Investigation of Sensor-Based Irrigation Systems for Apple Orchards

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Importance of Irrigation

Necessity:

- Mandatory for dry and semi-arid area
- Supplemental for drought days/uneven rainfall in humid area

Proper irrigation:

- Increase yield
- Improve quality
- Conserve water
- Save energy
- Decrease fertilizer
- Reduce environmental impact

Our Studies

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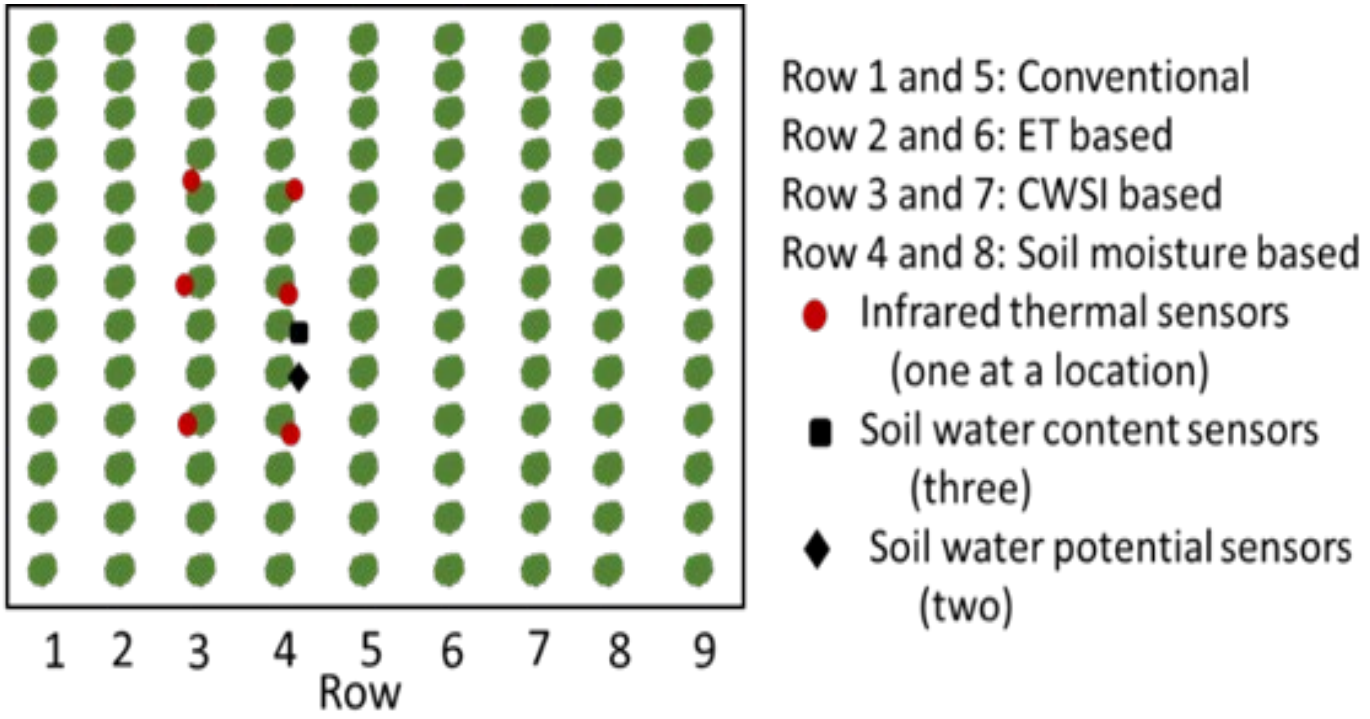
Primary Goal

Investigate an efficient sensor-based irrigation scheduling strategy for apple orchards in Mid-Atlantic region.

Experimental Setup



Irrigation Scheduling Methods

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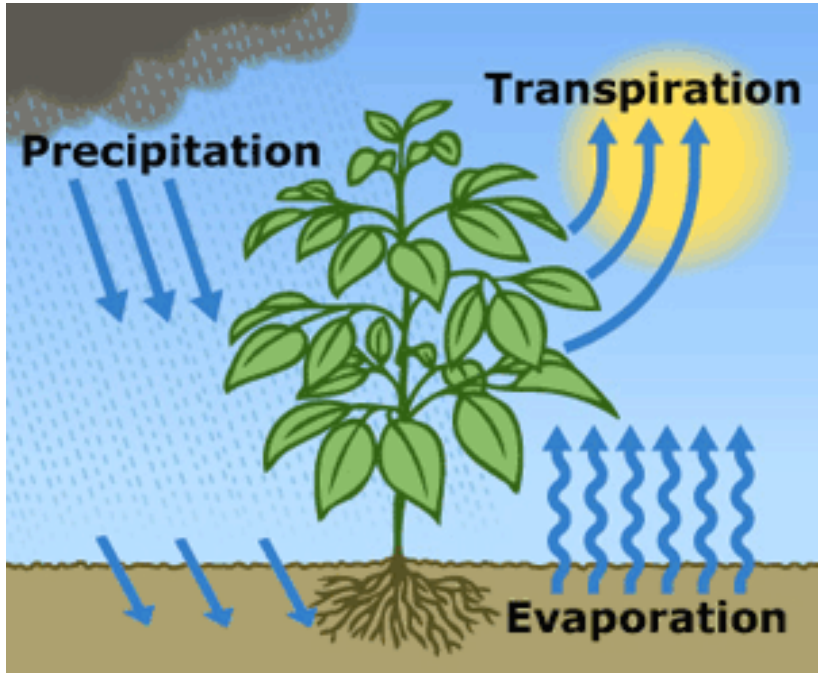
Evapotranspiration (ET)



Penman–Monteith Model (P-M)

- Reference ET_0
- Estimated ET = K_c x ET_0

Parameters:

- Maximum air temperature
- Minimum air temperature
- Relative humidity
- Wind speed
- Solar radiation

When **Transpiration + Evaporation > Precipitation**, ***Irrigation*** is needed.

Irrigation Scheduling Methods

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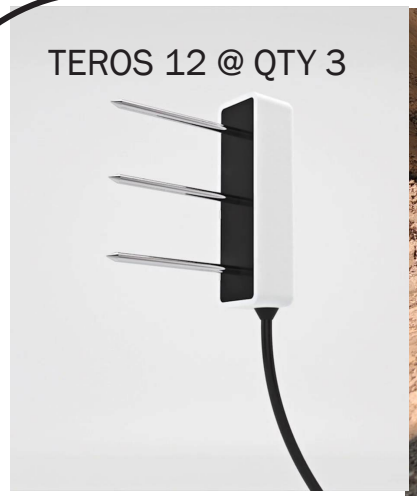
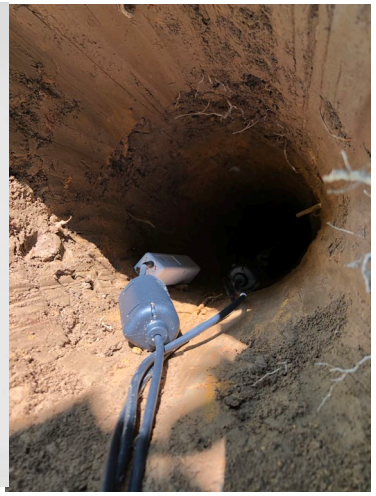
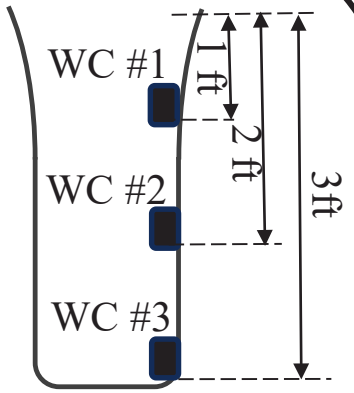
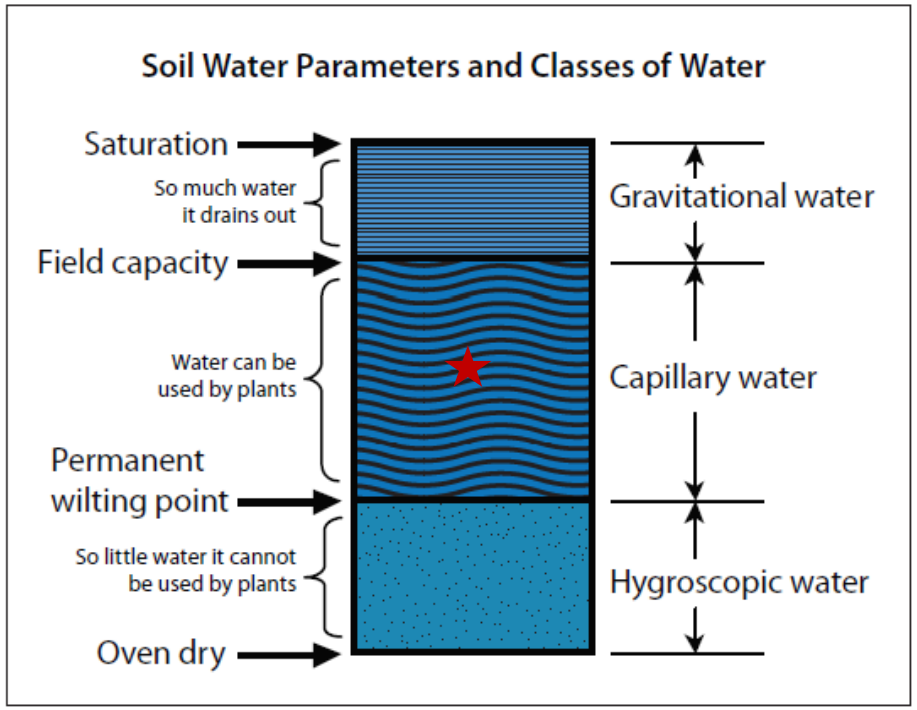
Soil Water Content









Soil Water Parameters (From: Texas A&M AgriLife Extension, E-618)

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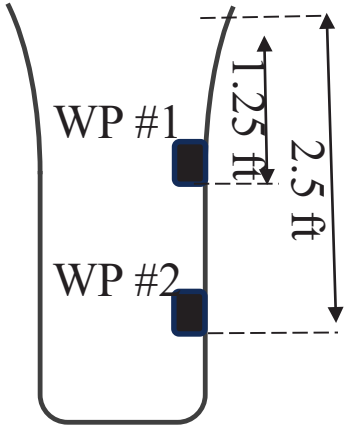
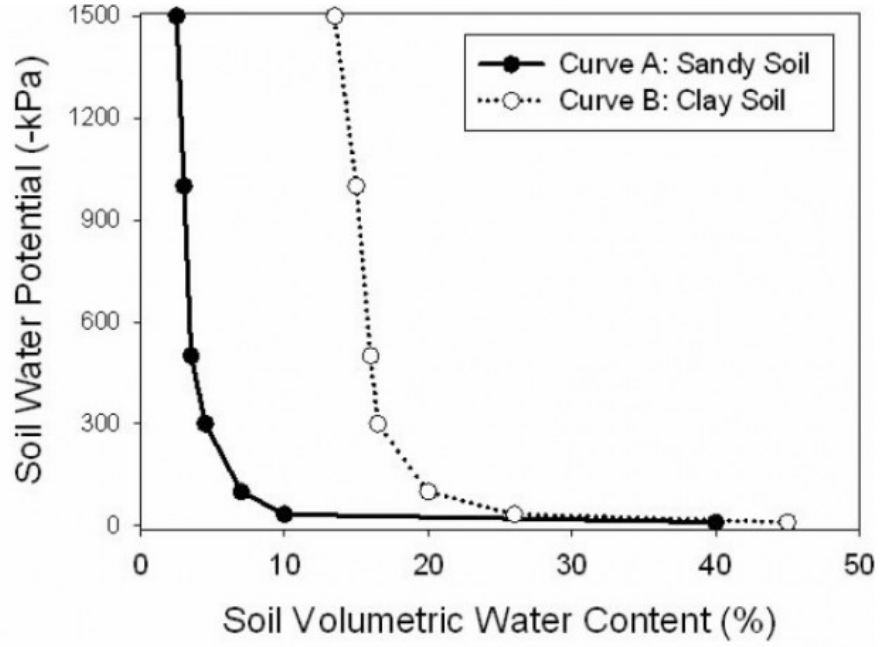
Soil Water Potential

TEROS 21 @ QTY 2





(From www.ictinternational.com)

- Water potential
- Soil temperature
- Soil type
- Precipitation

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Crop Water Stress Index

IR/t 3x (Thermal sensor) @ QTY 6

Crop Water Stress Index:

$$CWSI = \frac{\Delta T_m - \Delta T_l}{\Delta T_u - \Delta T_l}$$

- ΔT_m: Measured difference of canopy and air temperature
- ΔT_u: Difference of canopy and air temperature for non-transpiring canopy
- ΔT_l: Difference of canopy and air temperature for well-watered canopy

- Canopy Temperature
- Air temperature
- Relative humidity
- Wind speed
- Solar radiation

Results

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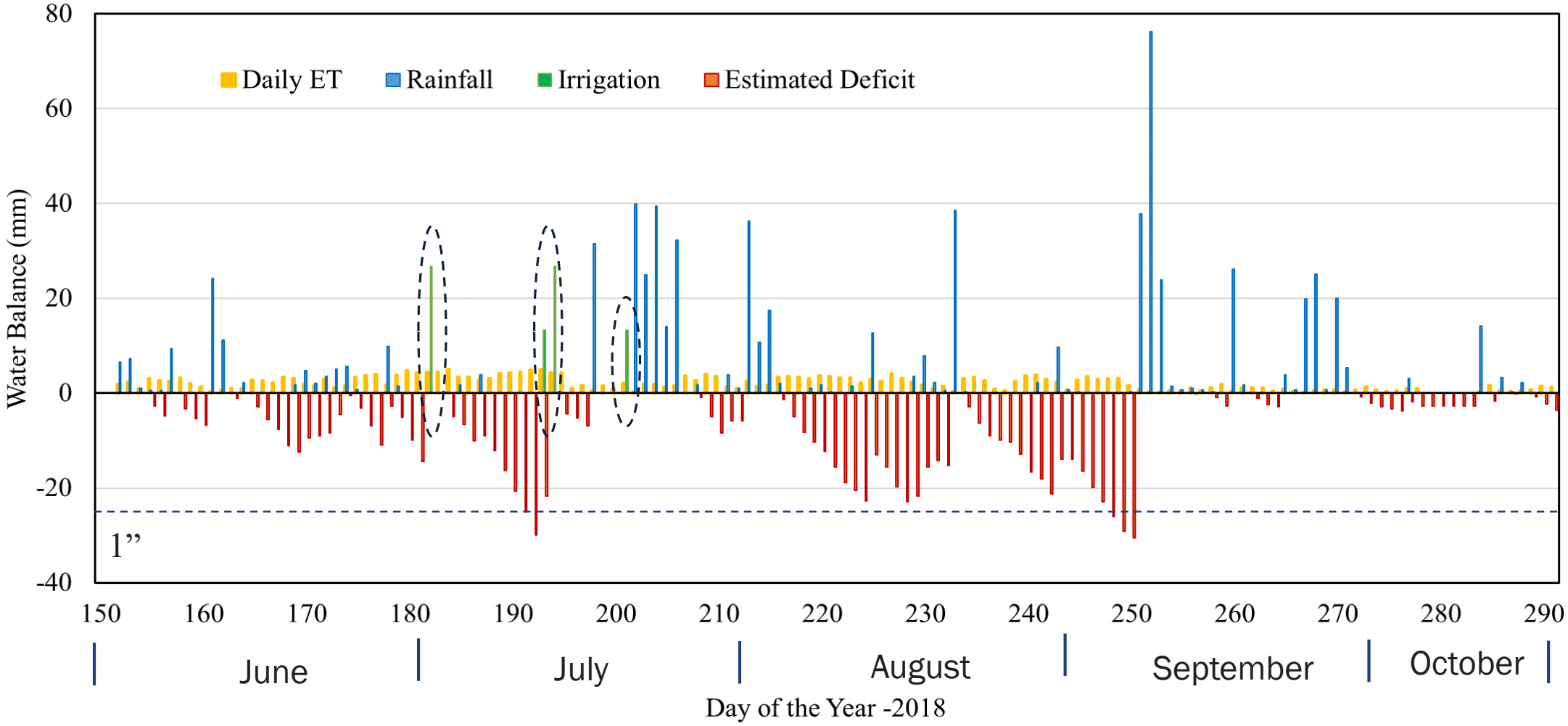
Evapotranspiration (ET)



Results

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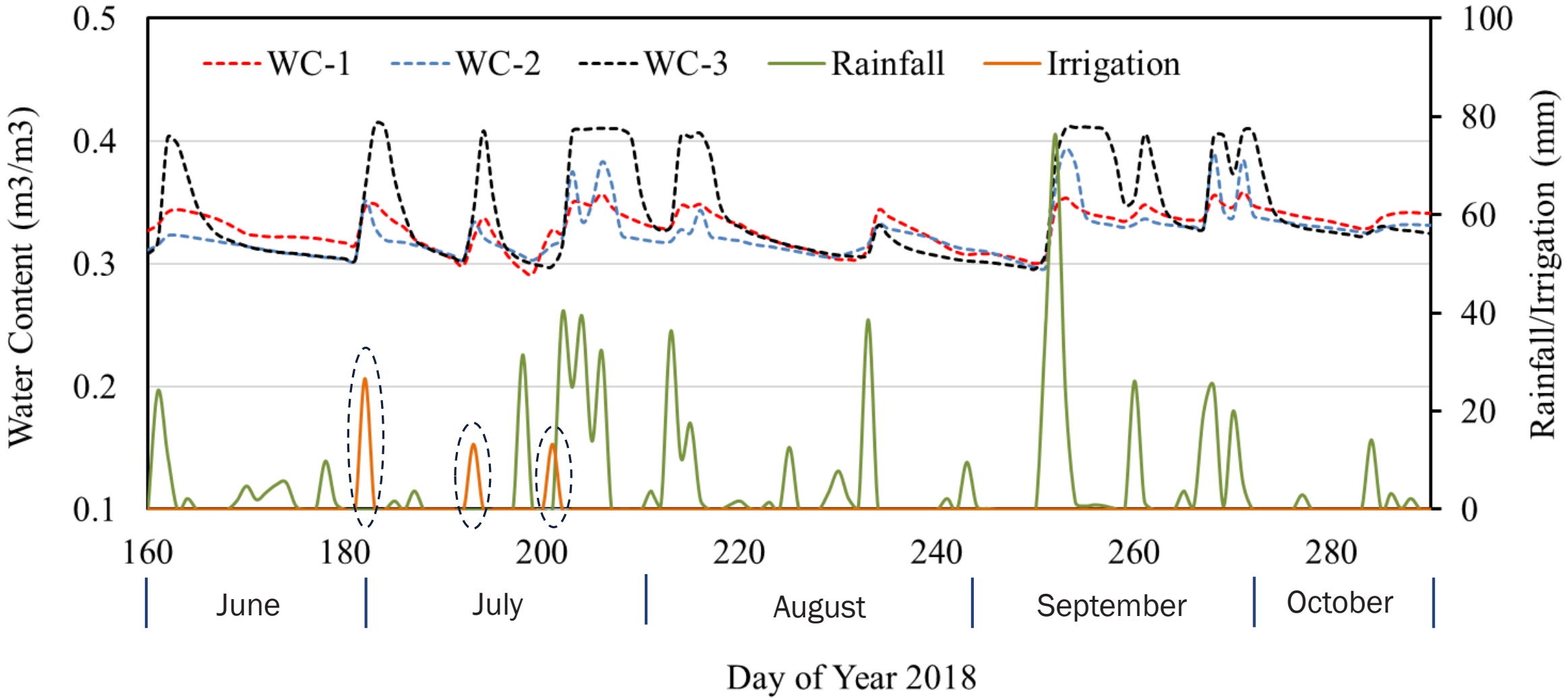
Soil Water Content



Results

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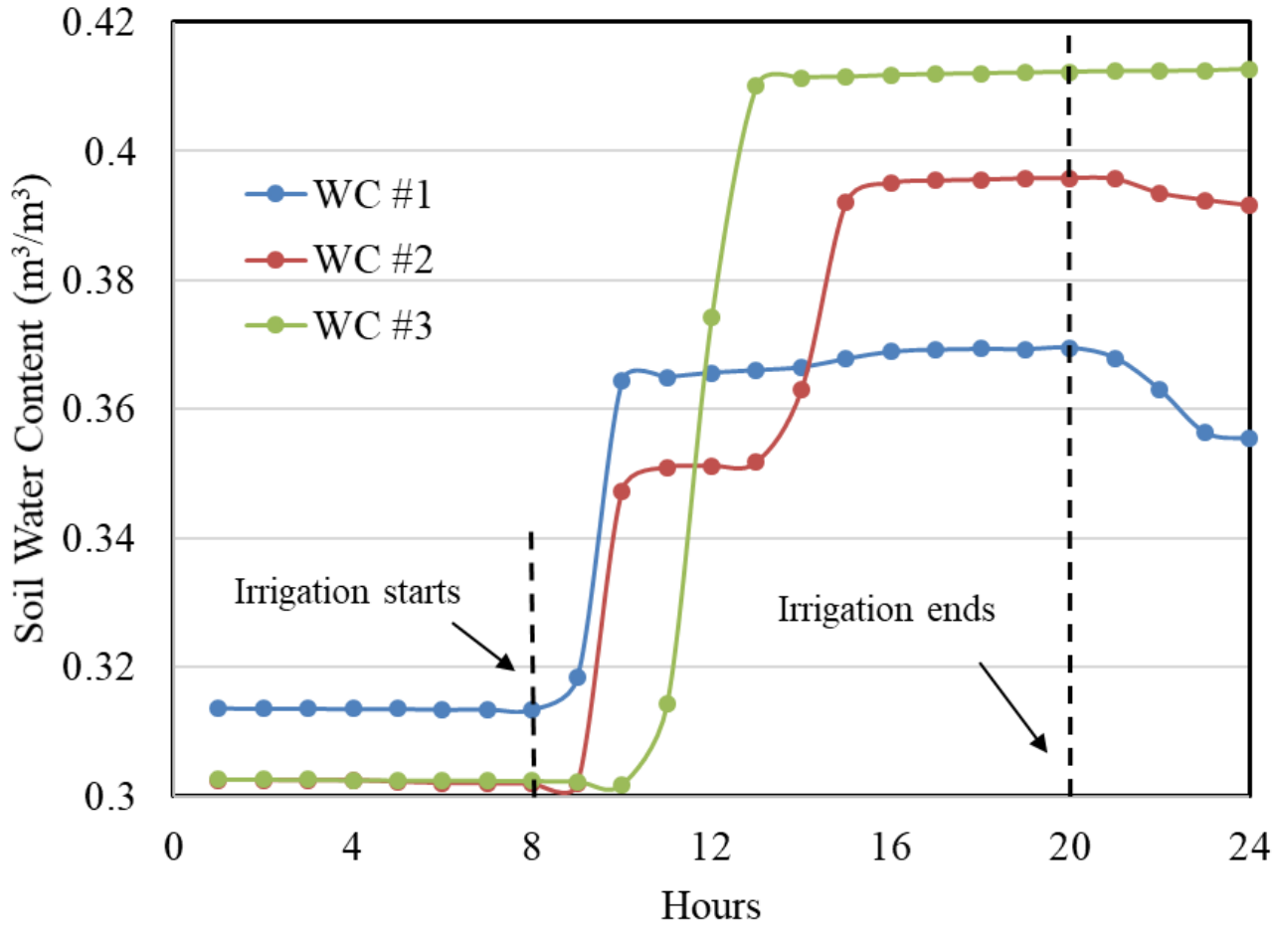
Soil Water Content (Irrigation Event)



Results

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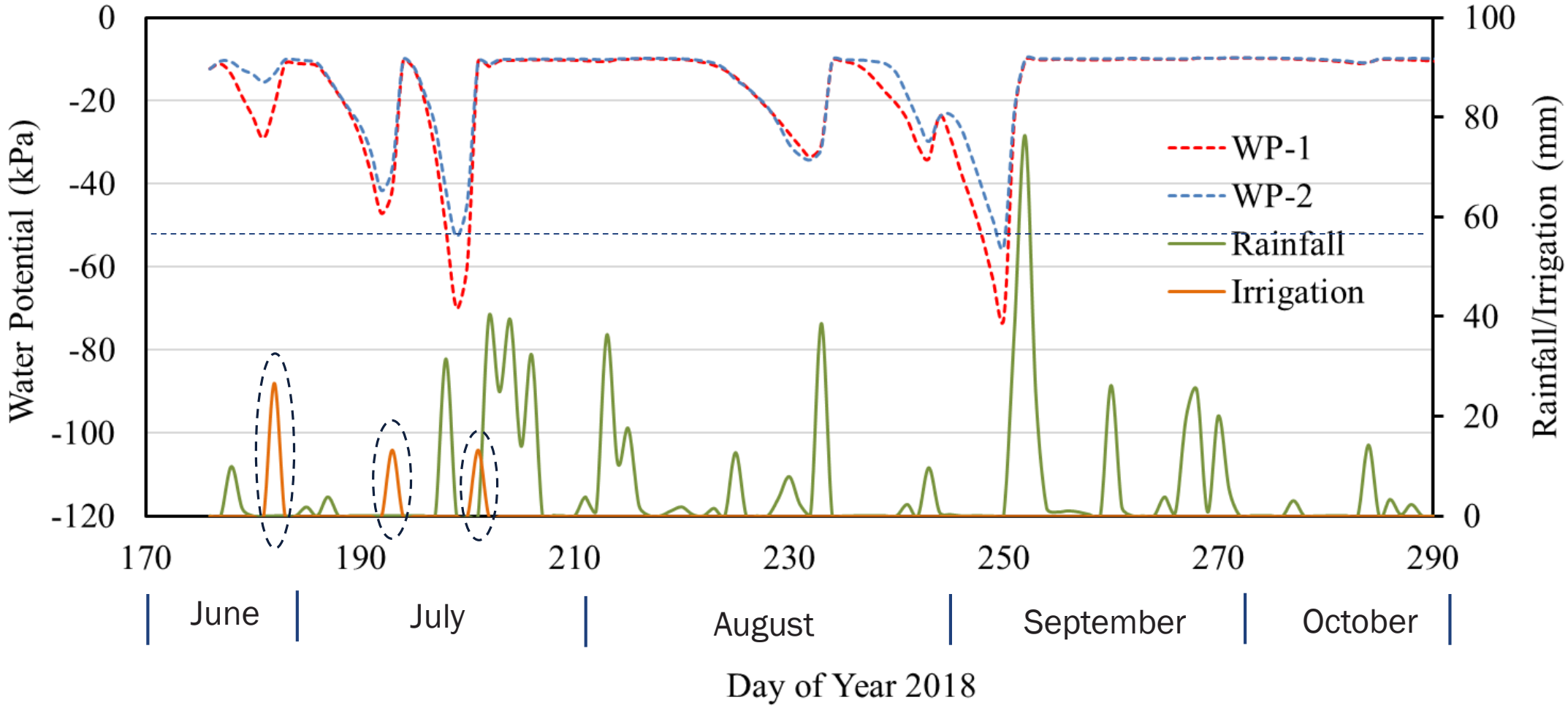
Soil Water Potential



Results

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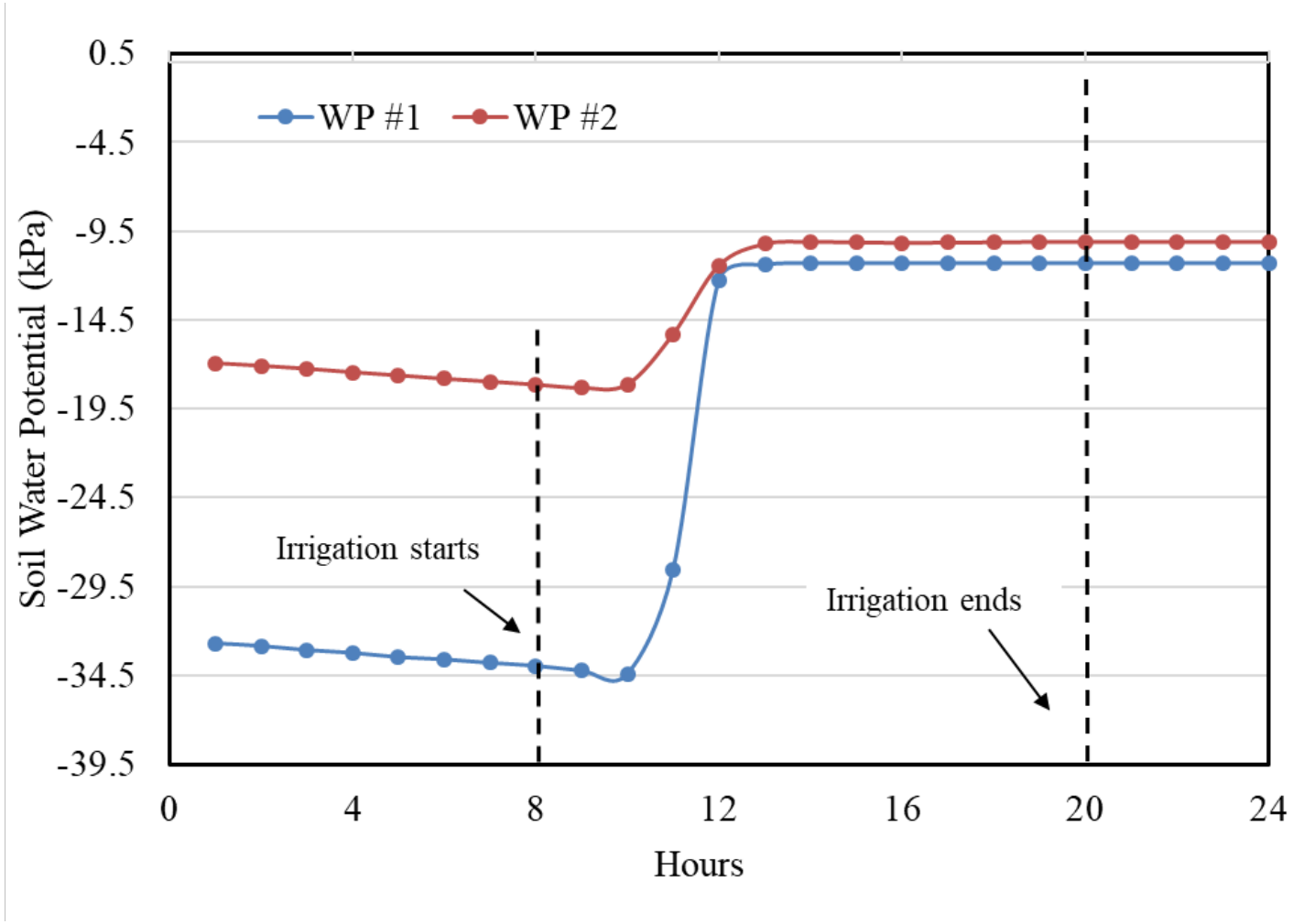
Soil Water Potential (Irrigation Event)



Results

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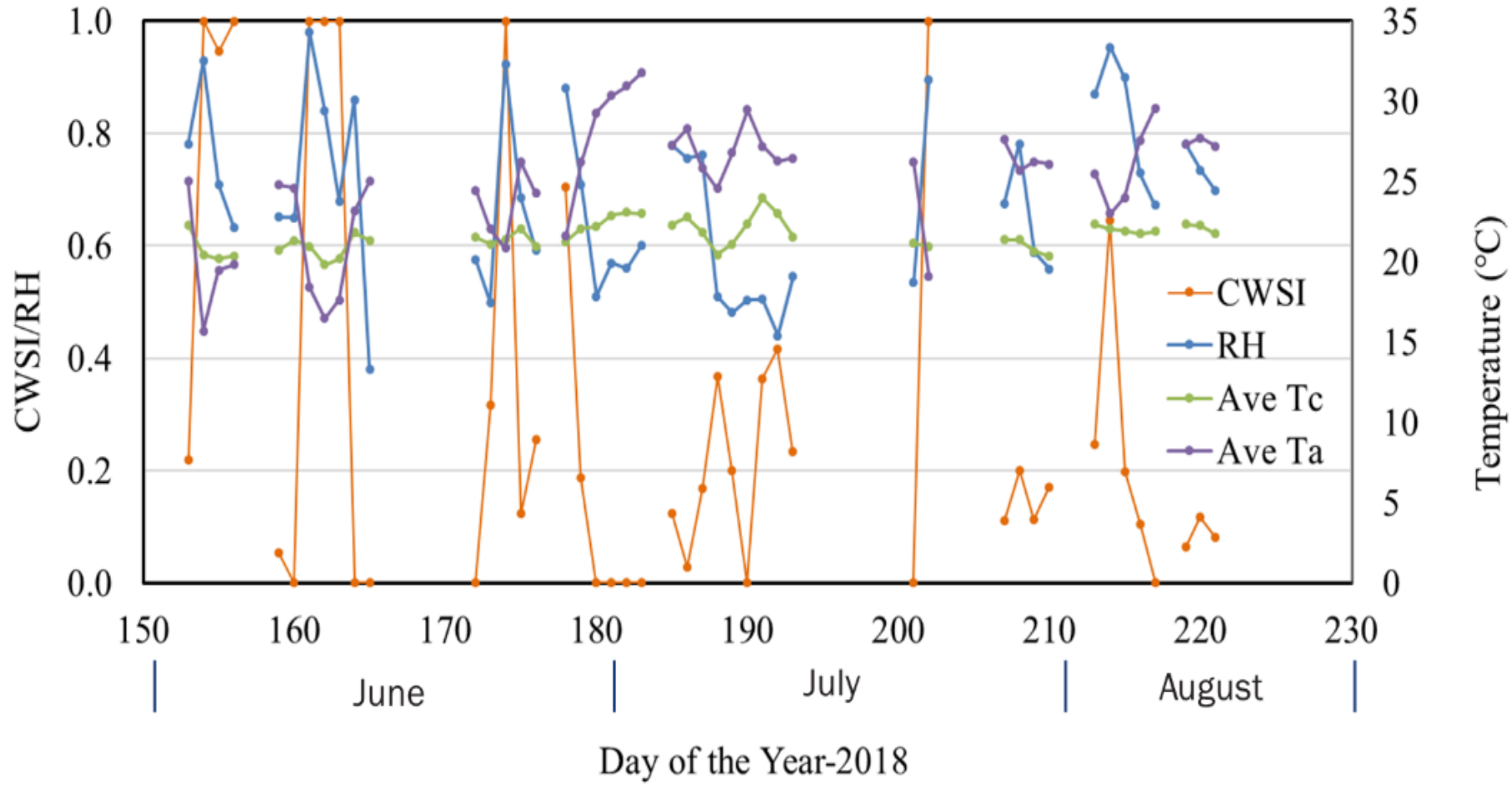
Crop Water Stress Index



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Results

	ET-Based	Soil Moisture-Based	Canopy Temperature-Based	Combination
Advantages	▪ Easy to apply ▪ No in-field sensors ▪ Low cost	▪ Direct reading of soil moisture ▪ Low cost	▪ Direct measuring plant stress ▪ Can be little bit costly	▪ ET + Soil Moisture ▪ Soil moisture + Canopy Temperature
Challenges	▪ Estimated value ▪ Accumulating error ▪ Your own weather station	▪ Root region ▪ Sensor location ▪ Soil type ▪ Real canopy stress	▪ Targeted area of sensor ▪ Climate (too humidity)	

Ongoing Studies

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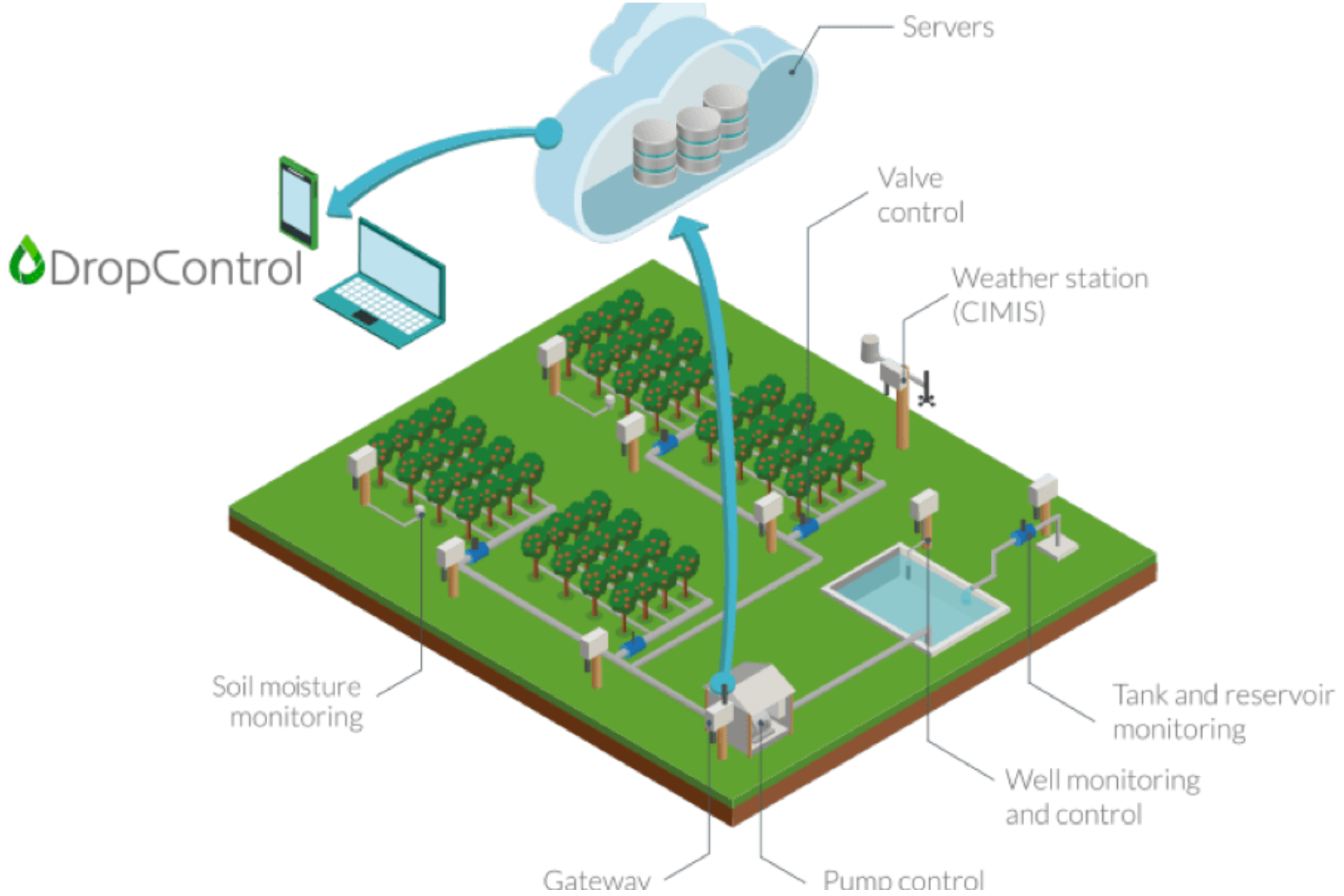
Lora-Based Smart Irrigation



https://fruitworldmedia.com/index.php/featured/automated-irrigation-systems-soon-reality-farmers-australia-tasmania/

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Thank you!

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