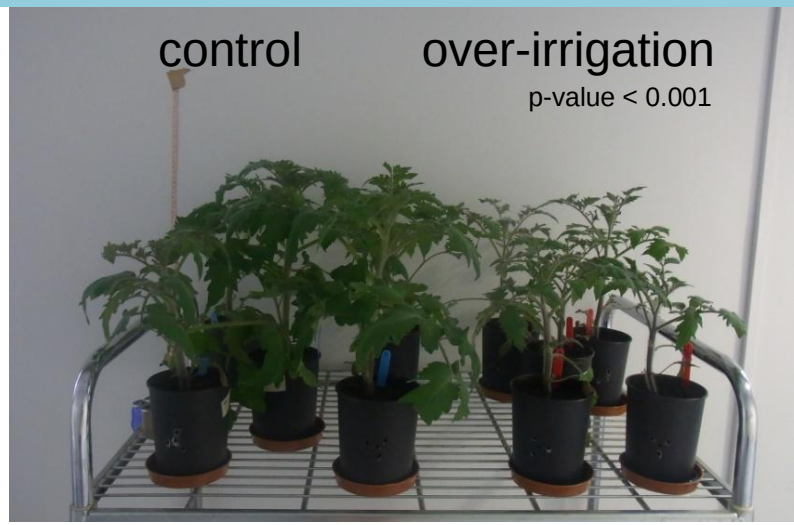
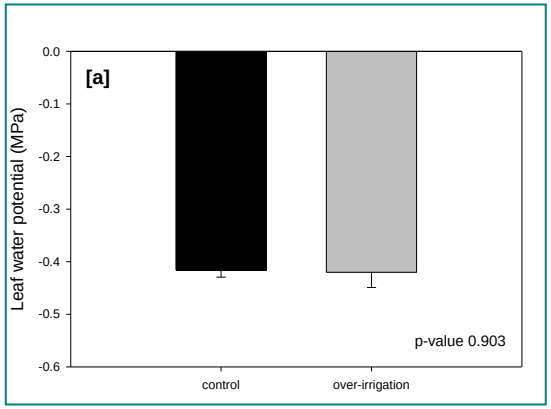
Effect of over-irrigation on tomato plant growth

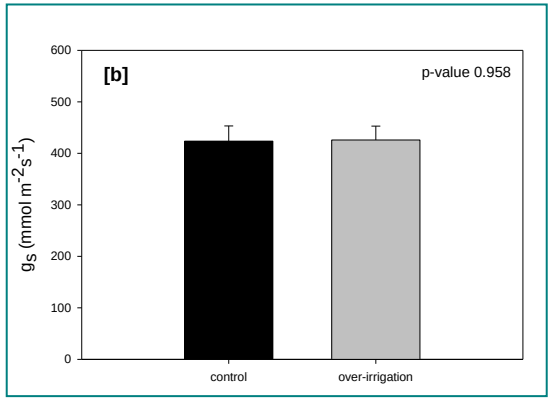
Significantly decreased growth

after 4 weeks of over-irrigation in

wild type tomato (‘Ailsa Craig’ [AC])







No significant differences in leaf water potential [a] or stomatal conductance [b]

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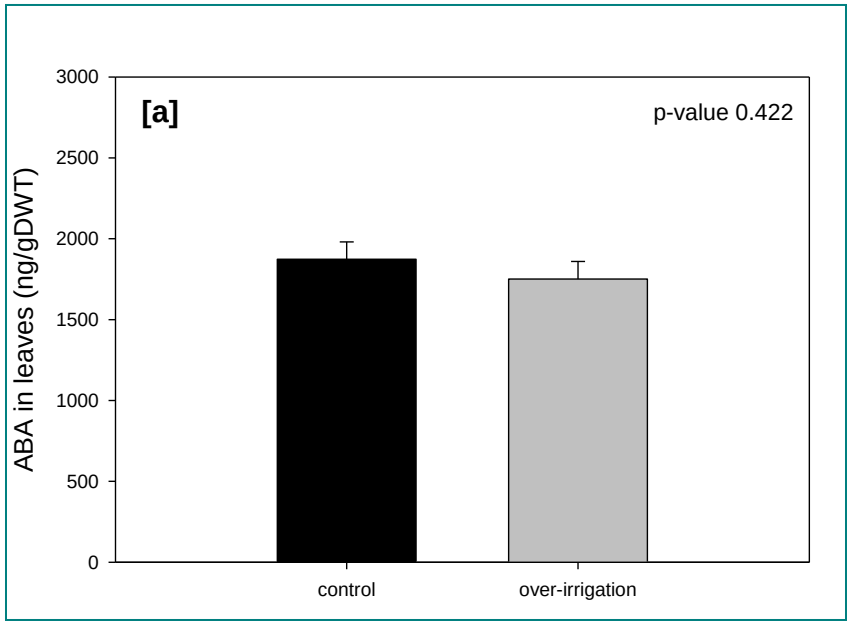
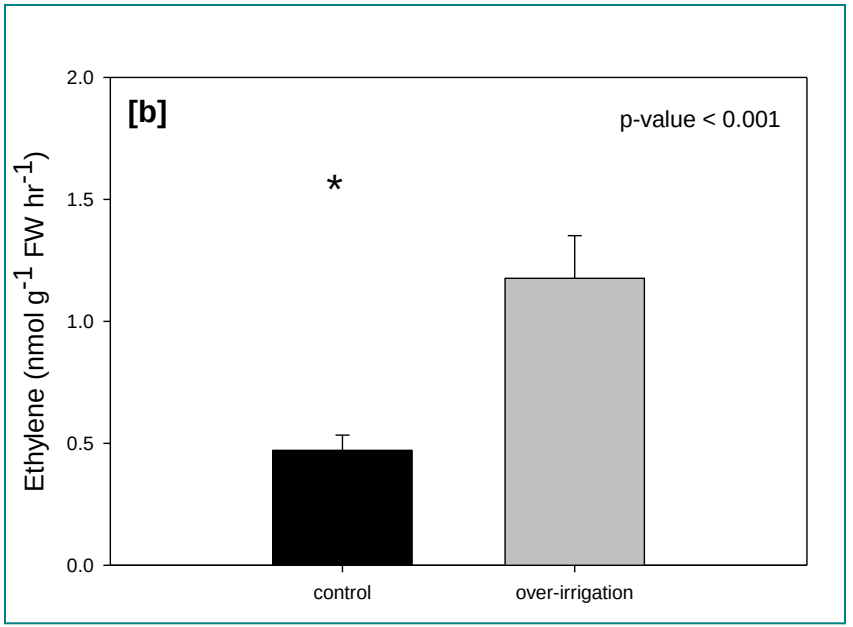
Plant hormones abscisic acid (ABA) and ethylene





No significant change in foliar ABA concentration [a]

Significantly increased foliar ethylene emission [b]

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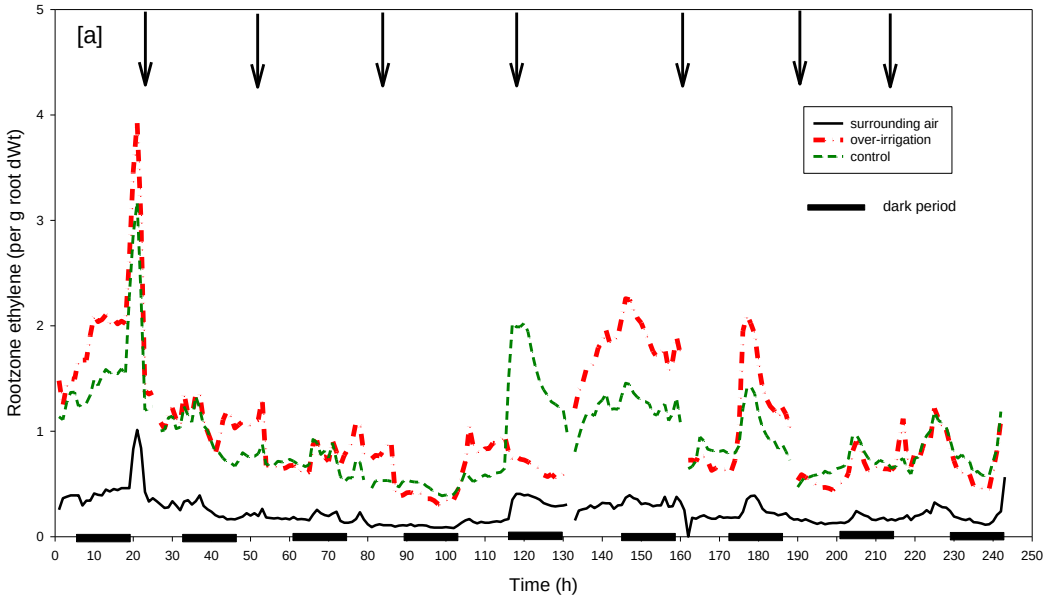
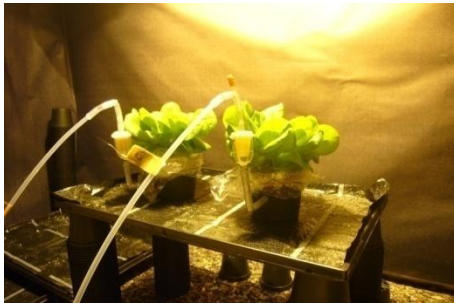
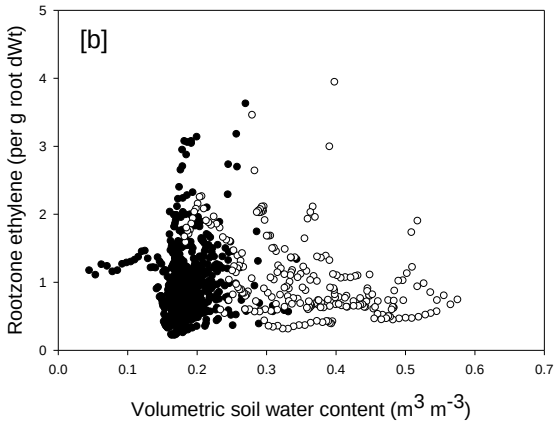
Root-zone ethylene measurements

↓ Time of watering







Soil moisture does not impact on root-zone ethylene

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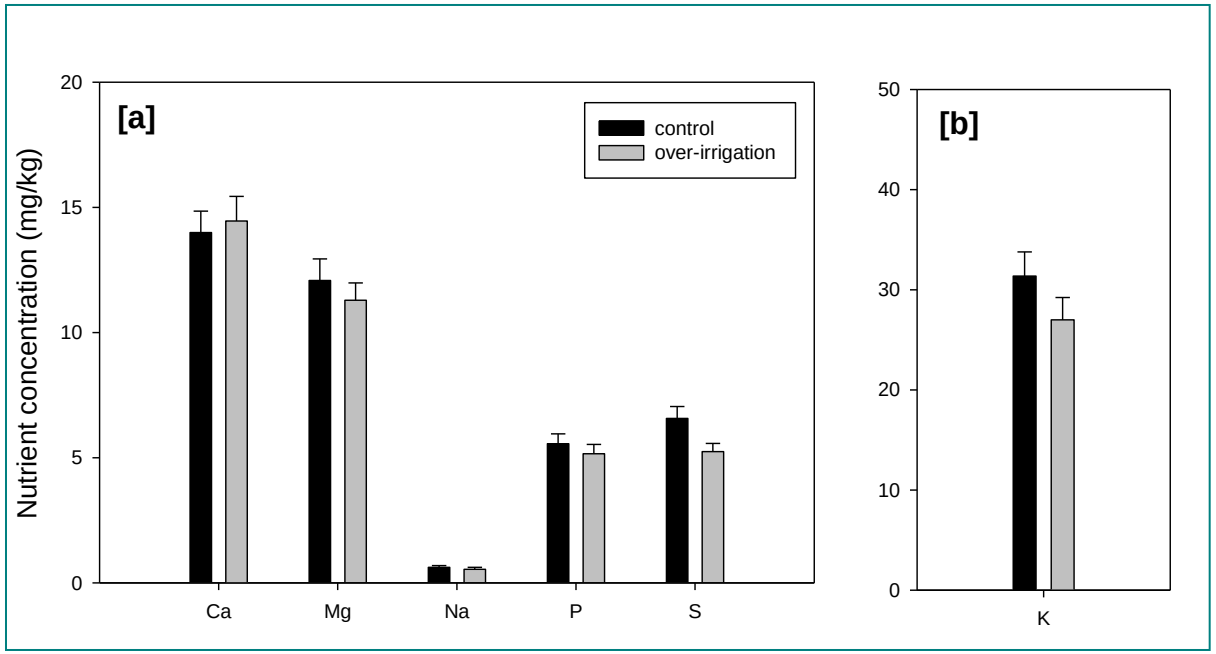
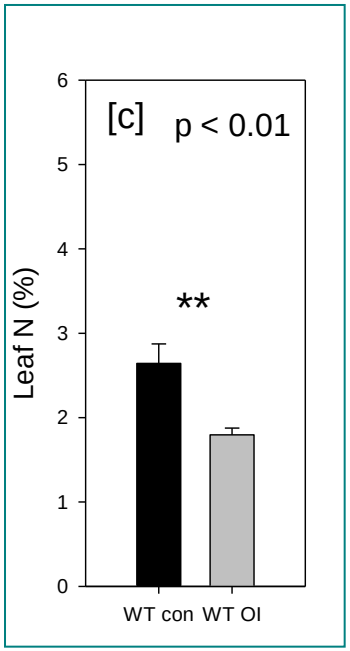
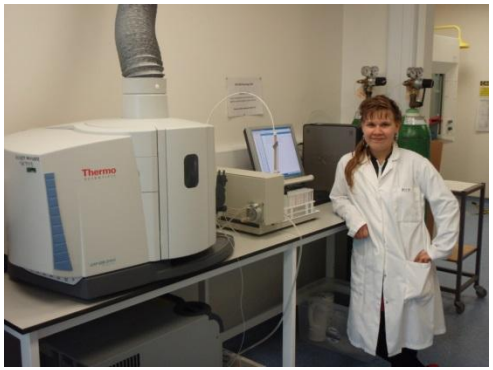
Macronutrients





No significant change in leaf nutrient status [a, b]

But significantly lower nitrogen [c]



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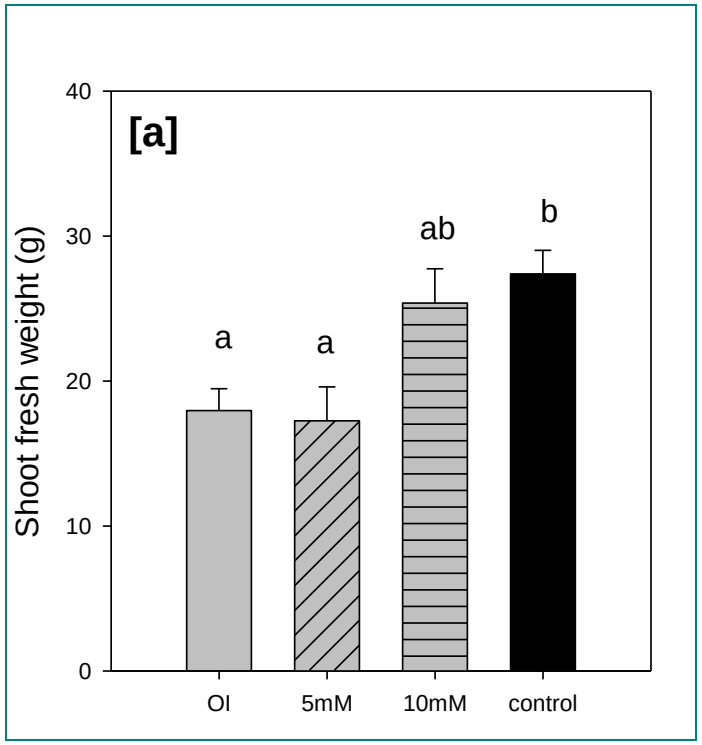
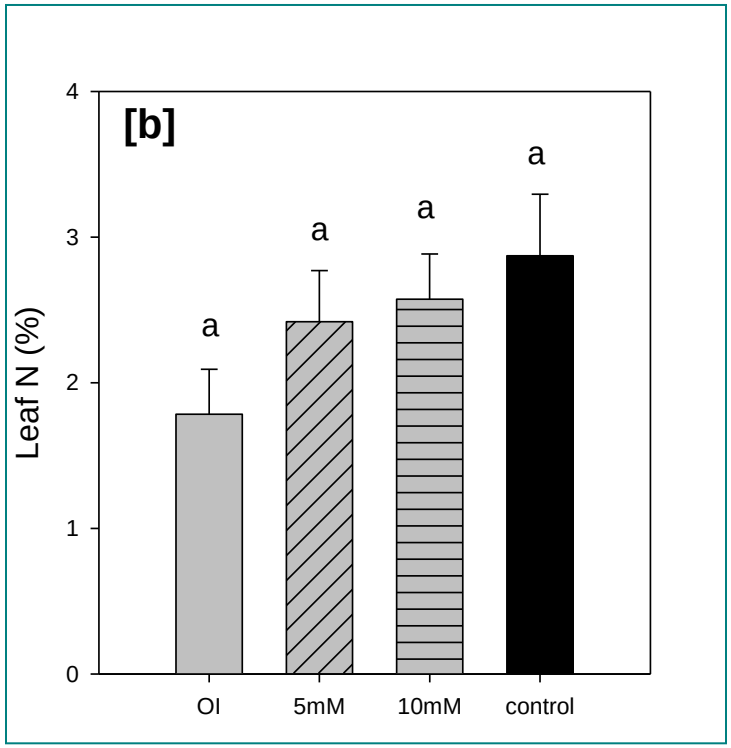
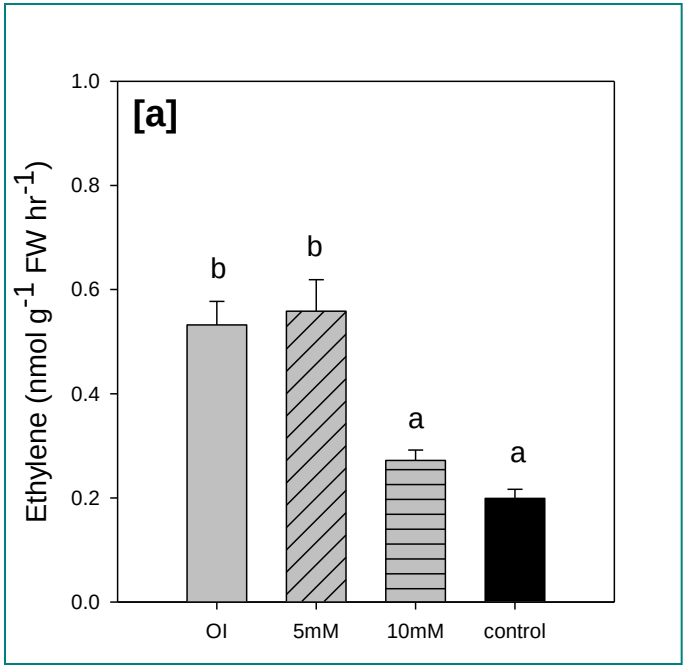
$Ca(NO_3)_2$ supplementation

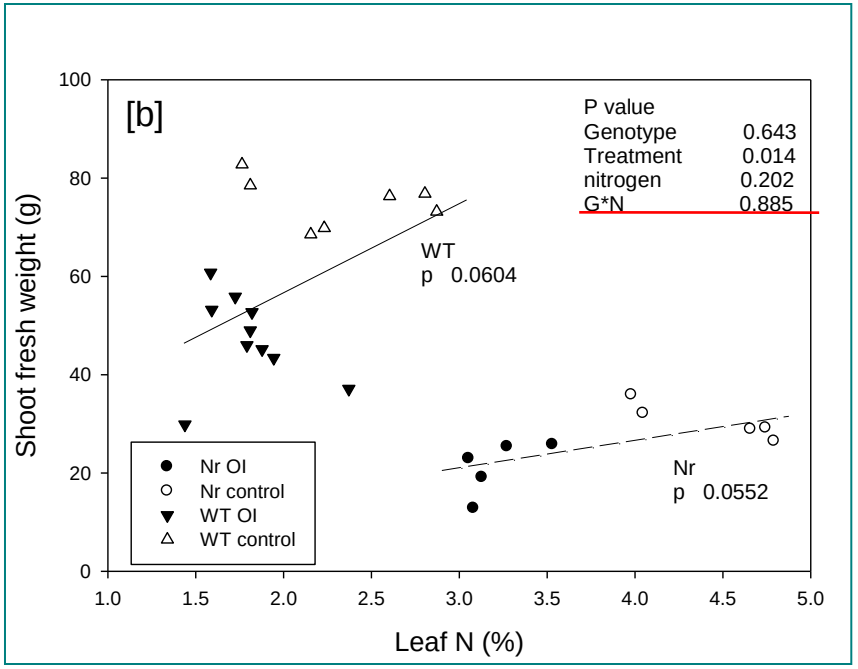




10 mM calcium nitrate supplementation **restores shoot fresh weight** [a] and **leaf nitrogen concentration** [b] to control plant levels

$Ca(NO_3)_2$ supplementation





10 mM calcium nitrate supplementation restores foliar ethylene emission [a]

But ethylene unlikely to be key growth regulator during over-irrigation [b] –

Instead, over-irrigation might change nitrogen availability or uptake

Effects of over-irrigation on tomato plants

Decreases shoot fresh weight and total leaf area

↓

No changes in Ψ_{leaf} , g_s, foliar ABA

↓

But: increase in leaf ethylene emission

↓

No significant differences in root-zone ethylene production

↓

Leaf nutrient status does not change, but significantly lower leaf nitrogen

↓

$Ca(NO_3)_2$ supplementation restores shoot fresh weight and leaf nitrogen concentration

↓

Over-irrigation might change N availability and uptake, inducing growth retardation

Where to from here (future projects)?

What impact does overirrigation have on other species or when other substrates are used?

- Use of commercially used substrates (rockwool)

- Use of plants grown in pots: ornamentals, strawberries, herbs

Where to from here (future projects)?

How can the automatic irrigation control be of advantage for growers (especially in the containerised area)?

- Embed soil moisture system in commercial greenhouses

→ Use as an irrigation control, but also as “advanced warning” before water stress is harmful

- Enhance crop quality, save water
- Interact directly with growers

IHC Brisbane (17th-22nd August)

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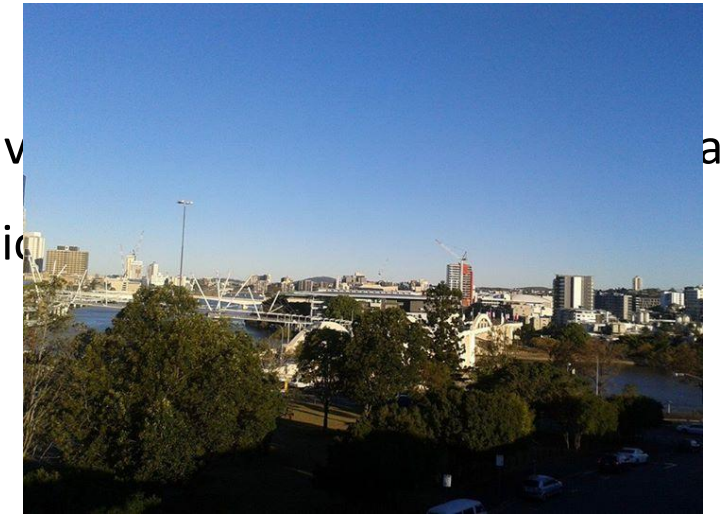

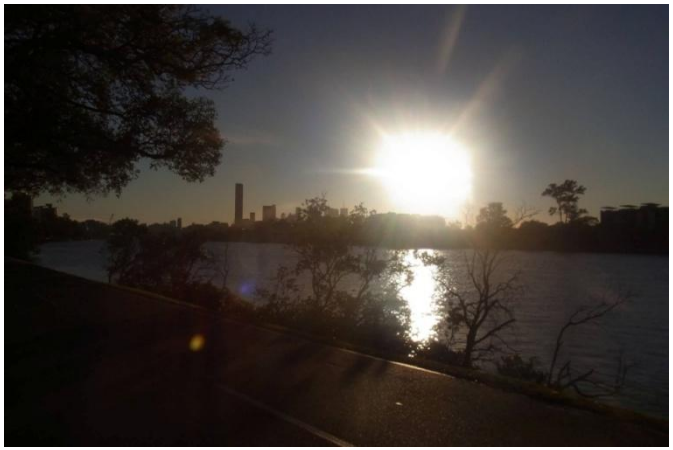

Thank you very much for your attention

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