

DI&NSW

 **Industry & Investment**

Integrated advanced fertigation (IAF) of citrus
VC HAL CT07041
 Steven Falivene^{1,3}

Knowledge and tools to manage fertigation technologies in highly productive citrus orchards for minimal environmental footprint
LWA DAN5027
 Michael Treeby^{1,2,3} Steven Falivene^{1,3} Mark Skewes² Karen Connolly¹

1 NSW Industries and Investment
 2 SARDI
 3 CRC Irrigation Futures

 **HAL**
 Know-how for Horticulture™

 **Cooperative Research Centre for IRRIGATION FUTURES**

 **Sustainable Irrigation**

Western Australia 3rd February 2010

Project Structure & Presentations

- IAF – HAL VC funded May 2008
 - VC contributors listed later
- “Fertigation Knowledge tools”
 - Funded by National Program Sustainable Irrigation
 - IAF – S.Falivene
 - Efficient Nutrient Management – M.Treeby I&I NSW / SARDI
 - SSET Modelling – M.Skews SARDI
- Preliminary “in progress” discussion of results
 - Specific results are limited to Dareton, different site may have different responses
 - Trial results may not deliver the final conclusion, but provide a better understanding to help you select on-farm tool and practice to suit your circumstances


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Efficient Nutrient Management

Michael Treeby
 (I&I NSW / SARDI)

Rootstocks & nutrient uptake trials

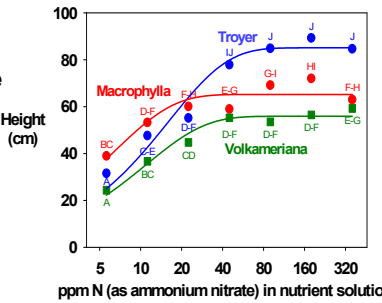


- Current
 - 6 rootstocks
 - N responses
 - 0.2-12.8 mM NH₄NO₃
 - (= 5.6-359 N ppm / mg L⁻¹)
- Next
 - fewer rootstocks
 - K/Ca balance

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Rootstock growth & N supply


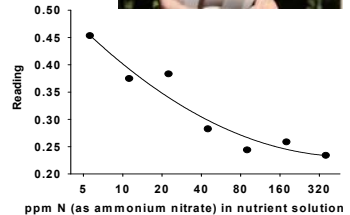
- Growth maximised
 - more N → same growth
- Different stocks
 - different water ppm N



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Assessing orchard N supply

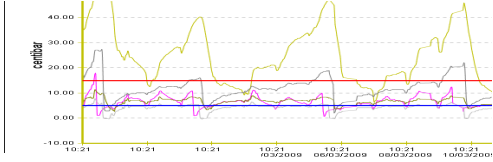
- Real time leaf N sensor
- non-destructive
- readings reflect N supply
- early days

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Soil moisture monitoring – How representative ?

Tensiometer readings from trees irrigated exactly the same



- May the correct tensiometer reading please stand forward ????? – worse on small trees?
 - Very important to gain confidence that a single probe installed on a 3-5 ha block is representative.
 - Calibration is required – Eto, visual symptoms etc

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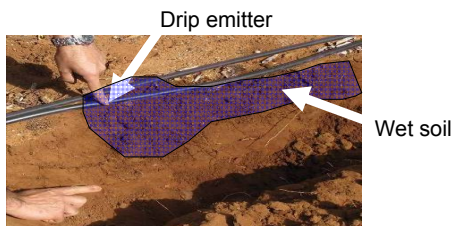
Tensiometers need maintenance

- Temperature affects reading
- Warming up readings drop & vica versa (2-5 cb)
- Thermal sun shielding significantly helps
- Take reading morning & before tubes in direct sunlight



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1st year establishment phase



- Irregular wetting & rooting patterns
 - Can cause irrigation and soil probes to give false readings
 - Probably due to soil structure (i.e. old wheel track)

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Soil evaporation

- 33x28cm basin 2.5 hours (hot windy Jan day)
 - Sun ~ 270ml
 - Shade ~170ml
 - Shade + mulch ~ 60ml



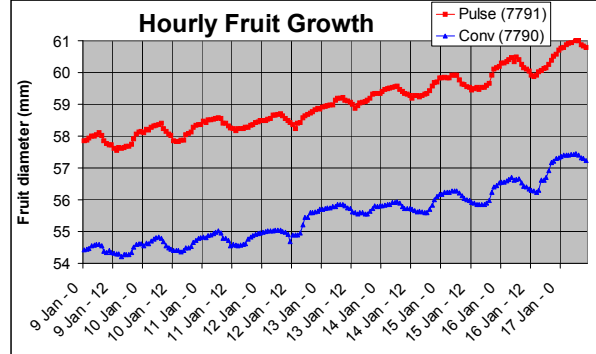
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Hourly Fruit Growth Data



- Two Phytex 15-70mm hourly fruit growth data loggers
 - Seen used by Israeli grower in 2004
 - ~ \$1300 each

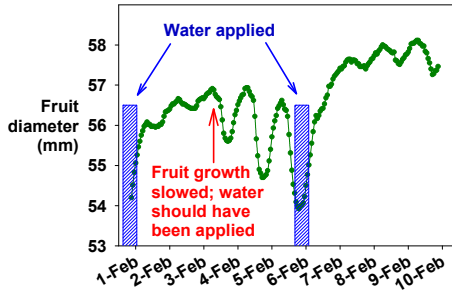
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- No visible short term difference between pulse & conventional
 - Fruit loose water during the day and rehydrate at night
 - Trees & fruit need to physiologically dehydrate slightly so they can pull up water

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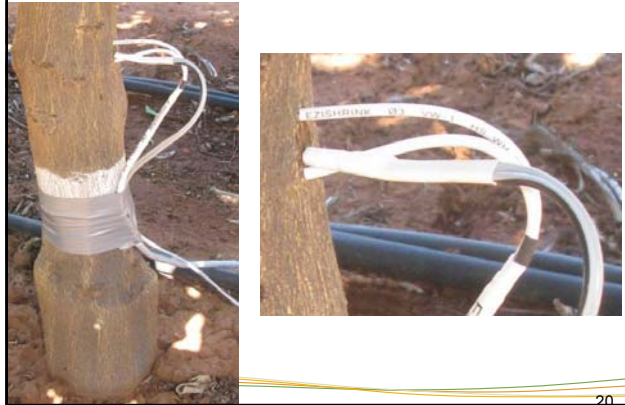
Fruit Growth :Can be used as a irrigation management tool



- Hourly fruit measurements can be a indicator to water stress
- Fruit rehydrated to normal size once water applied
- Short term ("one off") water stress may have little effect on tree health ; continual/regular water stress is the problem

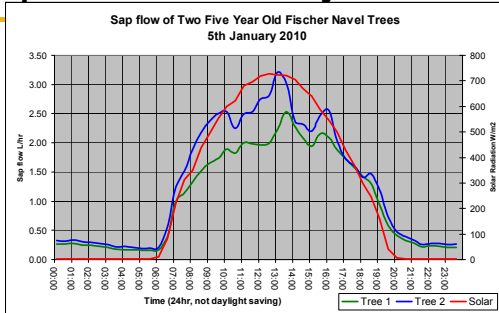
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2xSap flow sensors (5,12,21,32mm)



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Sap flow – no “mid day shut down”



- Trees self regulate during peak demand (hot : 9am-5pm) not to transpire more water than that can move up the trunk
- Self regulation is by frequently closing and opening stomata (leaf pores)
- i.e. turning a tap on and off regularly to regulate flow

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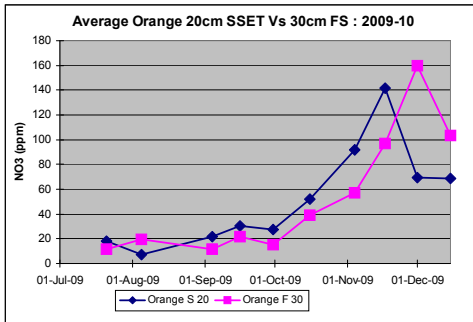
Soil Solution

- Soil solution extraction tubes (SSET) & full stop
- 2008-09 Regular high nitrate (1000ppm +) & EC spikes (5dS/m)
- 2009-10 More stable
 - Spikes probably mainly due reduced water = compact rootzone + some excessive fertiliser



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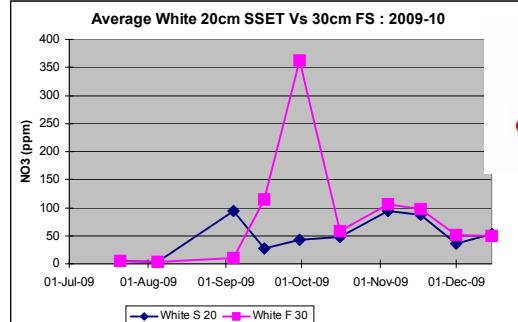
Full stop vs SSET NO₃: 20cm OH slow dripper



- 30cm Full stop shows similar pattern to 20cm soil solution

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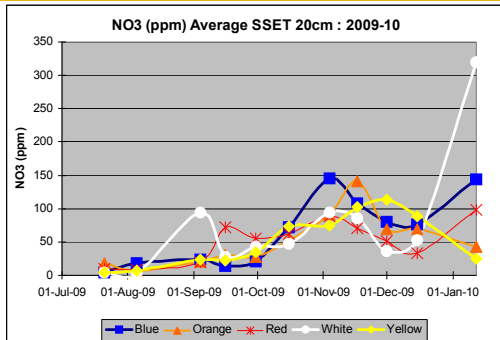
Full stop vs SSET NO₃: 20cm Conventional



- Urea slug may have set within/on top the funnel of full stop or SSET missed the slug ?

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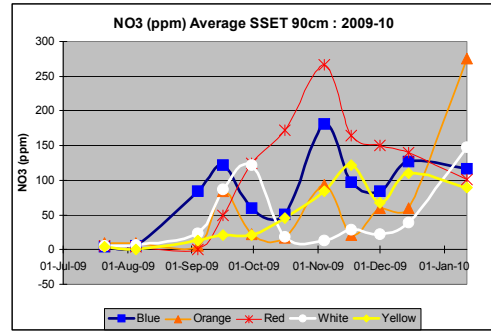
Nitrate 20 cm soil solution extraction tube



Blue = OH pulse, Orange = OH slow dripper, White = Best practice conventional
Red = Pulse & conv. Fert., Yellow = conv. Irr. & prop. fert

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Nitrate 90 cm soil solution extraction tube



Blue = OH pulse, Orange = OH slow dripper, White = Best practice conventional
Red = Pulse & conv. Fert., Yellow = conv. Irr. & prop. fert

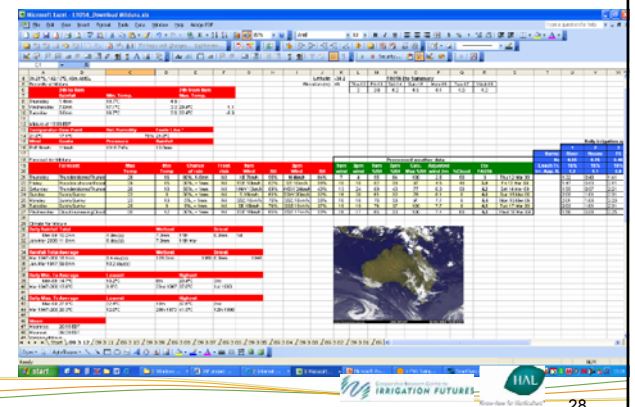
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Extension: irrigation scheduling tool

- No practical guidelines for young trees
 - Information difficult to integrate
- Spreadsheets:
- Crop coefficient *Based on site characteristics*
 - Monthly water use *Average monthly water use based on historical ETo data*
 - Current ETo data *Calculate RAW*
 - ETo & water needs (hours day⁻¹) prediction

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A tool to predict water needs: making it easier for growers to use all the information



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Extension Workshops (Mastery Technical Series)

Empowerment in confidence through knowledge & understanding

- Nutrition
 - 2 day course (4 × ½ days)
 - Content based on citrus literature
 - Fertigation/nutrition management spreadsheet tool

Delivered

- 1 × Riverina
- 2 × Sunraysia
- 1 × Mid Murray
- 1 × Riverland

Planned

- Sunraysia (Mar 2010)
- Riverina (Mar 2010)

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Nutrition Workshop



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Nutrition Workshop

Crop load estimation



Leaf sampling for tree nutrient status measurements

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Soil Solution Workshops

Delivered

- 2 x CRC-IF (Canberra & Adelaide)
- 1 x Riverina
- 1 x Sunraysia

Planned

- Riverina & Riverland (Oct 2010)
- Vic CRCIF (April 2010)



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Other Planned Workshops

- Soils – understand the soil & how to interpret soil tests
- Crop water use & drip irrigation – calculation & estimation of irrigation needs (use spreadsheet tools)
- Fertigation – equipment, mixing fertilisers
- Physiology – how trees operate

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Extension: Planned Factsheets

- Some examples
 - Fertigation
 - Interpreting soil solution analysis,
 - Advanced irrigation
 - (Fertigation book)



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Questions & thoughts – work in progress

- Is the compact rootzone seen in OH systems partly a result of pulse watering?
 - reduced soil wetted volume
- Is claimed increase in production of OH a statement of current practices?
 - OH forces the user to keep trees well watered, can a well watered conventional do the same?
 - Is conventional estimation of irrigation needs underestimated
 - Overestimate soil water holding capacity, soil water delivery & root density for high demand conditions; grower practices have potential to improve with more informed & accurate irrigation

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Questions & thoughts – work in progress

- Field observations : OH Significant improvements in young tree establishment
 - Overestimation of the extent (volume) and capacity of young tree roots to extract water & nutrients
 - Can a well managed conventional system that recognises a small root zone and more regular nutrition application perform similar to OH?
 - Easy to encourage a “water shoot” tree with excess nutrition

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Suggestions on dealing with saline water

1. Monitor water, soil solution & leaf tests
2. Do not use trifoliata
3. Maintain soil moisture at higher than usual moisture levels
4. Calcium will help to reduce sodium uptake and push sodium ion off clay particles so it can be leached away
5. Sulphate, nitrate can reduce chloride uptake
6. Leach salts when water quality best - follow up on rain
7. Incorporate some gypsum and/or potassium sulphate & calcium nitrate and go back to step 1
 - Twin line drip – increase soil volume dilutes salt

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Acknowledgements

IAF HAL VC contributors



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THE END.....for now!

- Thanks to Moora Citrus, Lawrence Kirton & Helen Ramsay for initiating & facilitating my WA visit
 - It's a pleasure to present you
- Please provide any comments or feedback



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