‘Multi-scale Monitoring Tools for Managing Australian Tree Crops - Industry Meets Innovation: Phase 2’. (2019- 2022)

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AUSTRALIAN OLIVE ASSOCIATION

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Introduction of Project

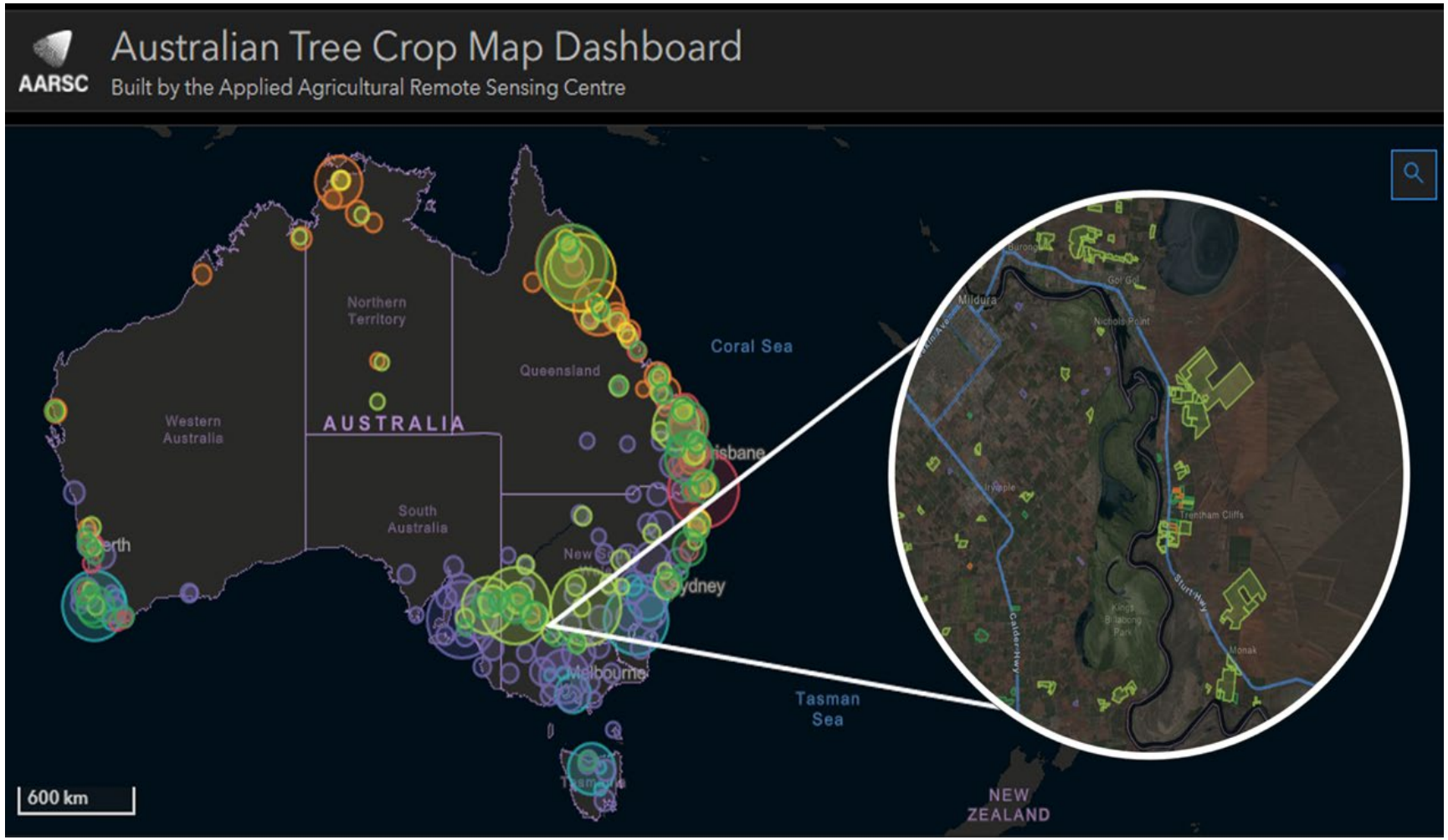
Three main components:

1. **Mapping all commercial olive groves (>1 ha) with Australian Olive Association.**
   - Provide vital core data on the extent (location area) of the industry
   - Support improved traceability, biosecurity preparedness and post disaster response

2. **Identifying the accuracies of remote sensing for measuring variability in tree health, and the associated relationships to yield and oil quality.**

3. **To identify what sensors/ remote sensing (thermal, multi spectral) are the most responsive 'and practical' for measuring the early onset of water stress.**

Australian Tree Crop Map: Mapping groves



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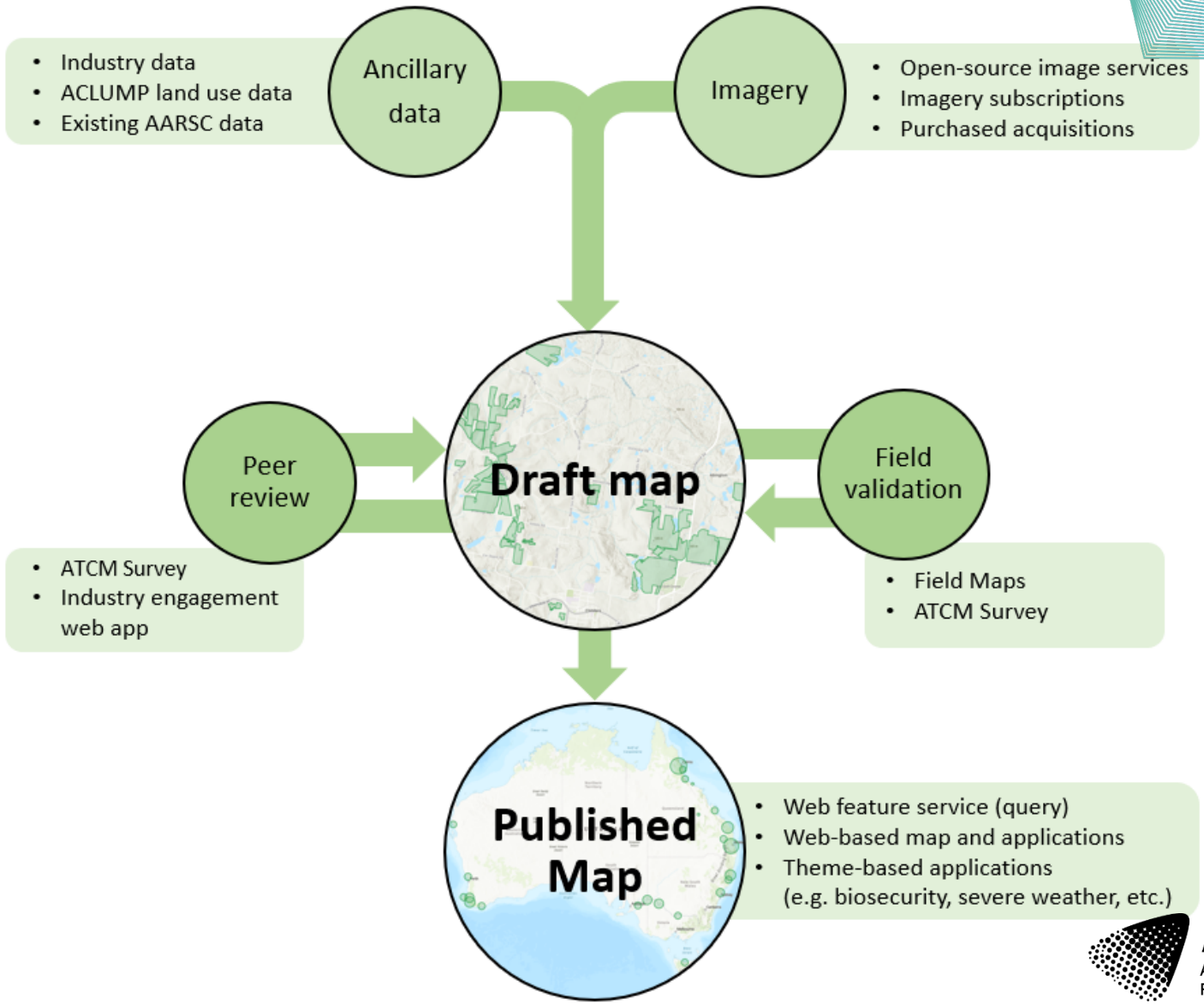
Australian Tree Crop Map

- Built with 4 main inputs
- Machine Learning (ML) and Artificial Intelligence (AI) can not do this alone
- Mapped to Australian mapping standards, can integrate with other software's
- Freely accessible when required
- Developed with industry (respects grower privacy and not seen as 'Big Brother')



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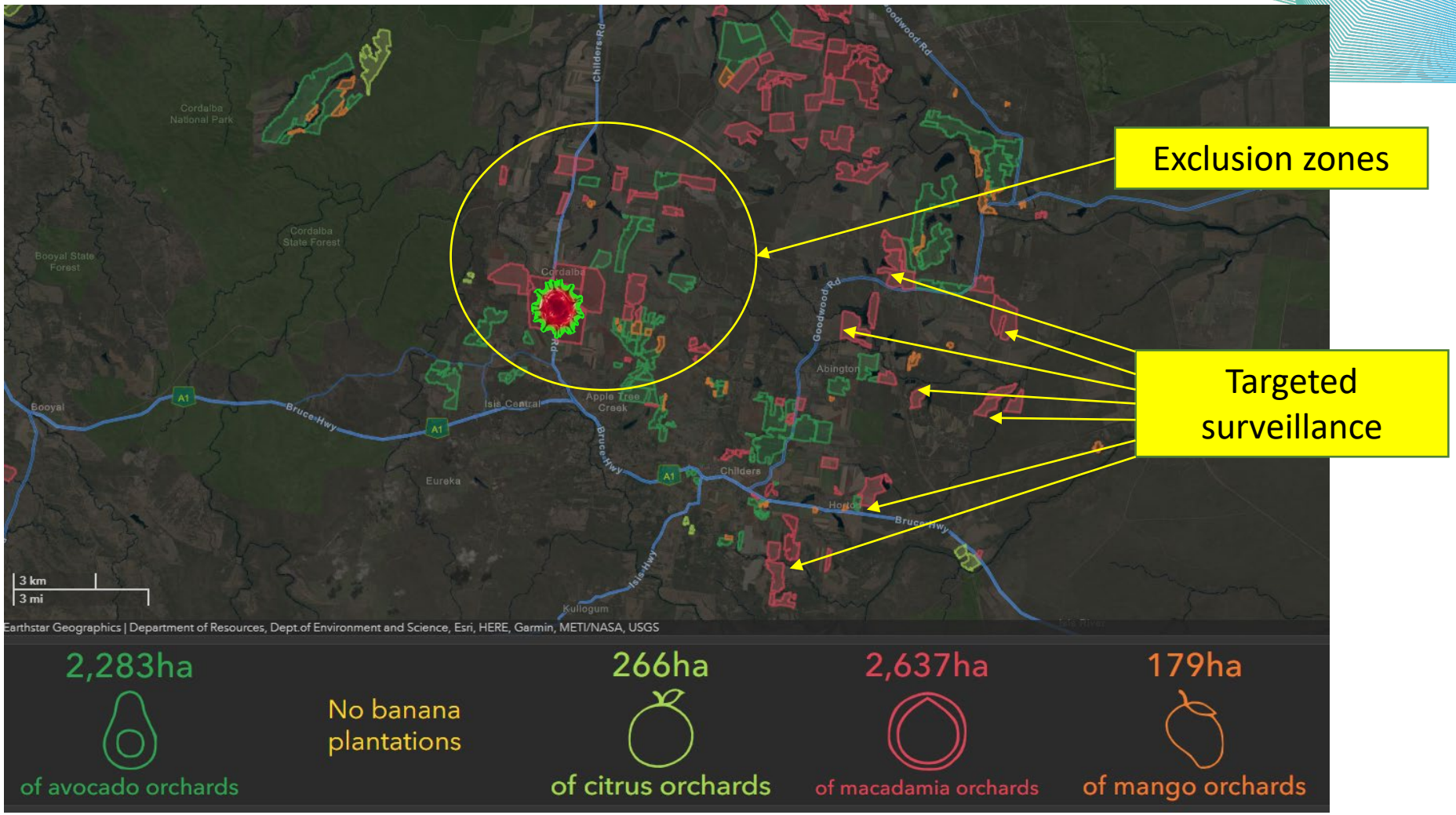
State / Territory	Hectares
Victoria	12,129
New South Wales	5,989
South Australia	6,013
Western Australia	5,733
Queensland	2,935
Tasmania	188
ACT	23
Total	**33,010**

Establishing exclusion zones and targeted surveillance

- Native vegetation
- Surrounding crops
- Vehicle routes
- Topography
- Watercourses
- Stock routes
- Walking tracks
- Drainage lines



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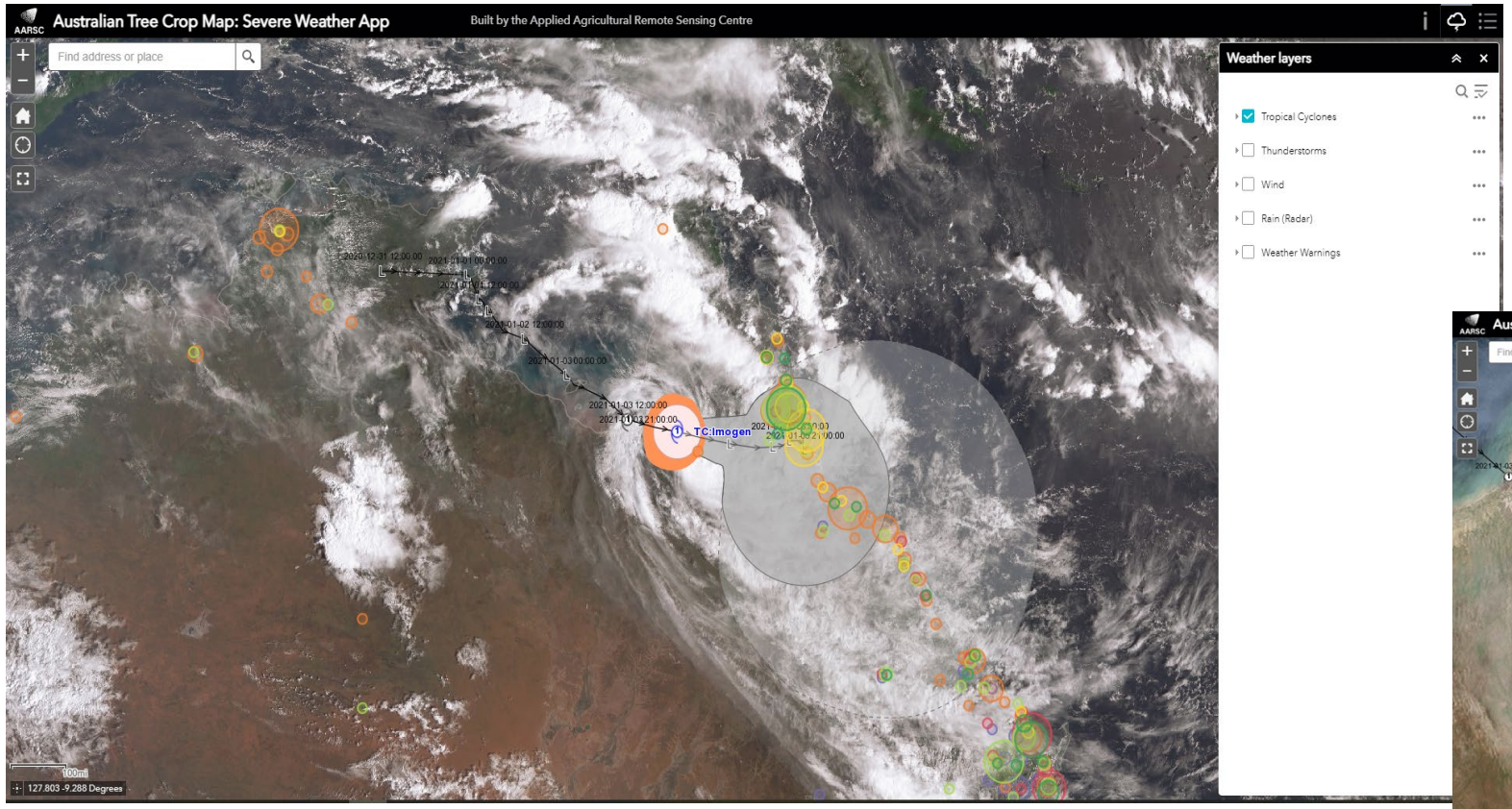
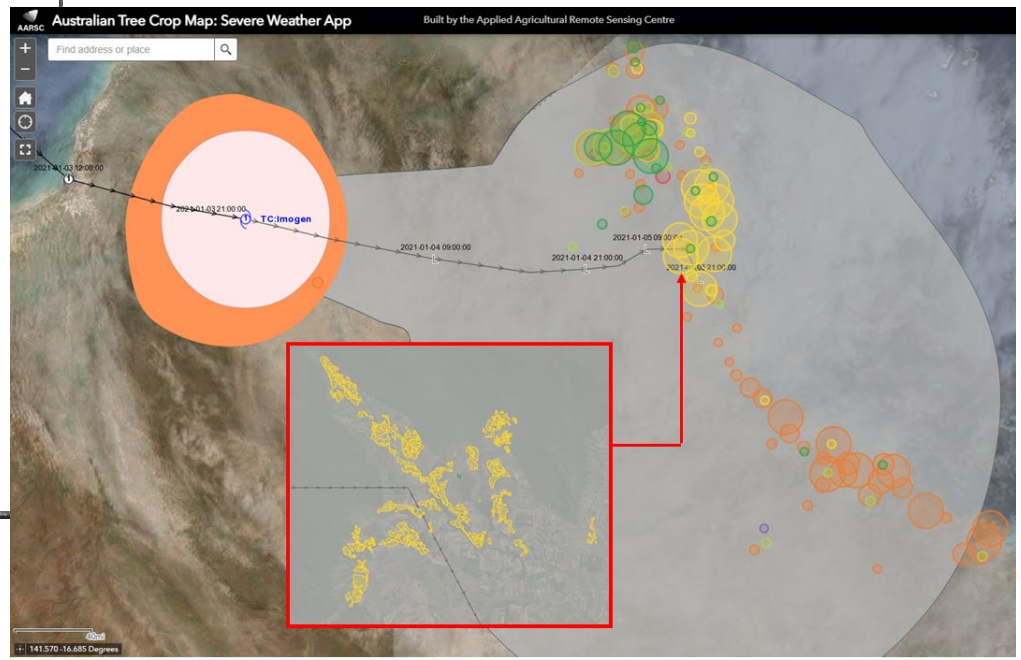
Mapping weather events





The addition of BOM weather information (severe weather warnings, cyclone paths etc) to the 'Australian Tree Crop Map'

https://une-2351.maps.arcgis.com/apps/webappviewer/index.html?id=d65a6a5fdf5e459e95fa73ad7cb516c9

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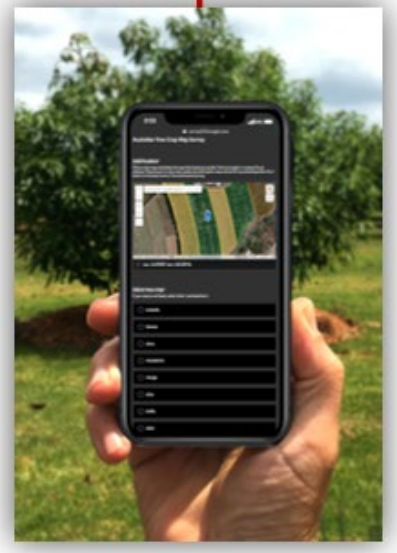
AOA needs your help to keep the map updated



ATCM Survey

Please check your grove is in the map…

"Something missing?"

Use the link to launch the ATCM Survey and tell us!

This feedback is essential to map new plantings!

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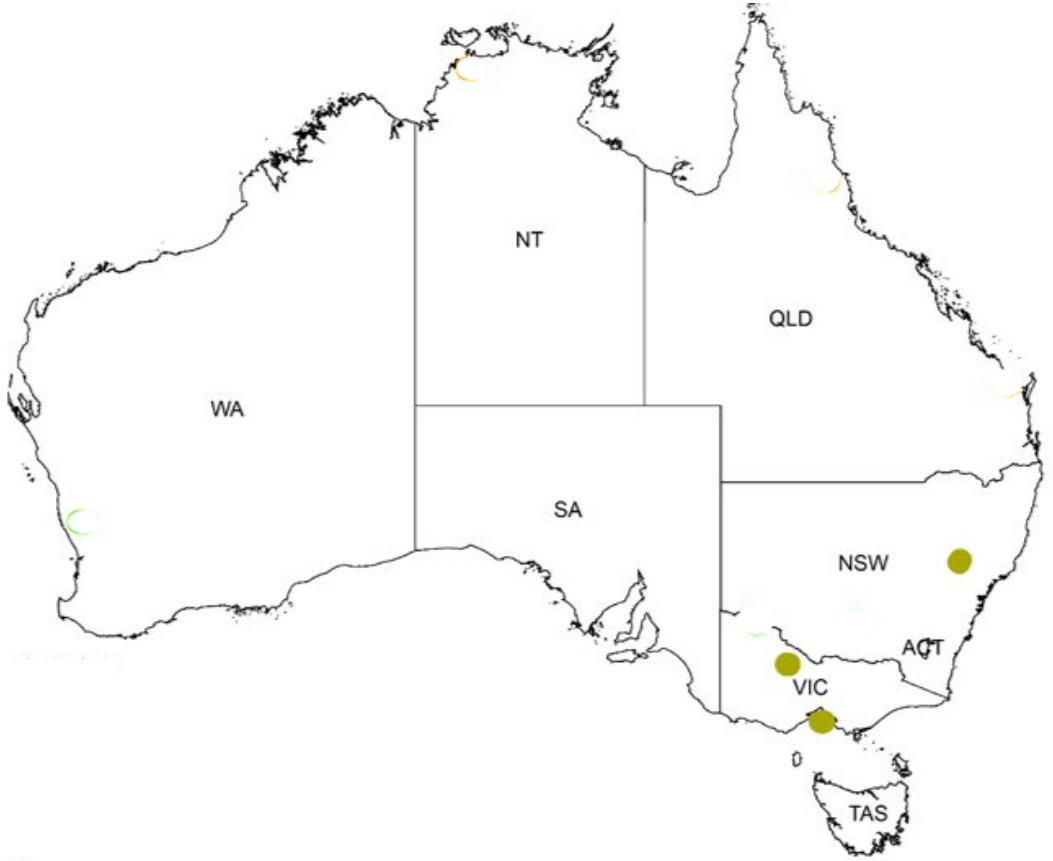
Measuring Tree Health, Yield and Oil Quality

Boort (2 Growers)
Mornington Peninsula (1 grower)
Hunter Valley (dropped due to COVID)



Grower demographic:

- Big
- Medium
- Small

Varieties included:

- Arbequina
- Picual
- Frantoio
- Leccino

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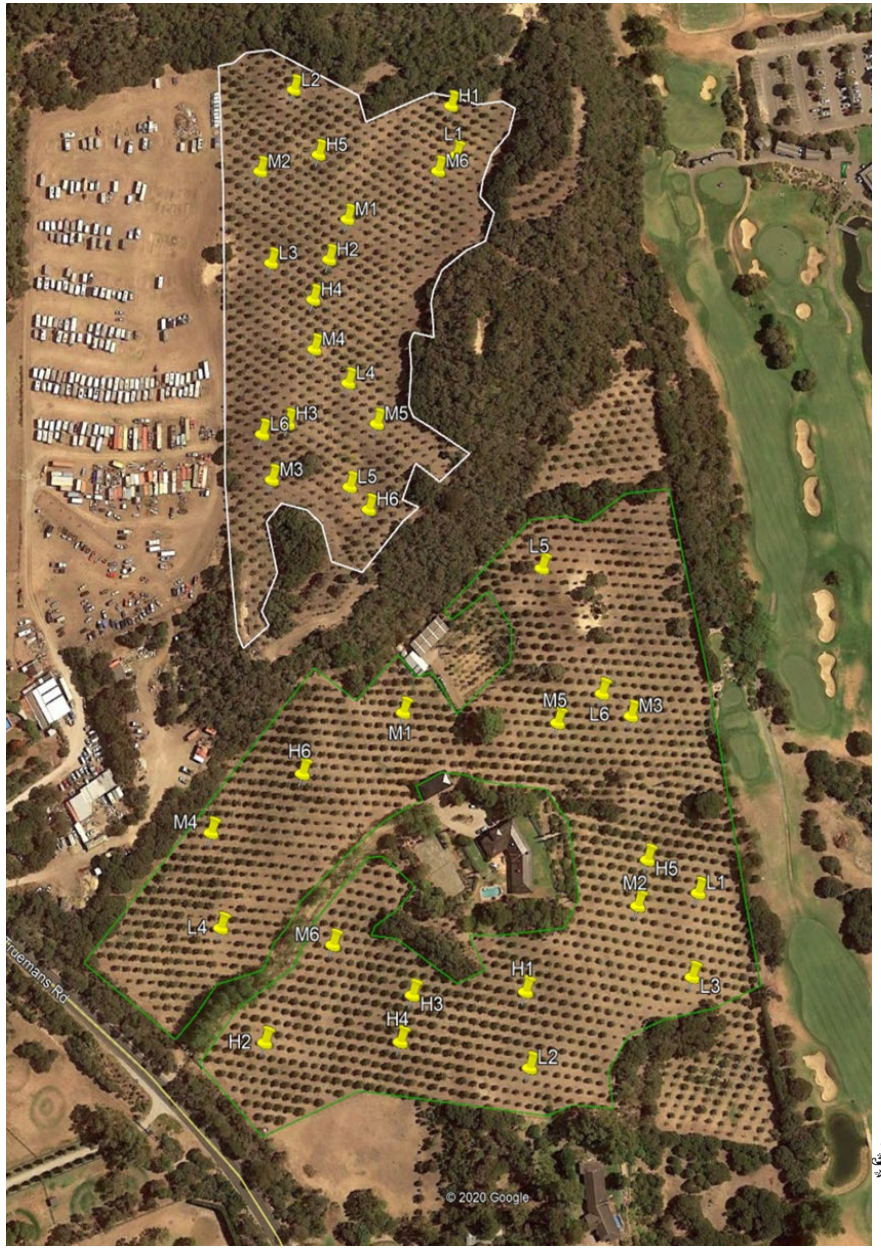
Sampling the Groves



18 calibration trees per block
(same management and variety)

- 6 low vigour trees
- 6 medium vigour trees
- 6 high vigour trees

Variability assessment of:

- Yield
- Fruit weight
- Moisture
- Oil content & quality

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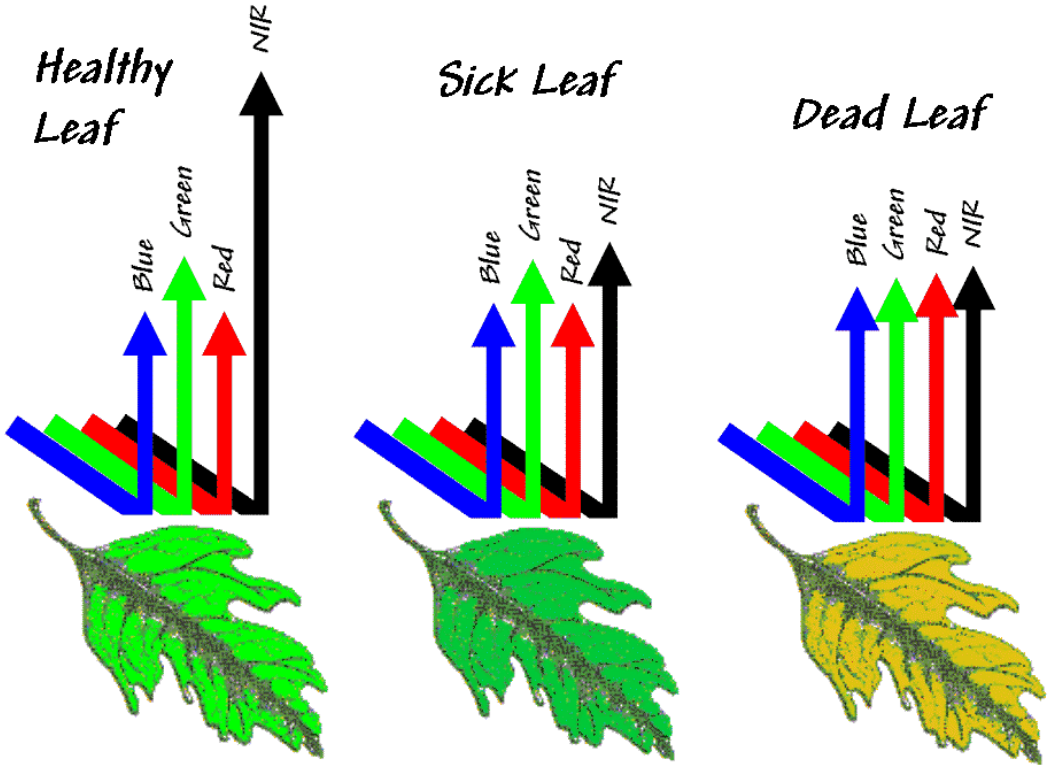
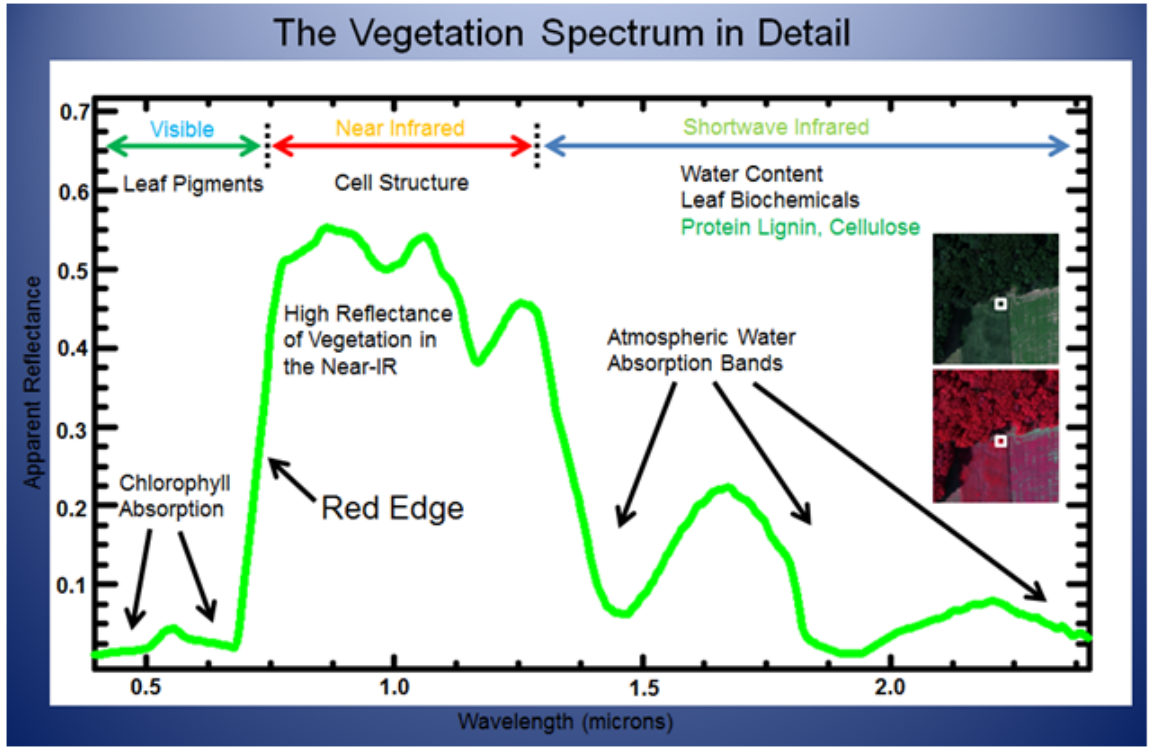
Remote Sensing: Spectral Resolution

Multispectral



http://www.innovativegis.com/basis/pfprimer/topic7/Topic7-8.gif

Hyperspectral



http://www.markelowitz.com/Hyperspectral.html

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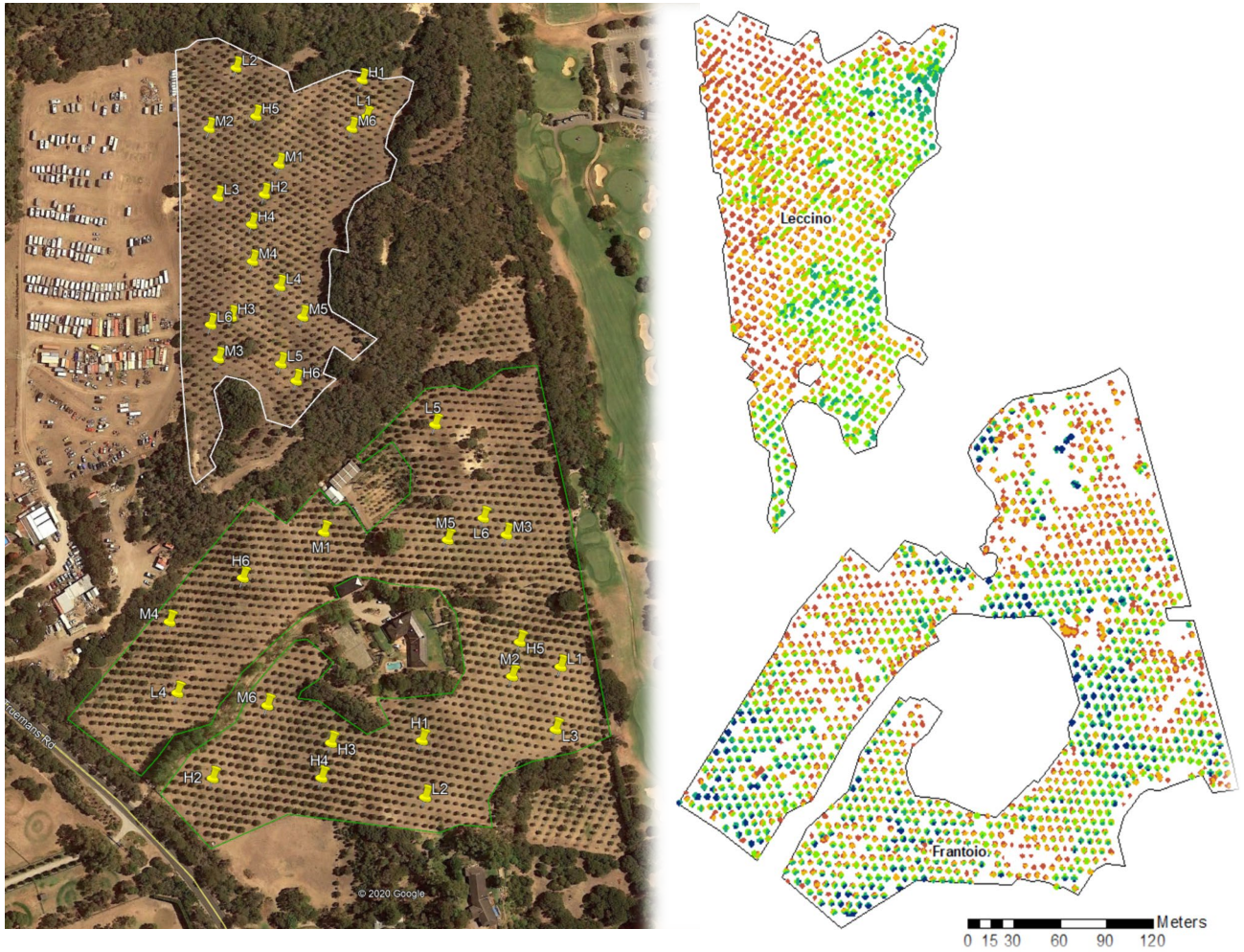
Remote Sensing: Spatial Resolution

Very high resolution to see individual trees



Mid resolution to see block and farm variability

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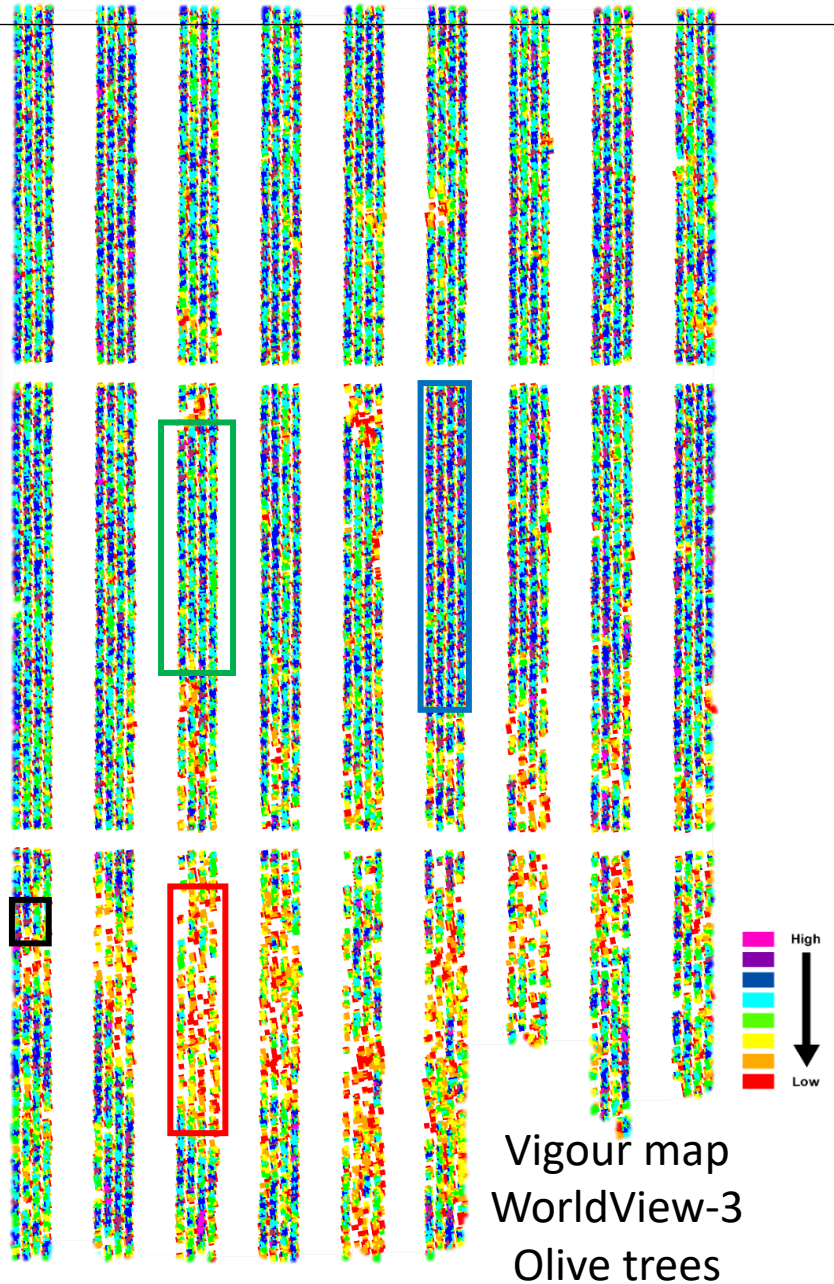
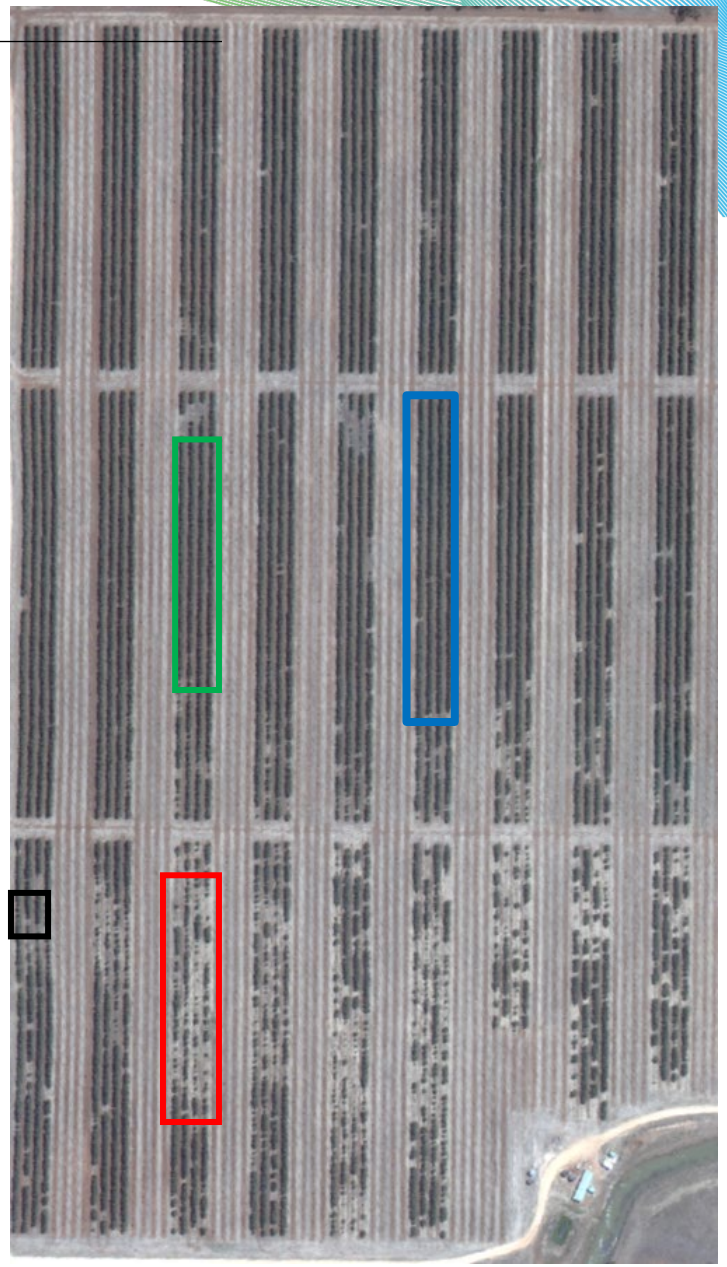
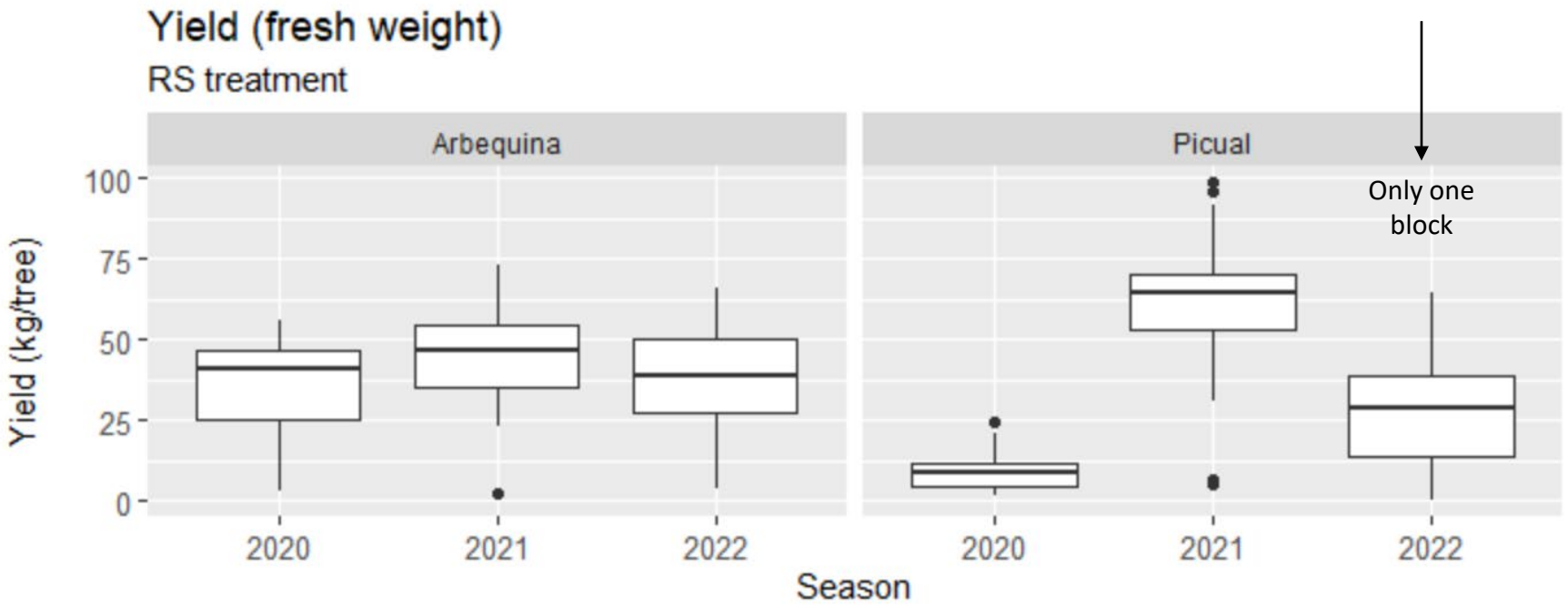
Measuring Tree Vigour



Vigour map
WorldView-3
Olive trees



Seasonal Variability in Yield at the block level



Arbequina:

- No evidence of (strong) biannual bearing

Picual

- Strong biannual bearing

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Yield variability per management and vigour zone

- **Arberquina**: **A consistent trend**: High vigour trees (blue box) yielded higher than low vigour trees (red box)
- **Picual**: Also exhibited High vigour trees (blue box) yielded higher than low vigour trees (red box), not as clear for block 2
- medium vigour trees (green box) produced similar yields to the high vigour trees during an 'on-season' *(for both Arbequina and Picual)*

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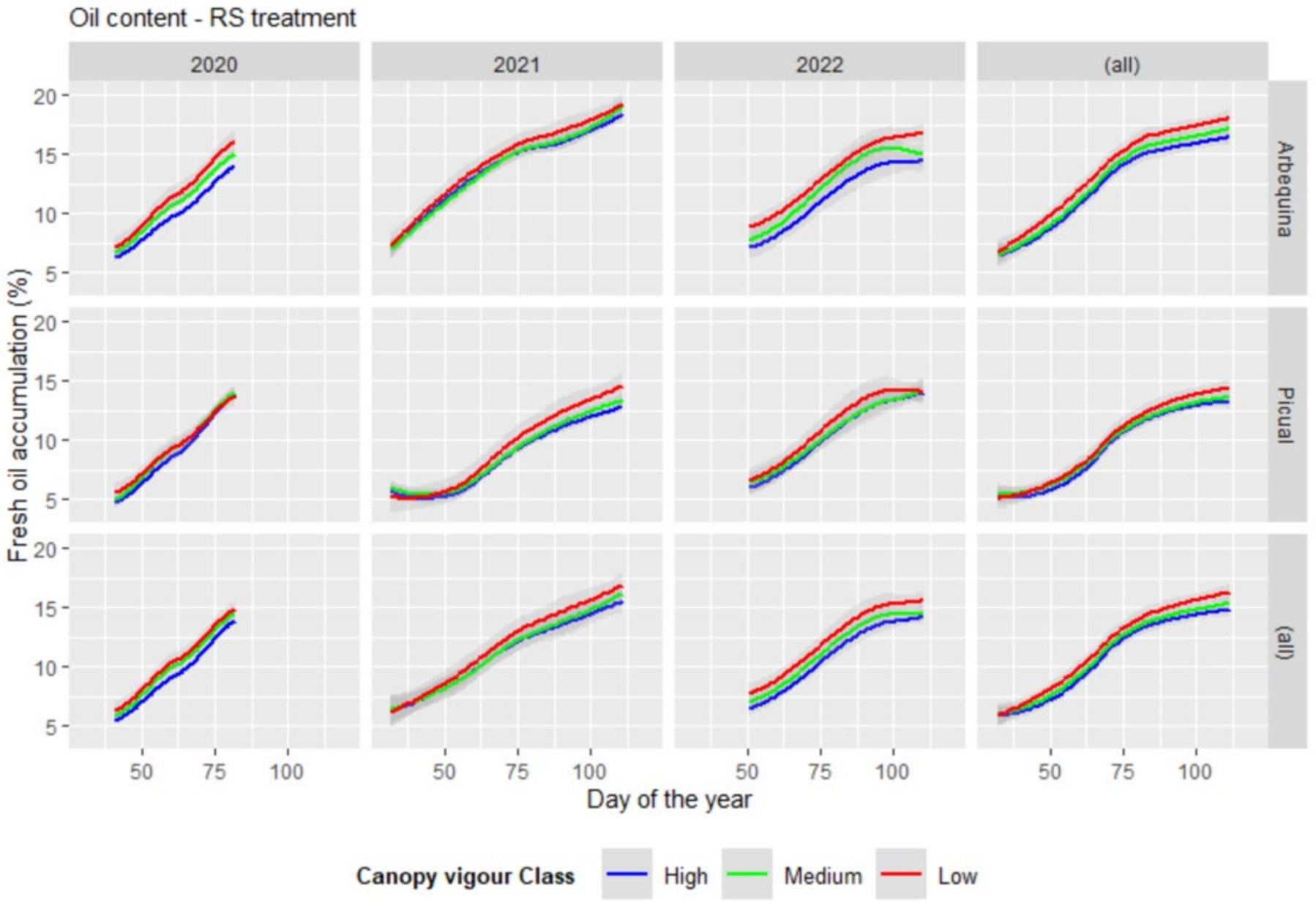
Oil Accumulation (%)



Low vigour (red line) trees accumulate oil faster than high (blue line) and medium (green line) vigour trees

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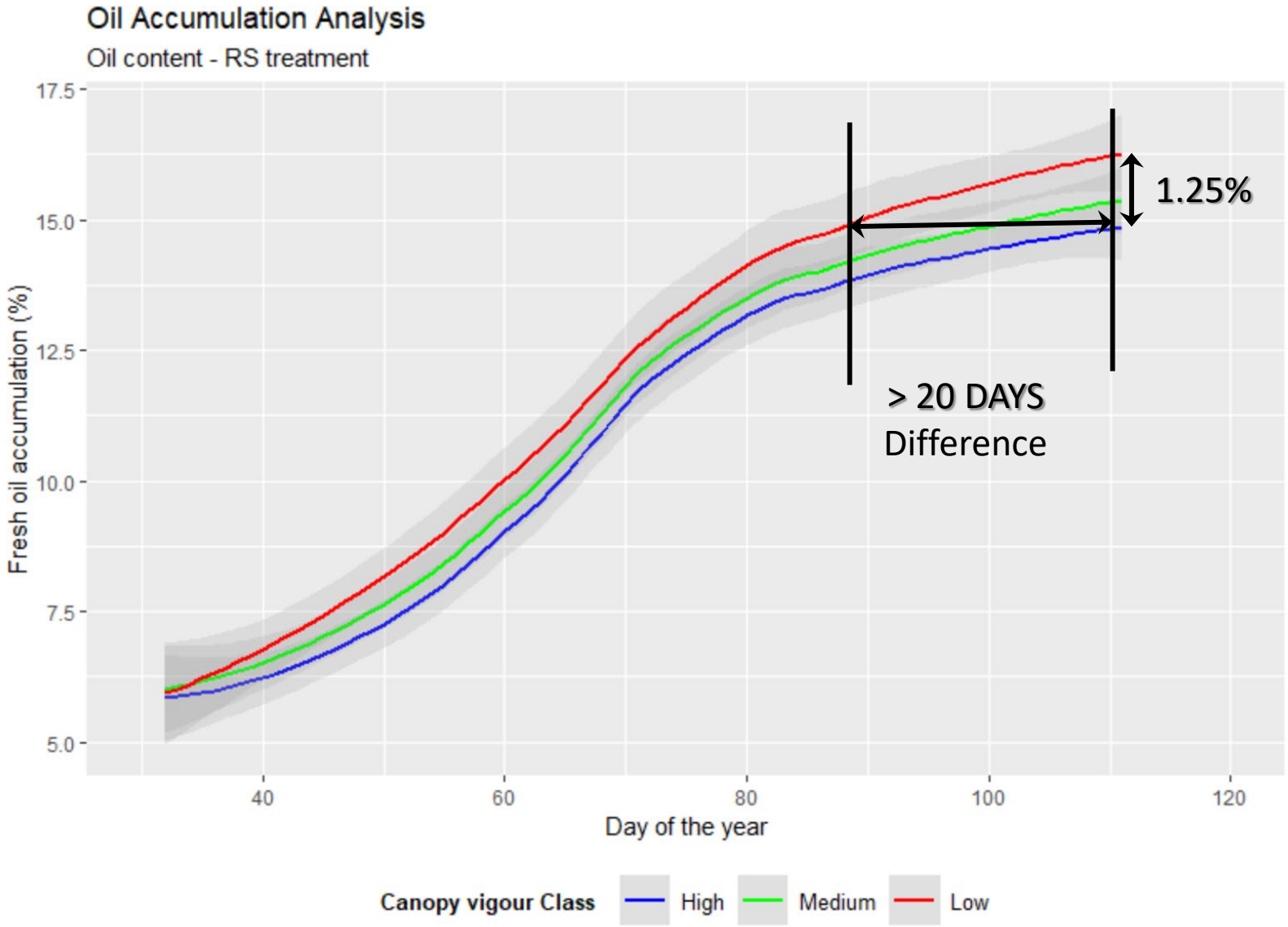
Potential for harvest segregation based on % oil



If optimum harvest date is driven by a critical oil (%) e.g. 15%, then this shows that low vigour trees could be harvested 20 days earlier than high vigour trees.

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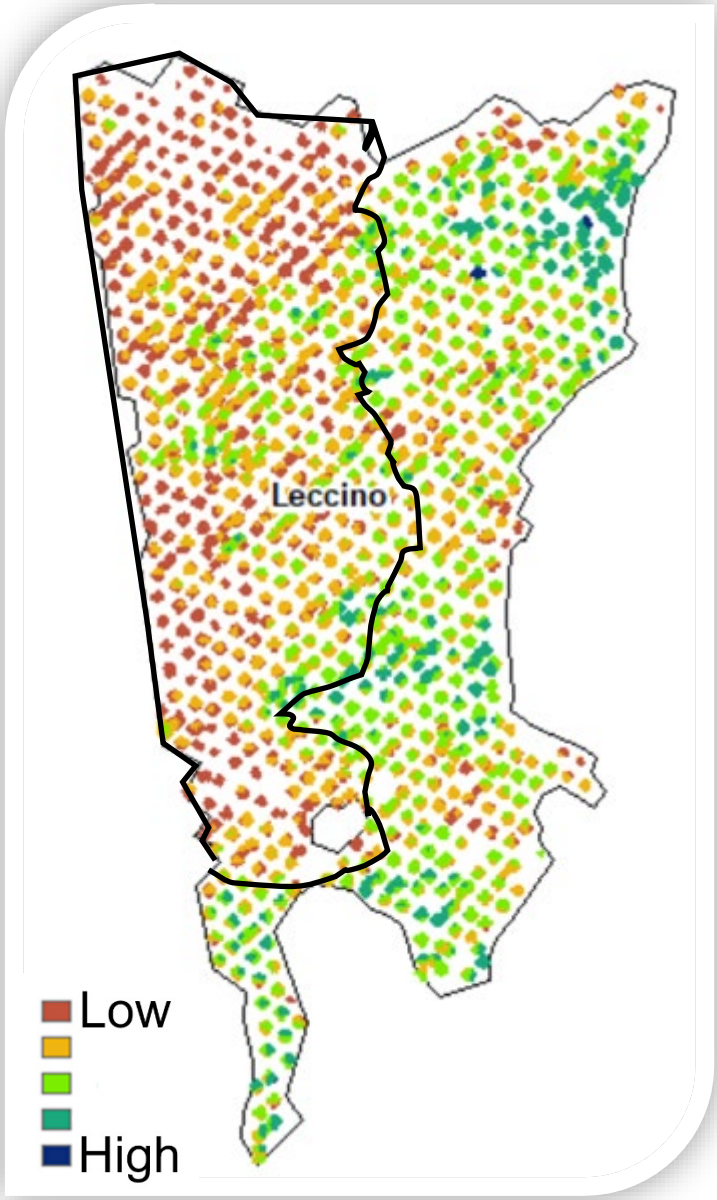
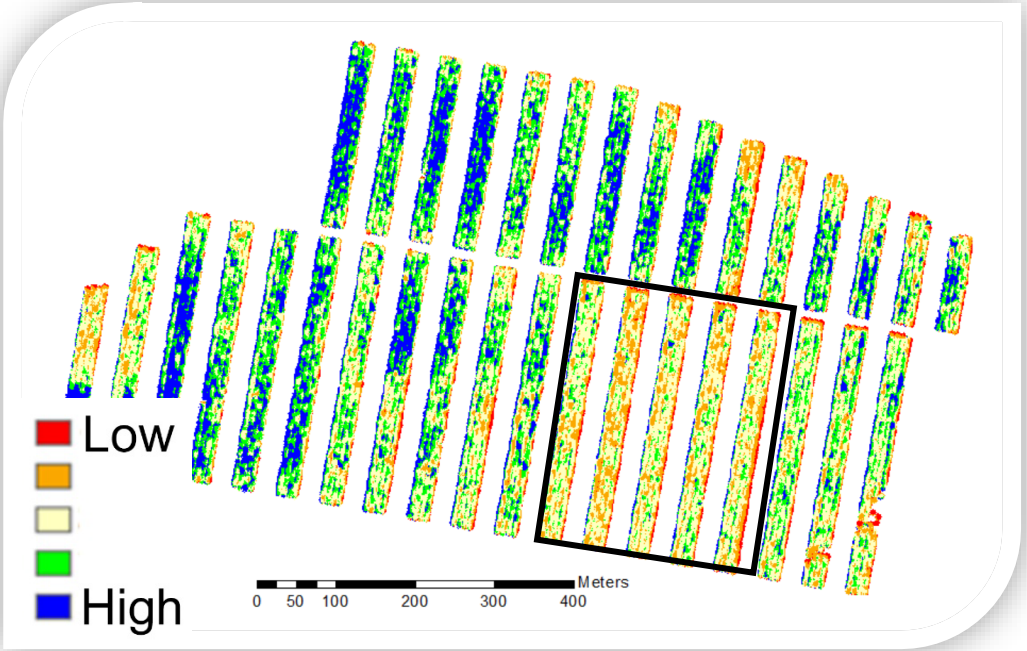
Potential for harvest segregation based on % oil



‘Intricate harvest segregation’

‘block level harvest segregation’



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Sensors and irrigation deficit trial

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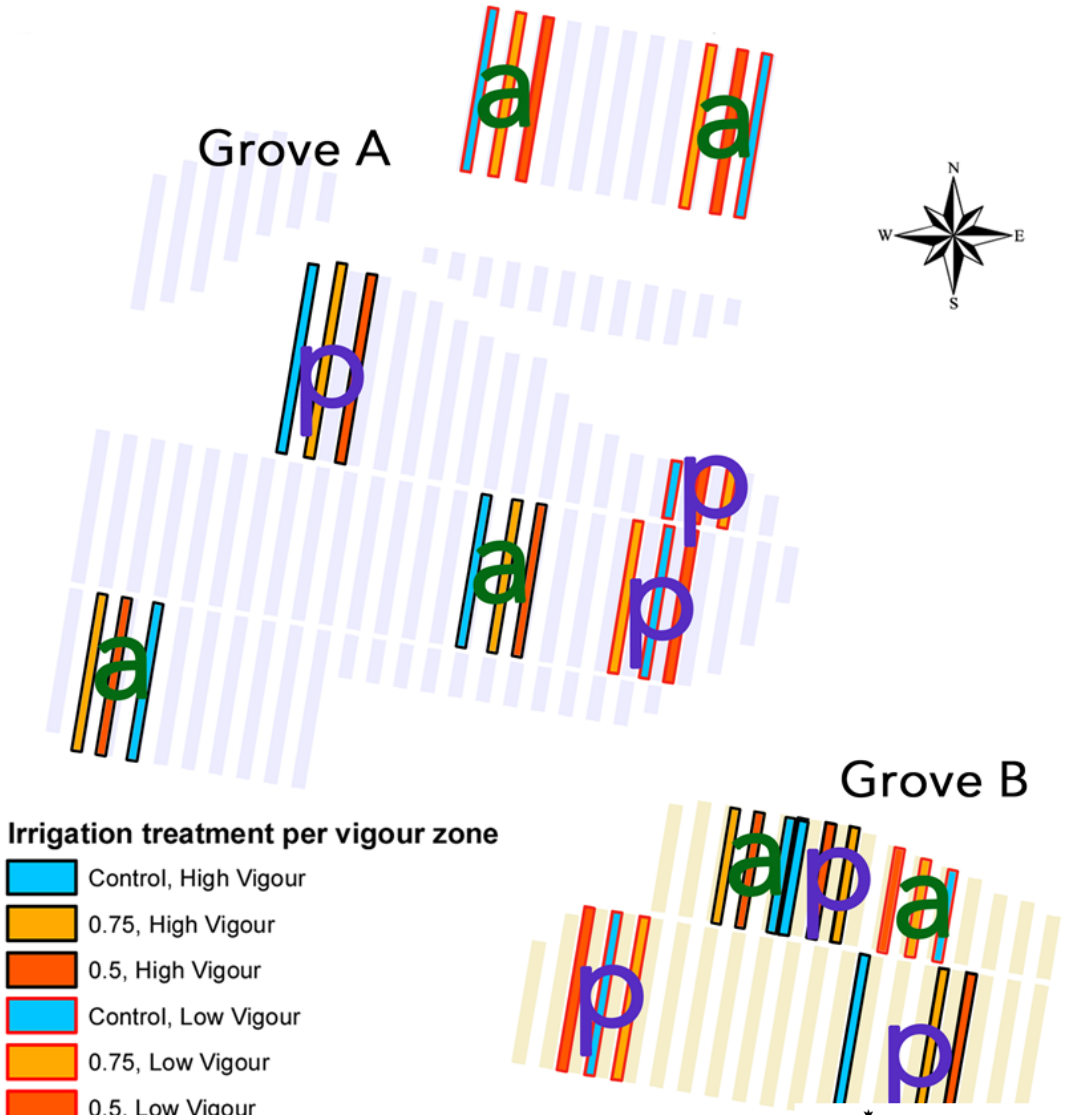
Why?



1. Reliability and availability of water
2. Impose a water stress to study with remote sensing
3. Evaluate soil and plant-based sensing tools

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Sensors

Thermal/spectral imagery

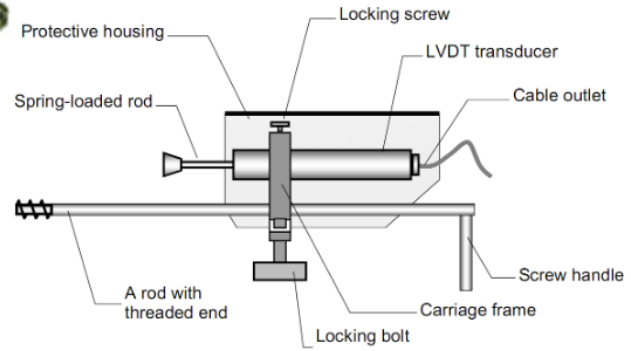
ETc (0.6-0.7 Eto)

Weather station

Temp/humidity

Soil moisture

Sap flow



Dendrometer

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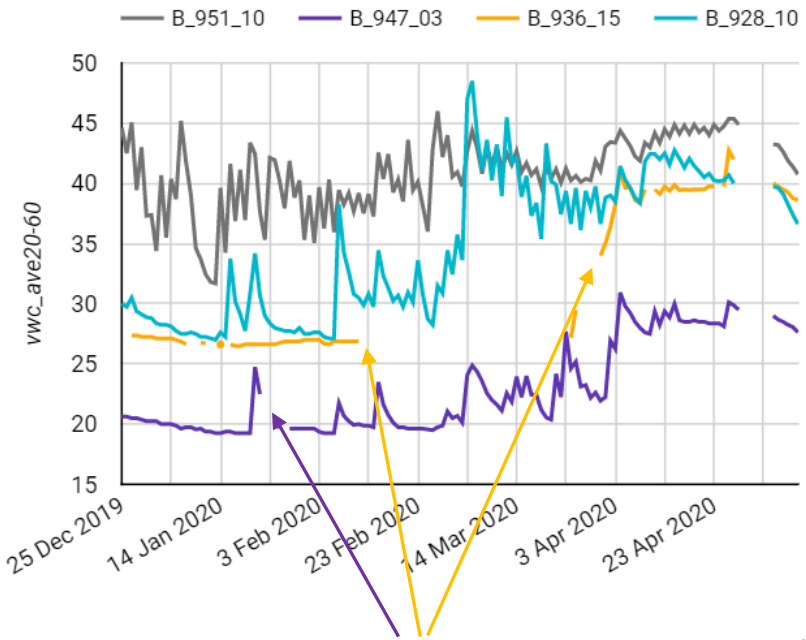
Olive IoT sensor network

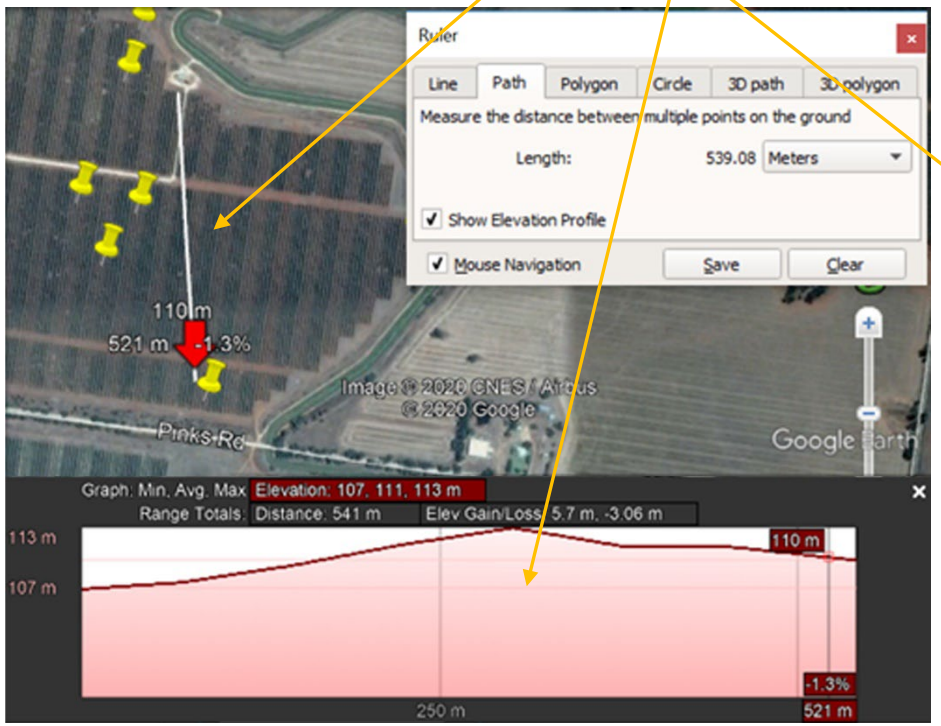
- SigFox network (cost, range, ease of setup)
- 12 irrigation monitoring stations
- 18 micro-climate stations
- Data collected over three seasons



Data dropouts

Challenging environment

- Distance
- Hills
- Tree canopies



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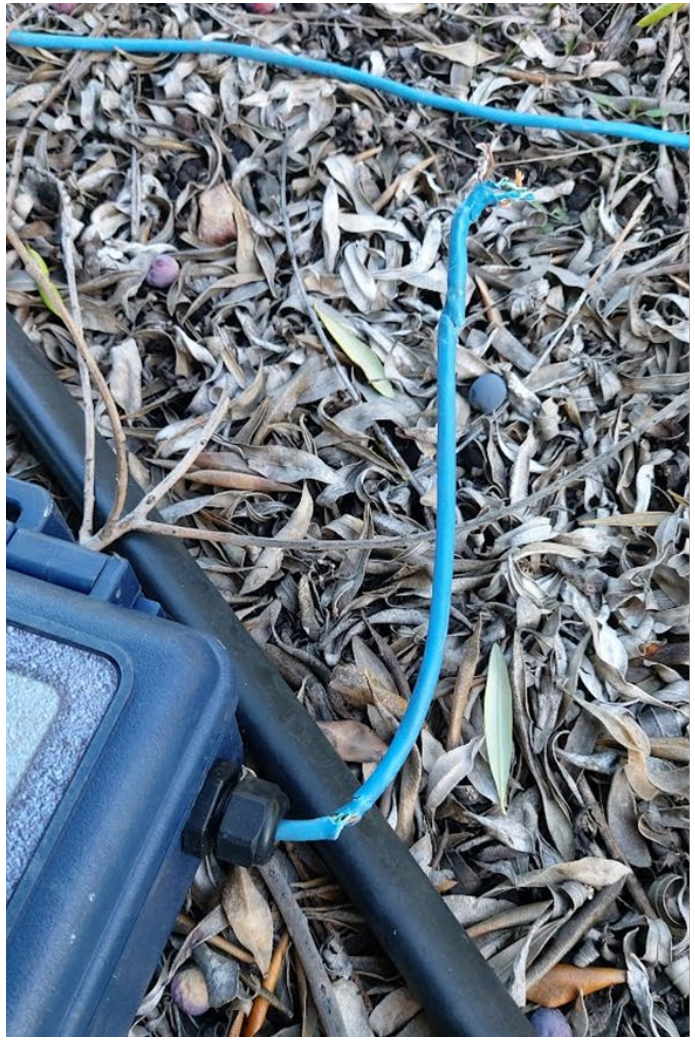
Sensor issues



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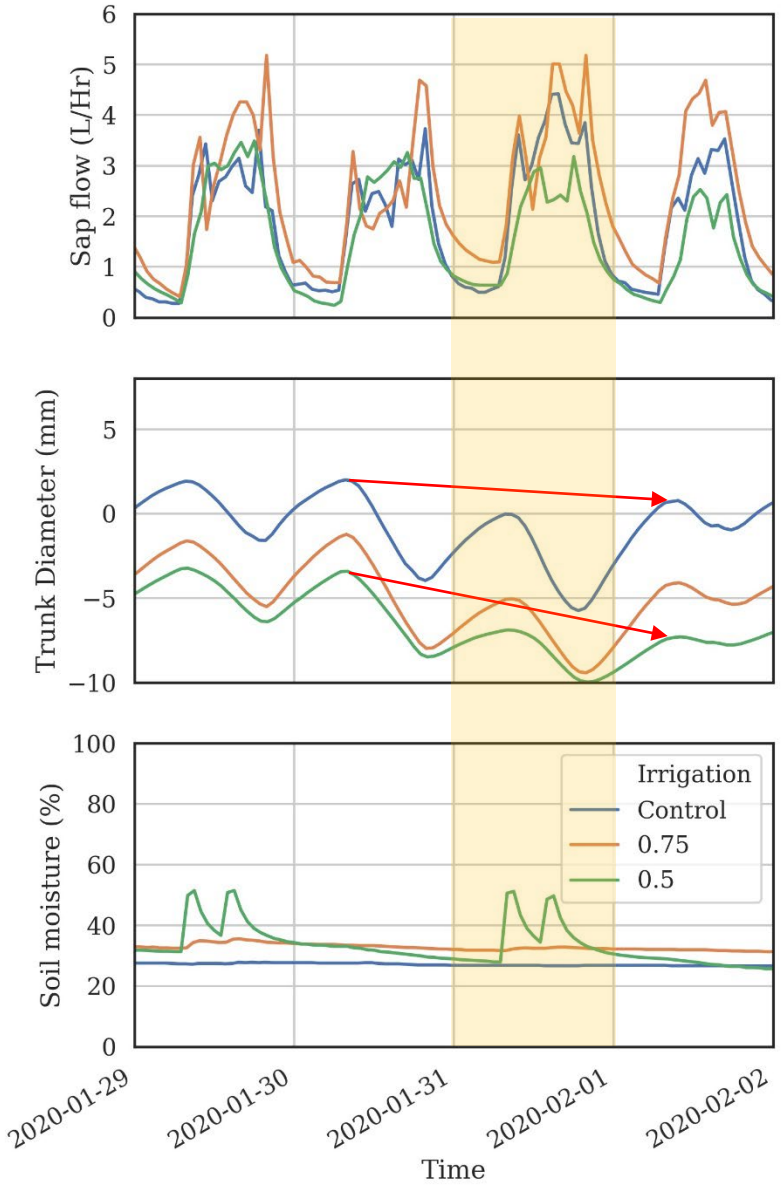
High ETo days



Date	ETo (mm)	Rain (mm)	Tmax (deg)	Solar rad (MJ)
29/01/2020	7.0	0.0	37.6	29.7
30/01/2020	9.7	0.0	41.6	29.5
31/01/2020	13.4	0.0	44.9	26.2
1/02/2020	5.0	0.1	33.7	13.4

- Sap flow high on high ETo days (provided soil moisture is available)
- Trunk diameter shrinks during day as tree transpires, then regrows at night (provided soil moisture is available)

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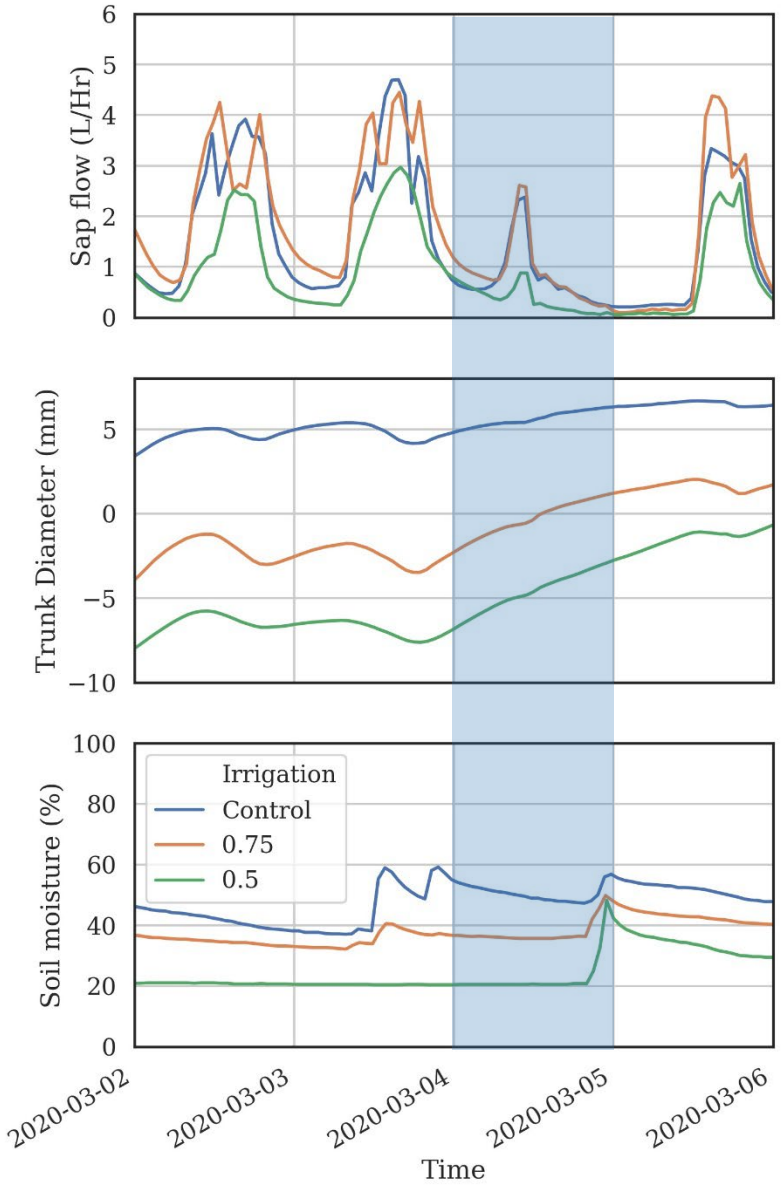
Low ETo days



Date	ETo (mm)	Rain (mm)	Tmax (deg)	Solar rad (MJ)
2/03/2020	6.2	0.0	24.6	20.7
3/03/2020	5.9	0.0	27.2	22.4
4/03/2020	2.1	0.0	20.6	3.9
5/03/2020	2.6	19.1	25.1	9.8

- Sap flow low on low ETo days
- Trunk diameter grows with very little shrinkage during the day

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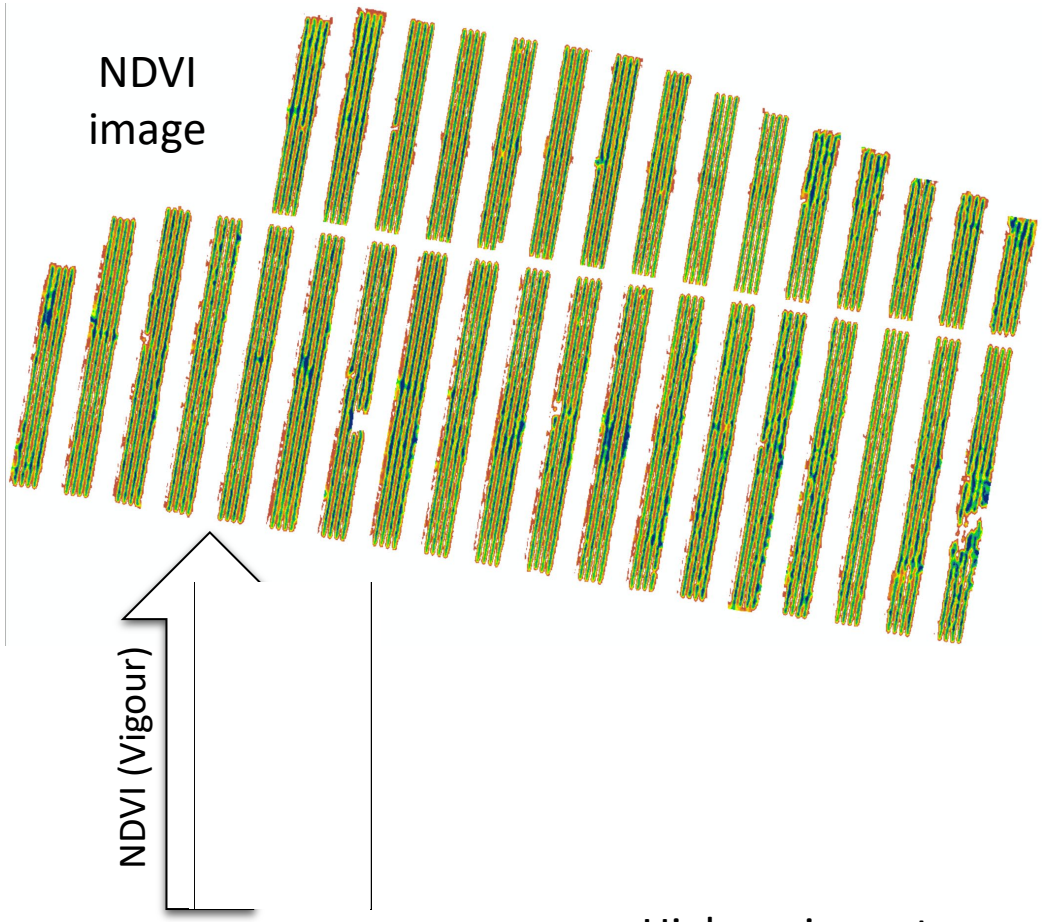
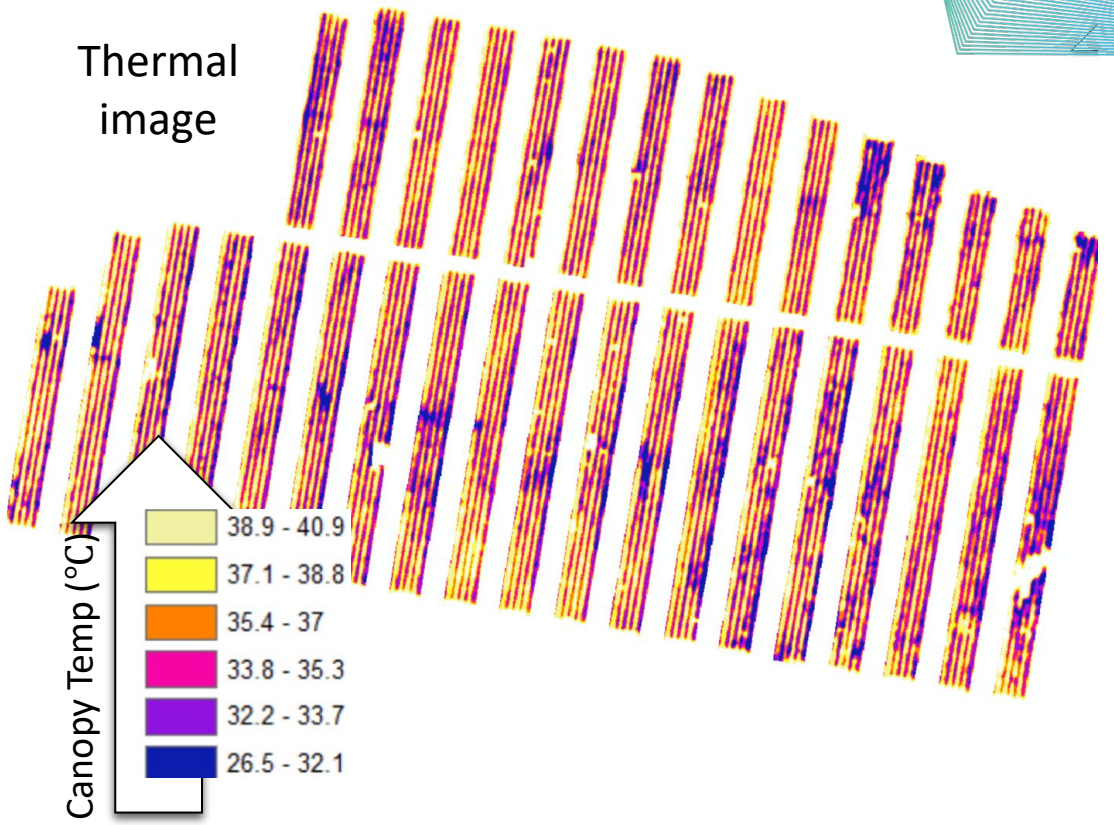
Thermal imagery for water stress detection?





Higher vigour trees -> lower temperature
Due to higher evapotranspiration, which cools the canopy

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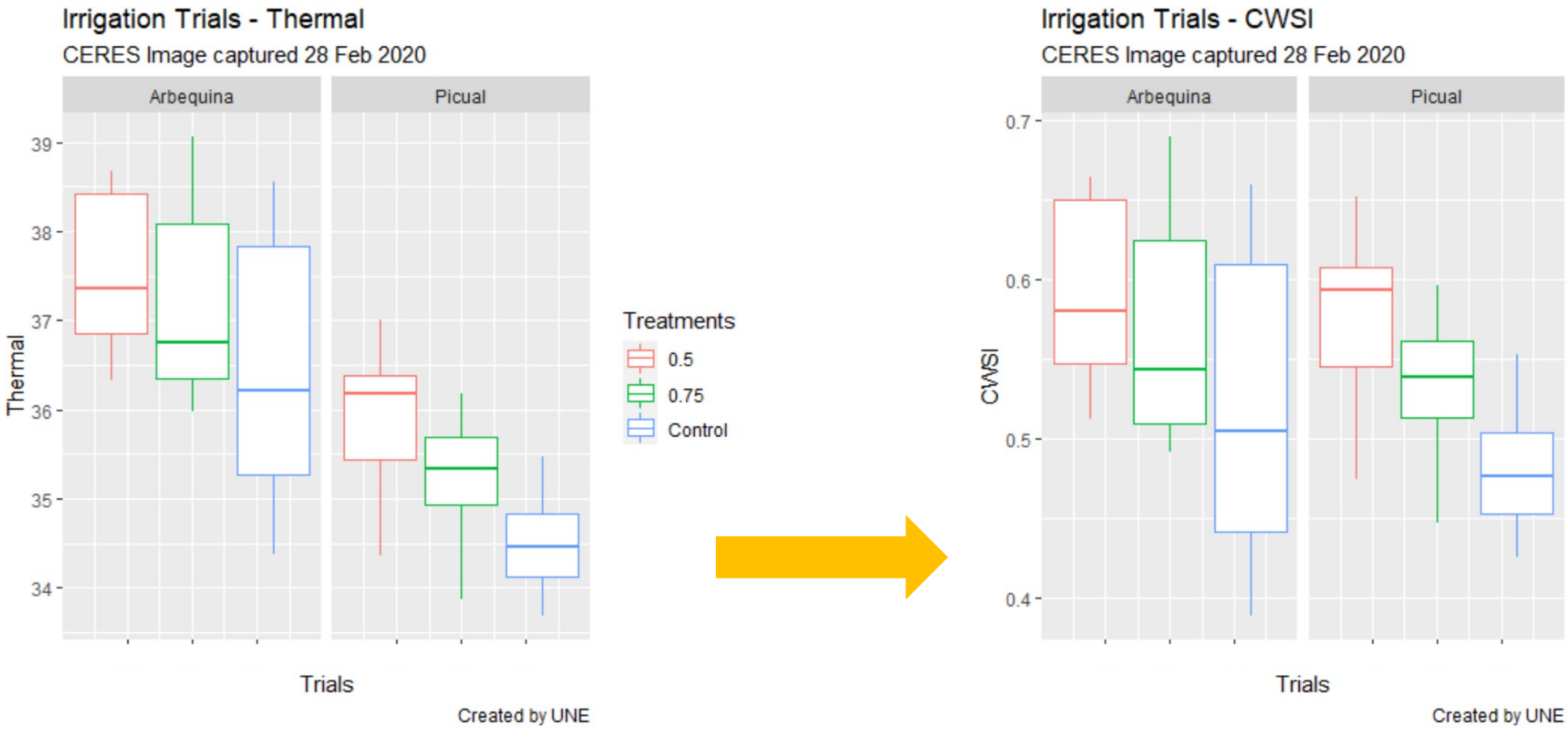
Using crop water stress index Crop Water Stress Index



The Crop Water Stress Index (CWSI) removes the influence of vigour in the temp values

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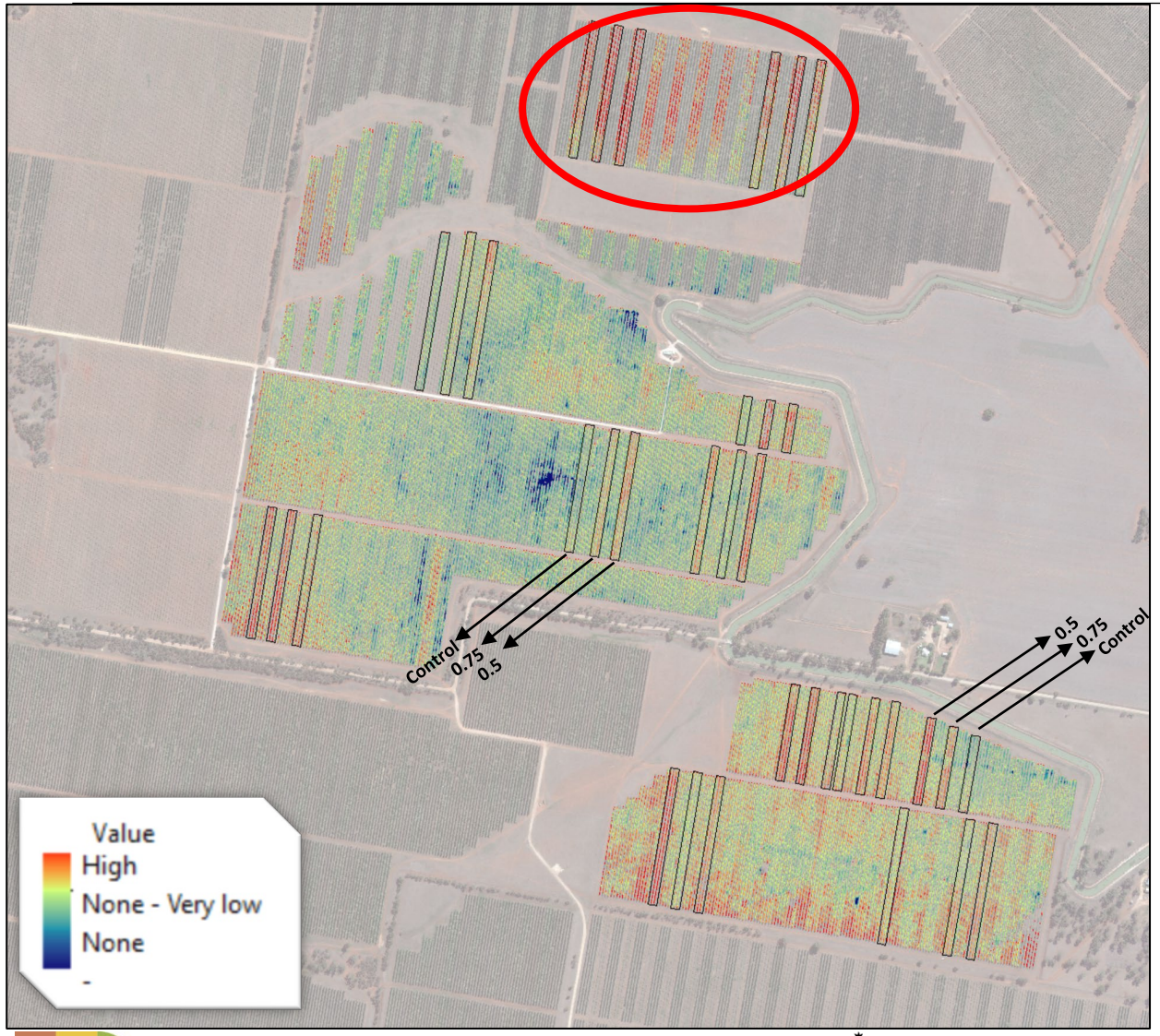
Using crop water stress index Crop Water Stress Index



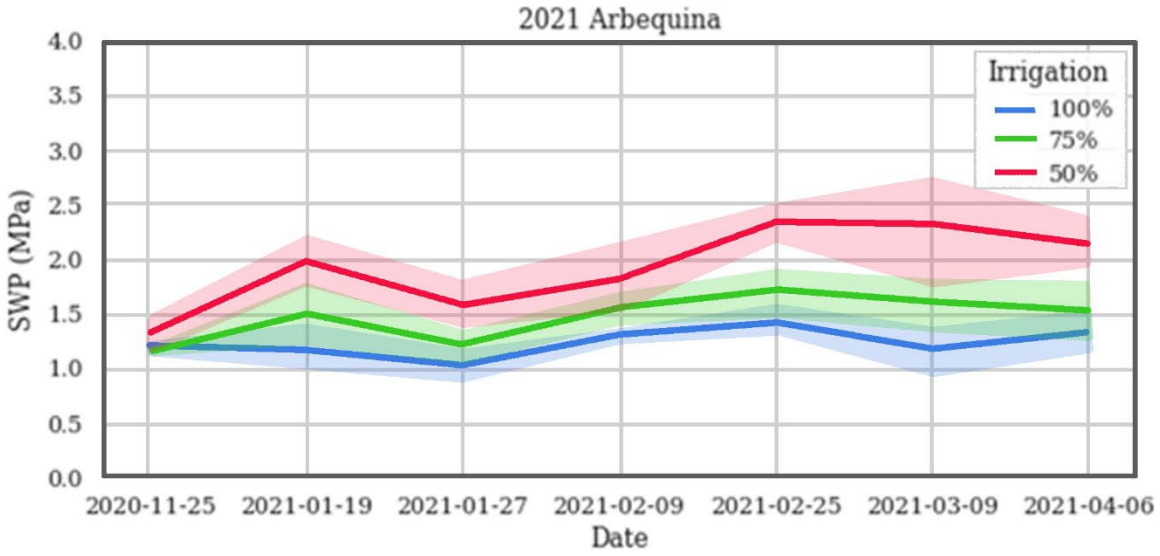
CERES imagery taken on Feb 23rd 2022

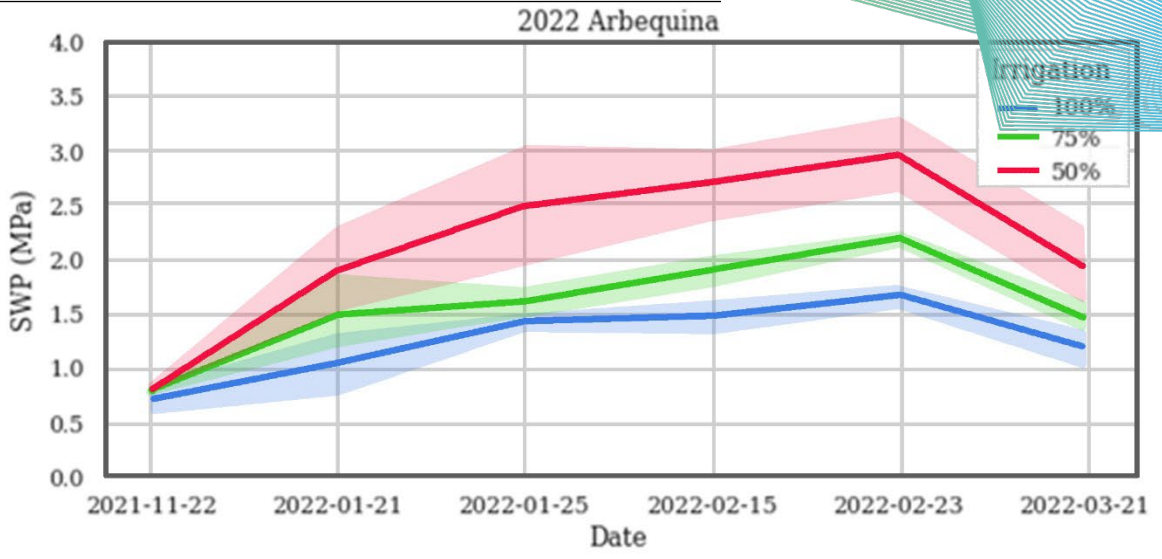
- Indicating areas under (potential) water stress

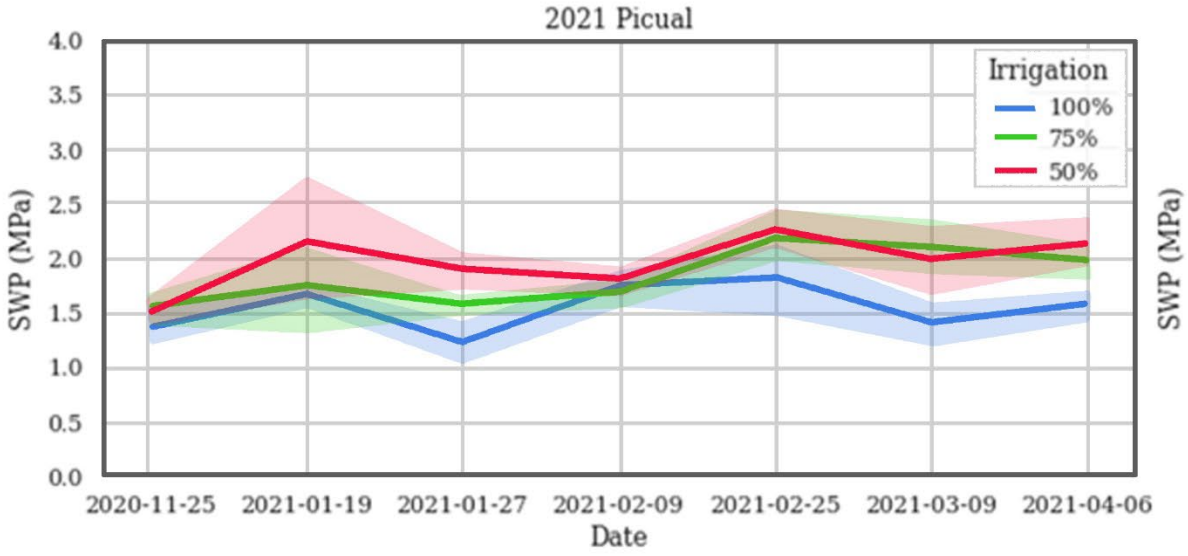
Sensor and monitoring take home points

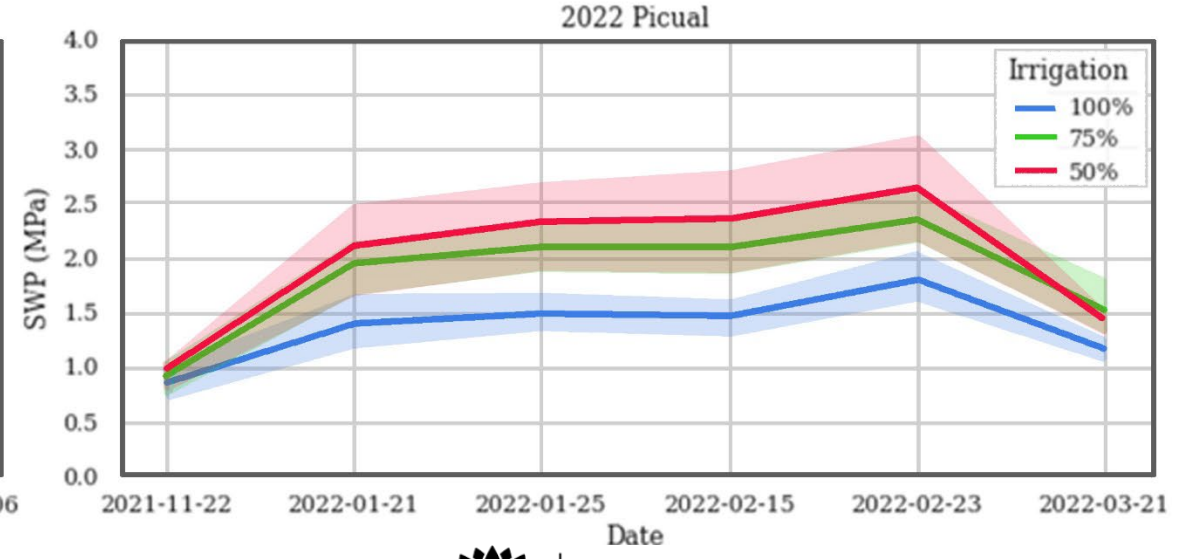
- Low-cost long-range sensors can work in tree crop situations
- Sap flow
  - Gives an indication of how much a tree has used in Litres
  - Could be used to precisely deliver amount of water to replenish soil
- Dendrometer
  - Gives quick indication of water stress, if trunk diameter is declining day-on-day
  - Maximum-minimum trunk diameter indicates evaporative demand
  - Preliminary analysis shows trunk diameter is very sensitive indicator of water stress
- Soil moisture probes
  - Indicate how much water is available to fulfil transpiration demand
- High frequency remote sensing
  - Showing promise at being able to spatially indicate areas that are water stressed

Did we drought stress the trees?









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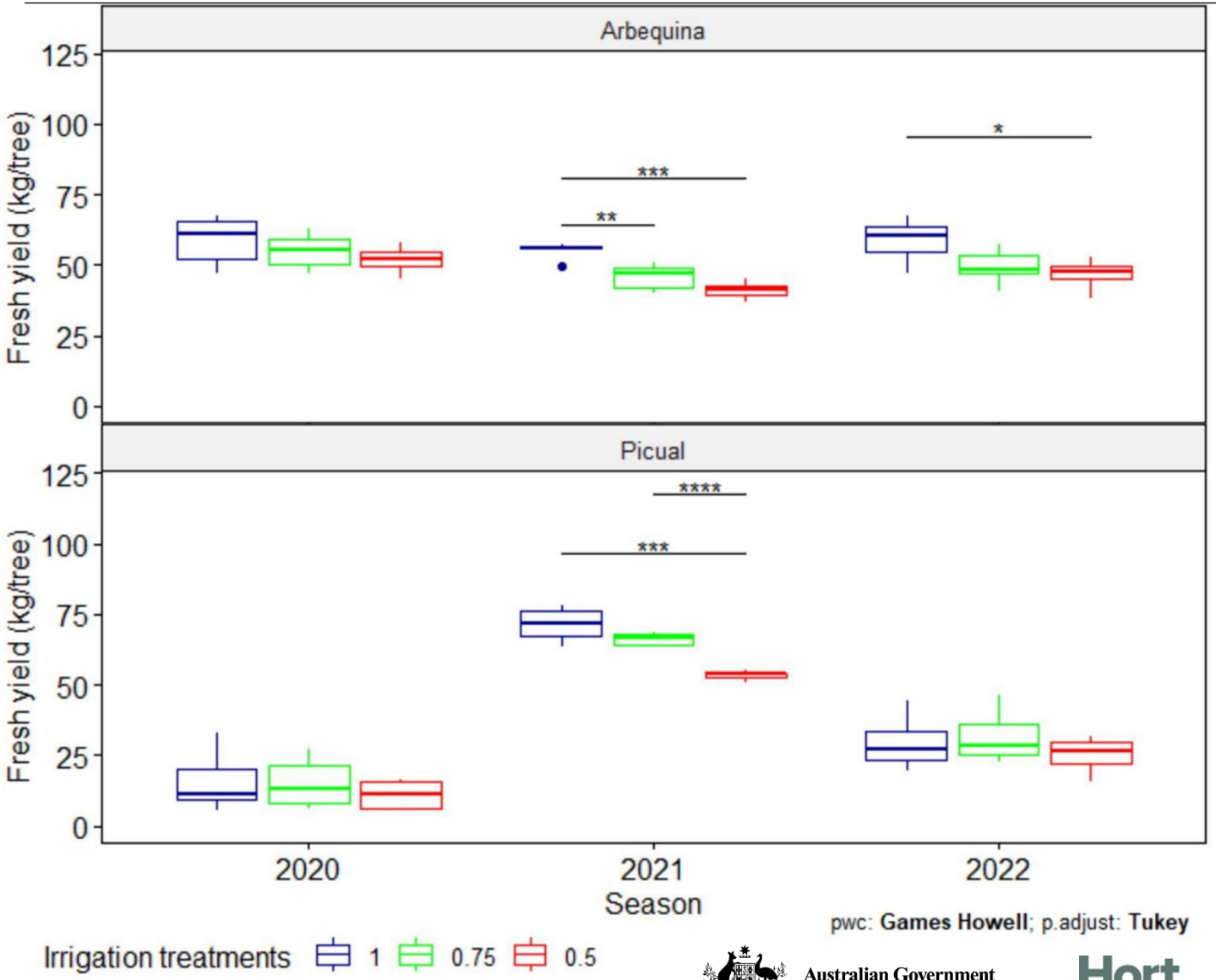
Yield results (kg/ha)



- 50% treatment effected yield in both varieties in 2021, OFF season for Arbequina ON for Picual, is it a seasonal effect?
- Only in Arbequina in 2021 did the 75% treatment effect yield
- Picual less effected than Arbequina
- Irrigation treatments impacted low vigour less then high vigour trees (not show in chart)
- No significant difference in oil content and FFA content across irrigation treatments

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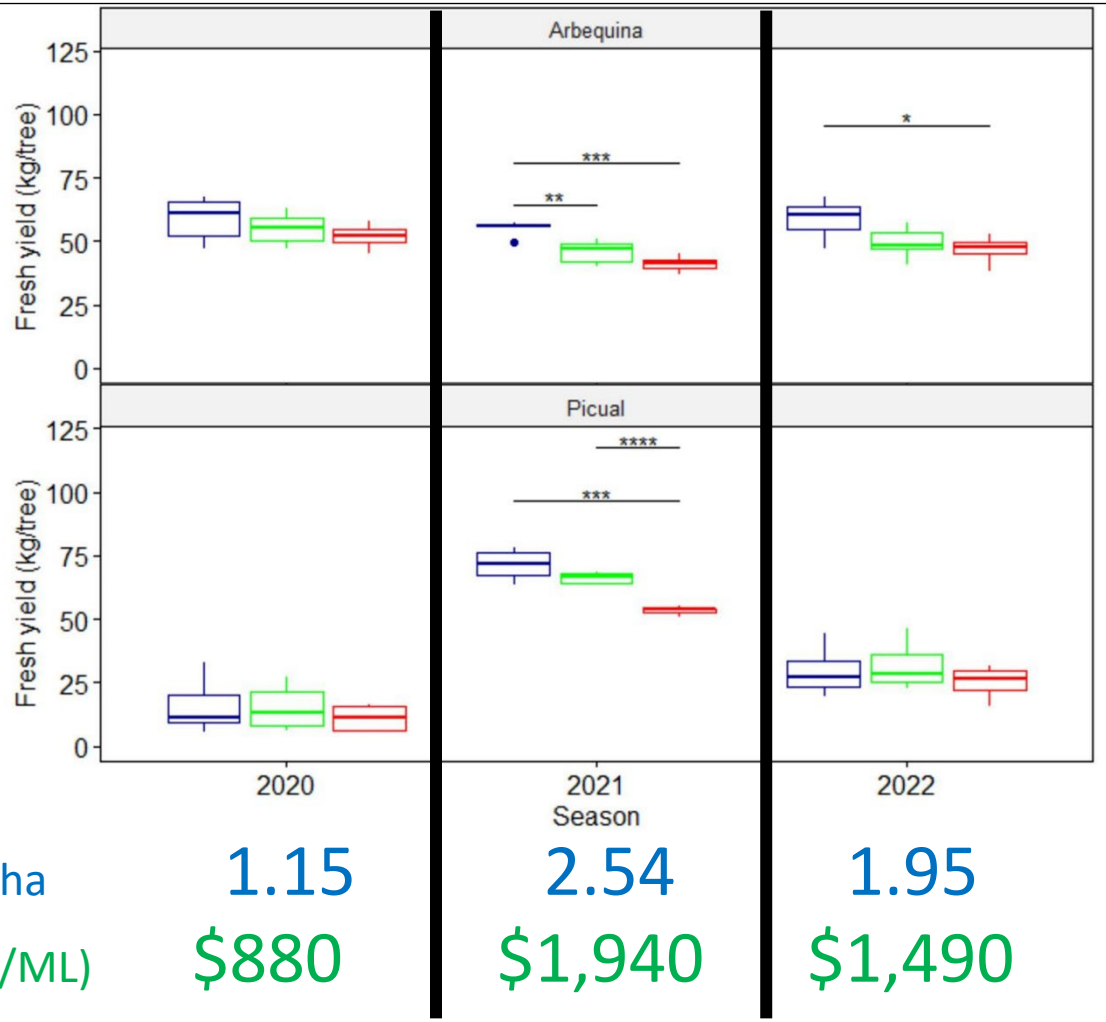
Water/cost saving of 50% irrigation treatment



	2020	2021	2022
Water saving ML/ha	1.15	2.54	1.95
Cost saving $/ha (at $765/ML)	$880	$1,940	$1,490

Irrigation treatments 1 0.75 0.5

pwc: **Games Howell**; p.adjust: **Tukey**

Are we over irrigating?

- 50% irrigation treatment did not reduce yield in half the experiment
- The 75% irrigation treatment only reduced yield in one example

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Questions?

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