Methodology for Scheduling Irrigation in the Mid-Atlantic Region

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Importance of Irrigation

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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

Irrigation Methods

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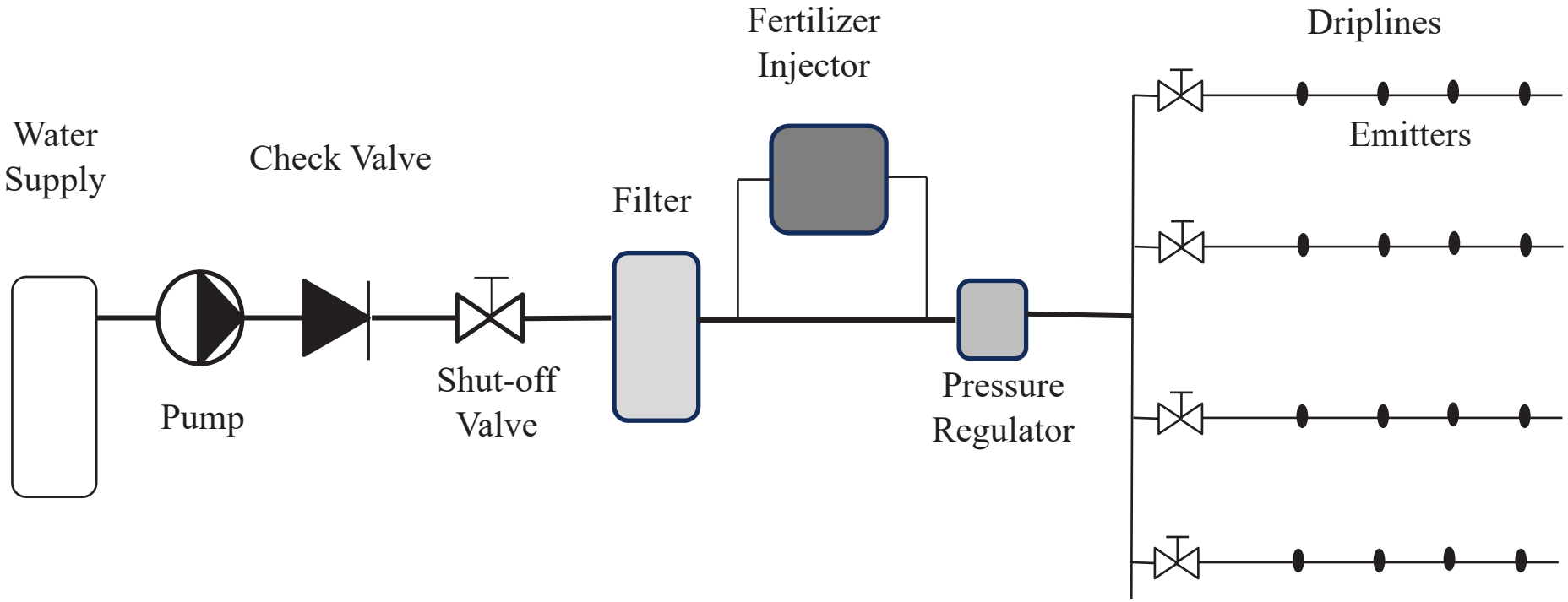
Drip Irrigation

Under Tree Sprinkler

Overhead Sprinkler

Pivot Irrigation

Drip Irrigation System



Water apply rate:

$$ApRt = 231.1 \frac{EmitterFlow}{RowSpc \times EmitterSpc}$$

Irrigation Scheduling

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Conventional method:

- Experience/observation
- Regular scheduling

Limitations:

- Not exactly reflect crop water needs
- Over irrigated or under irrigated
- Soil nutrients loss

From Google Image

More Precise Irrigation Scheduling Method Is Needed!

Precision Irrigation

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When to Irrigate?

How much to Irrigate?

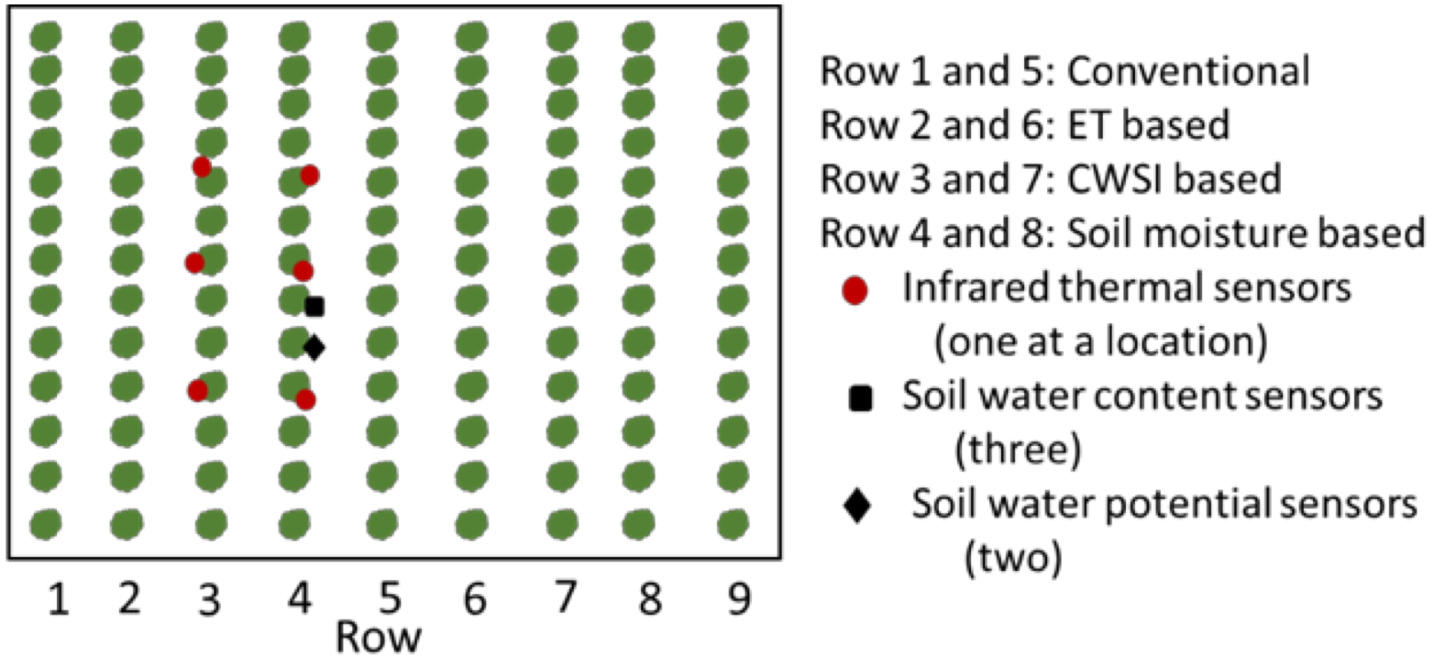
Consideration:

- Accuracy
- Initial cost
- Installation
- Data accessibility
- Compatible with Farm Practices
- Labor and energy saving
- Production improvement

Our Studies

Sensor-based irrigation scheduling

Orchard for test – Tall spindle Fuji trees



Schematic illustration of the experimental setup

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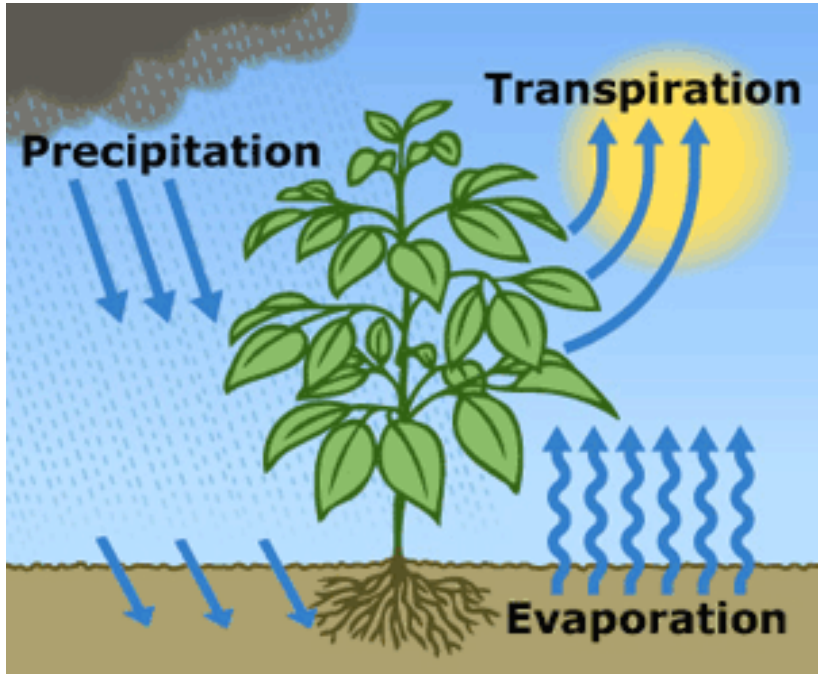
Evapotranspiration (ET)-Based Irrigation



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.

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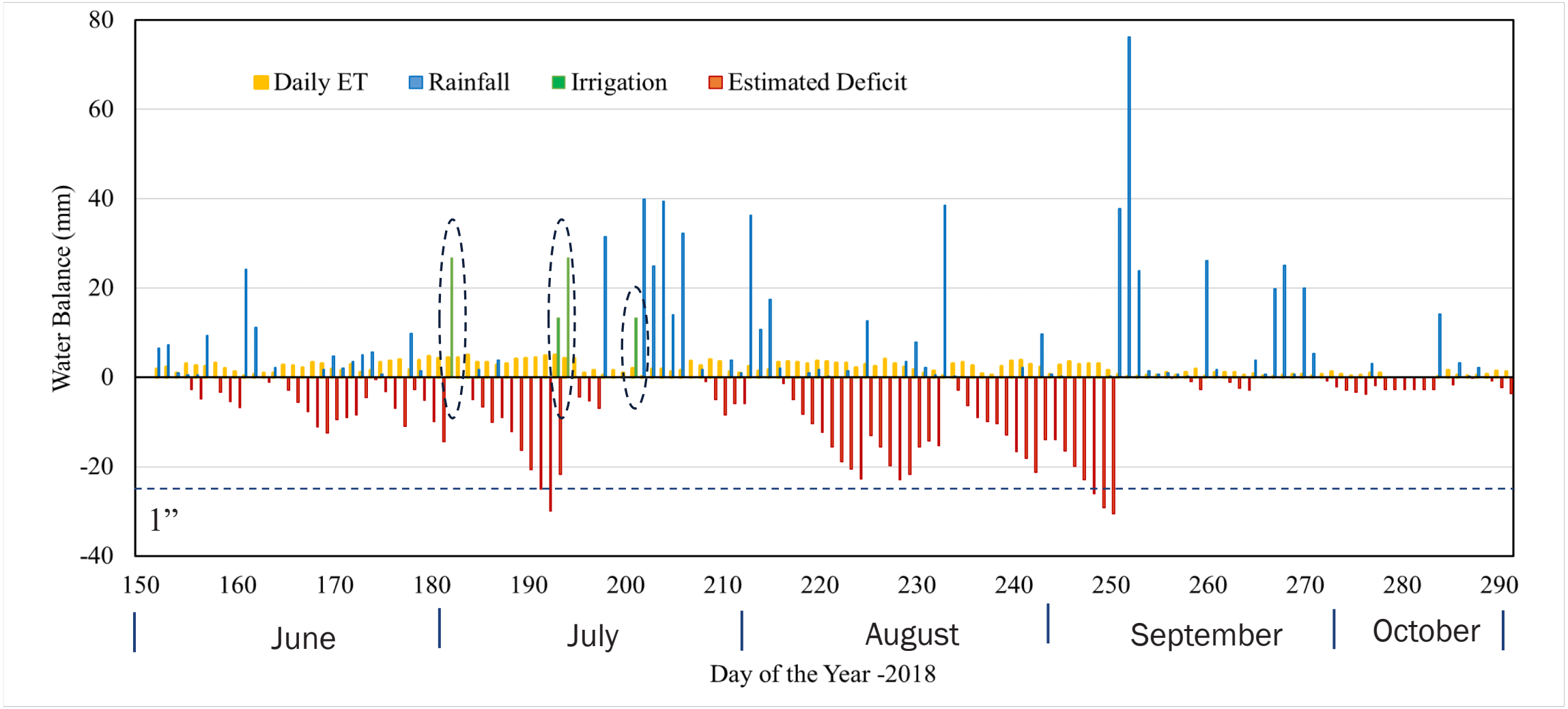
Evapotranspiration (ET)-Based Irrigation



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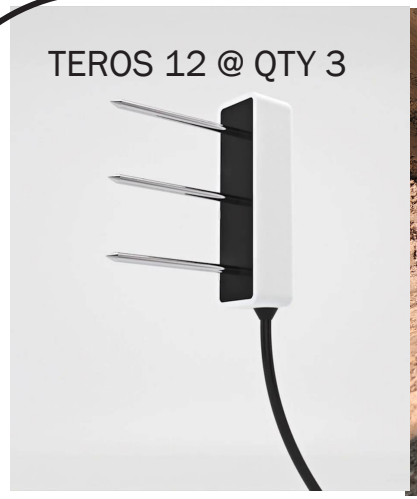
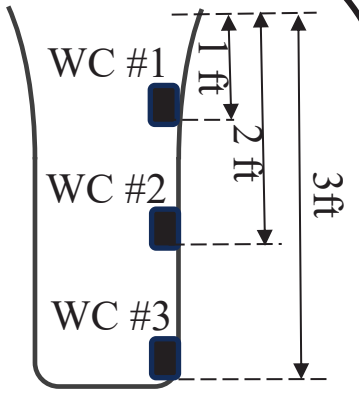
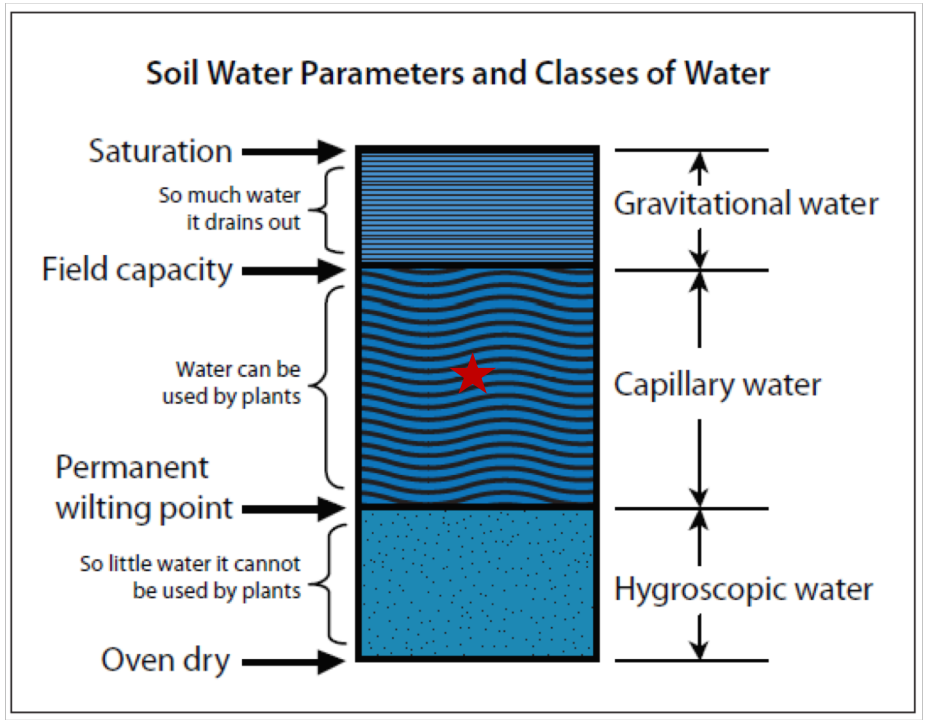
Soil Water Content–Based Irrigation







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

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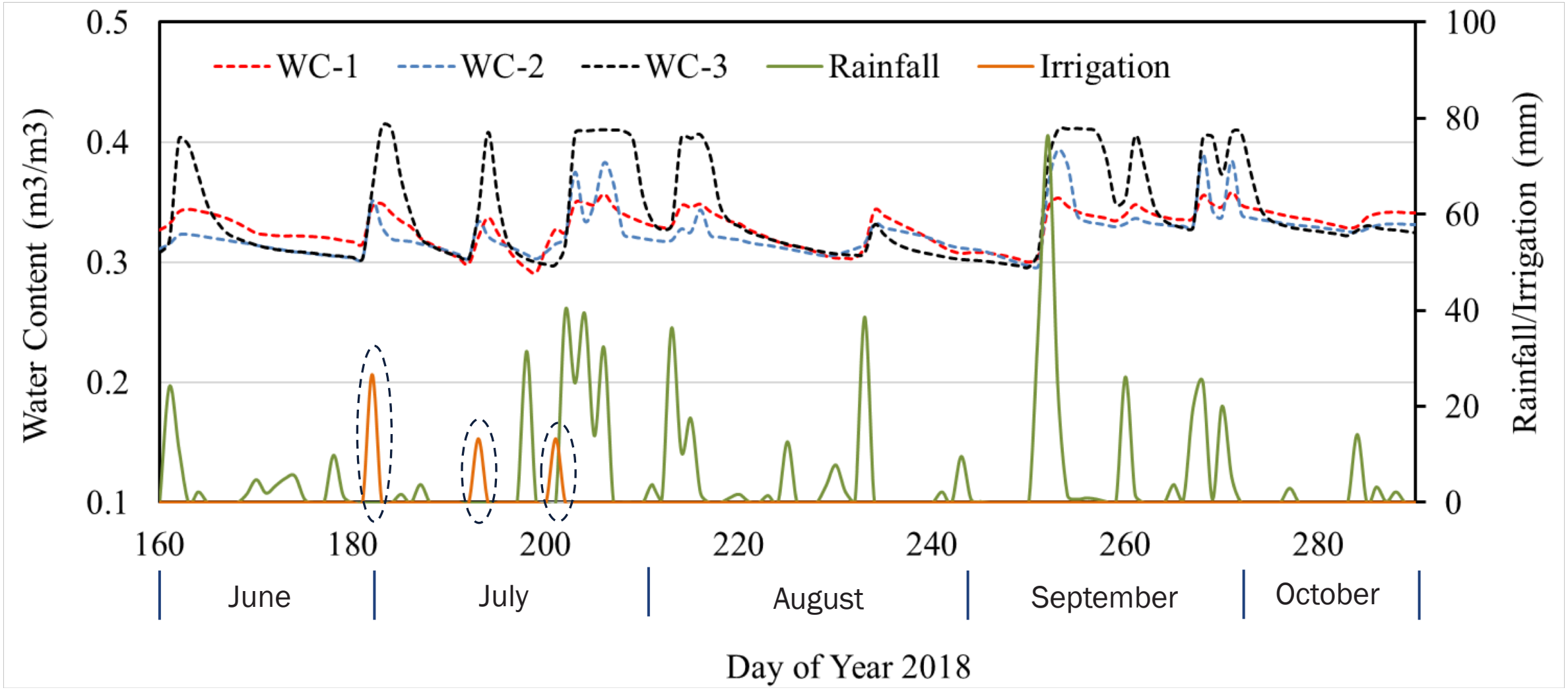
Soil Water Content–Based Irrigation



Precision Irrigation

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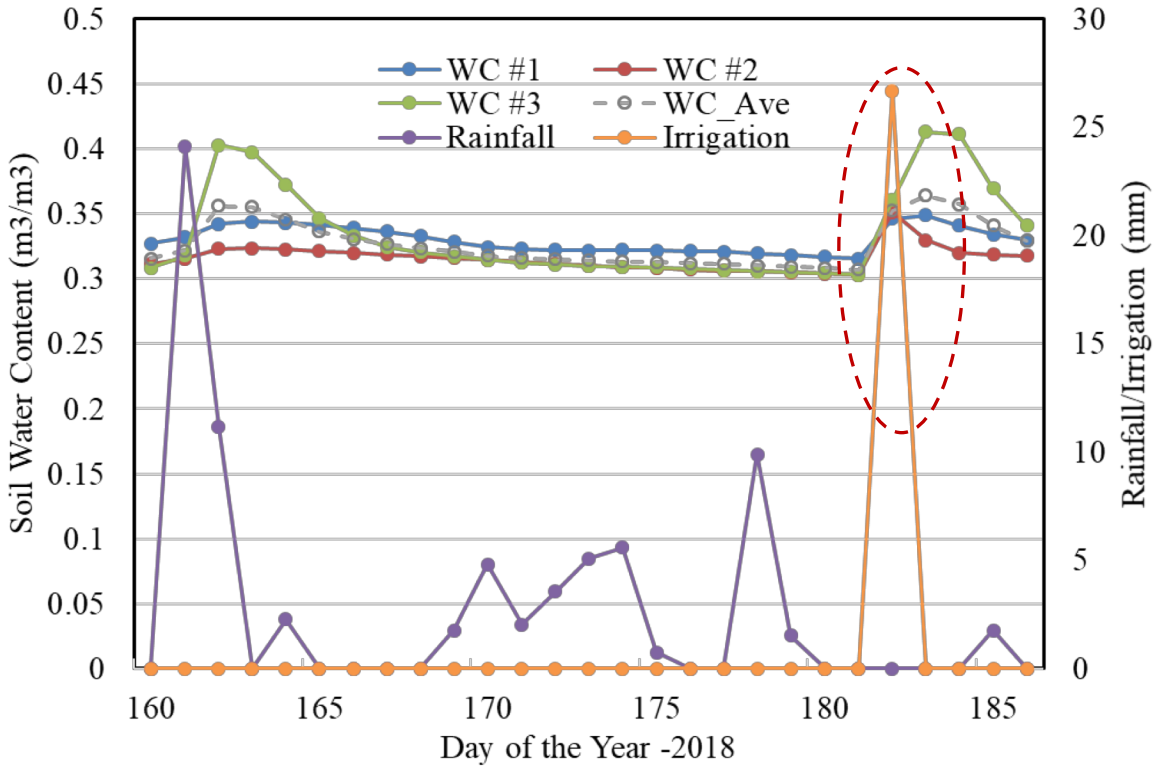
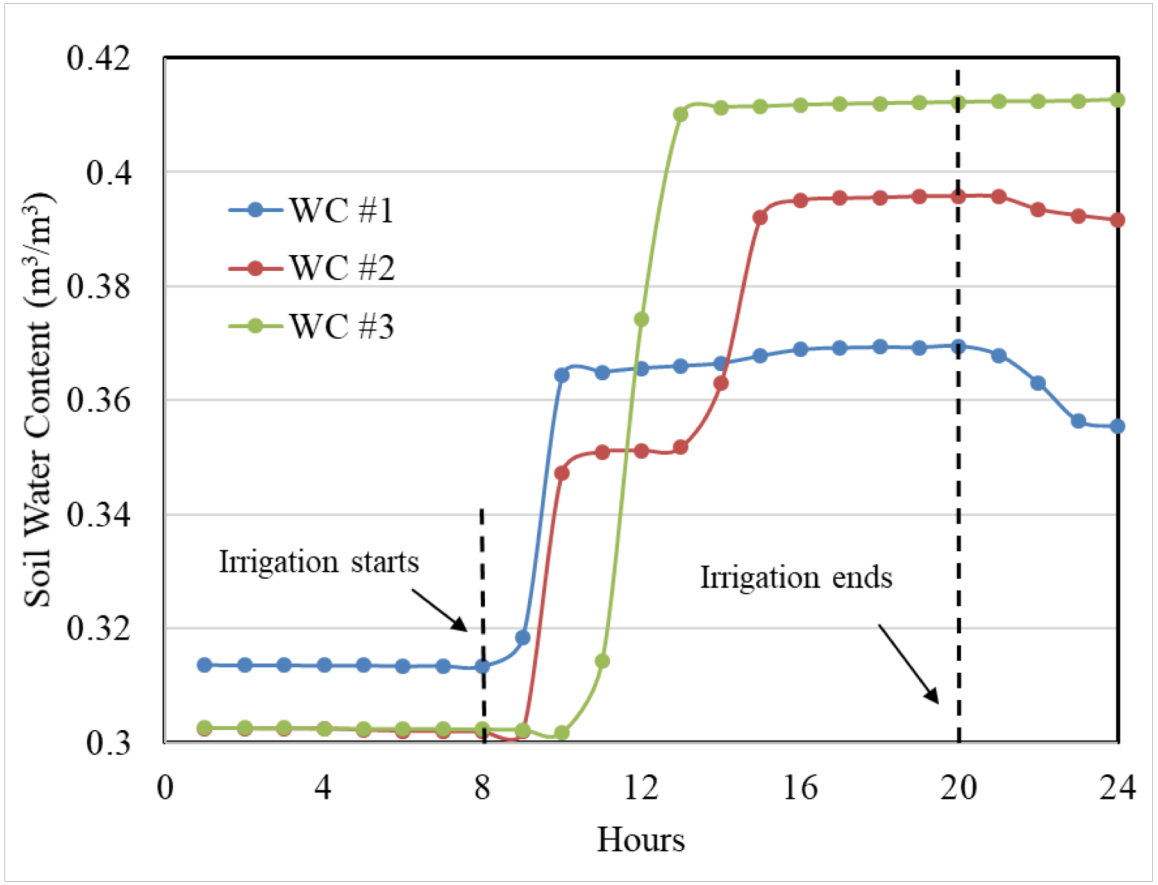
Soil Water Content–Based Irrigation





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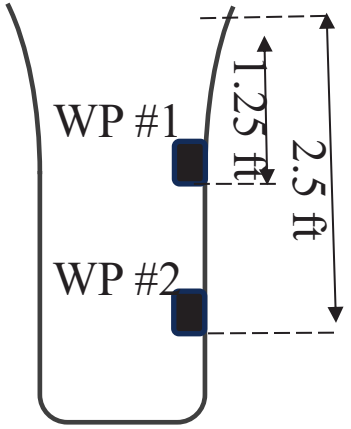
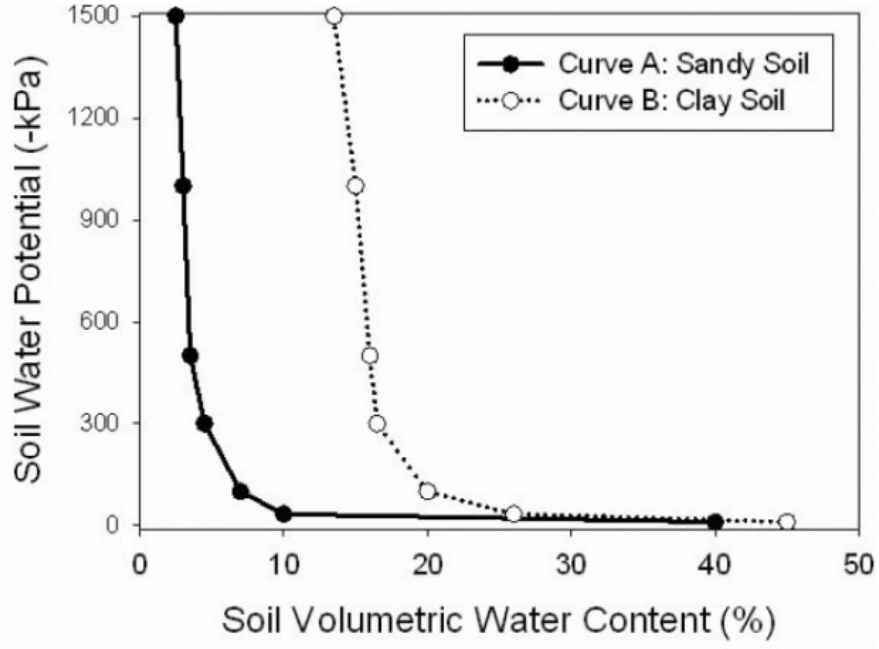
Soil Water Potential-Based Irrigation

TEROS 21 @ QTY 2





(From www.ictinternational.com)

- Water potential
- Soil temperature
- Soil type
- Precipitation

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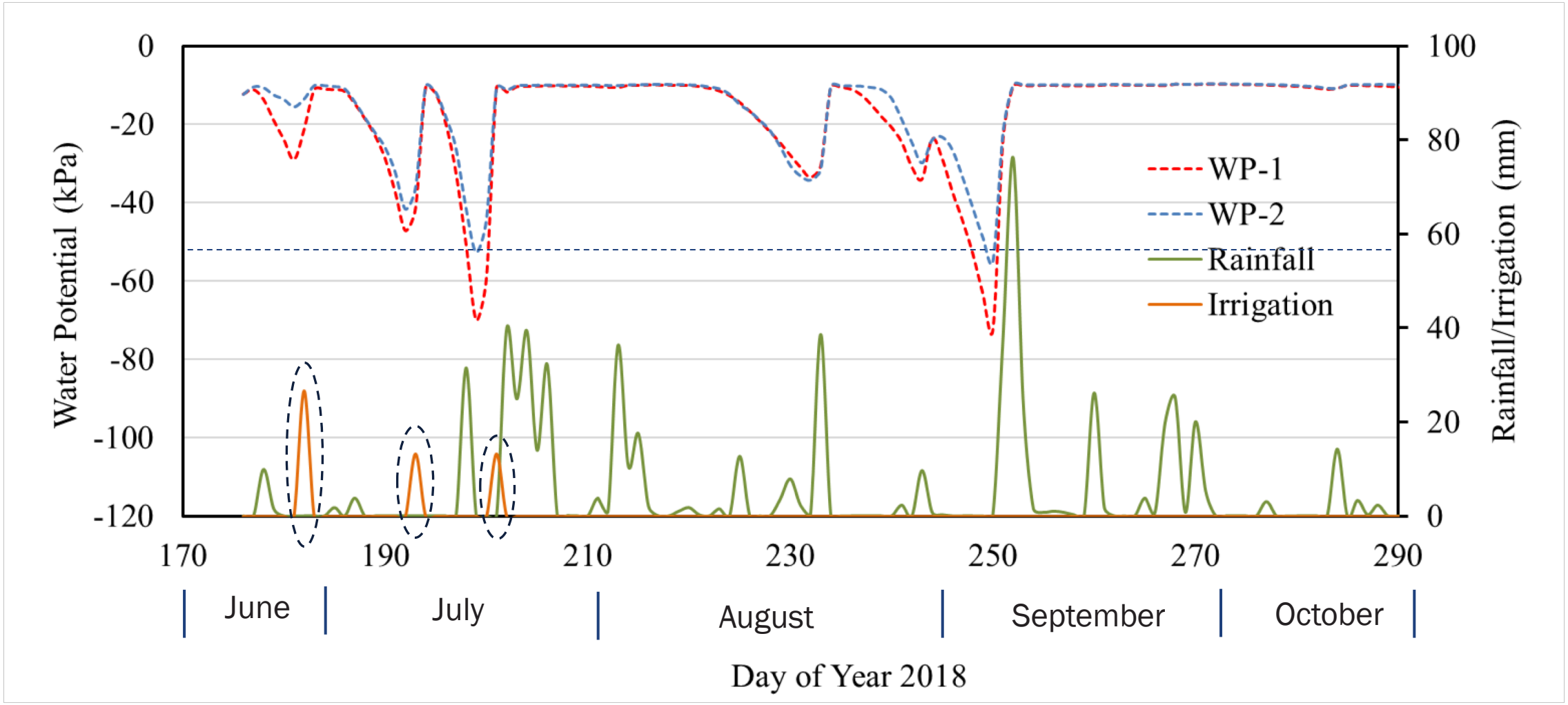
Soil Water Potential-Based Irrigation



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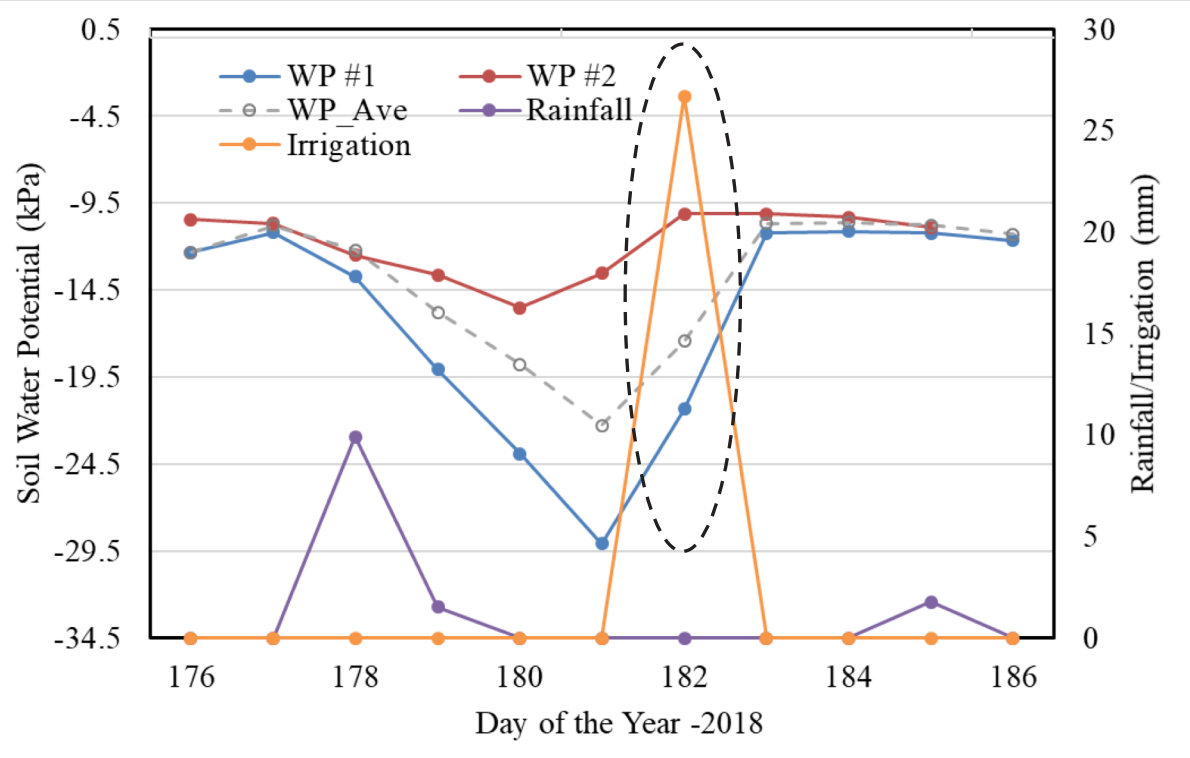
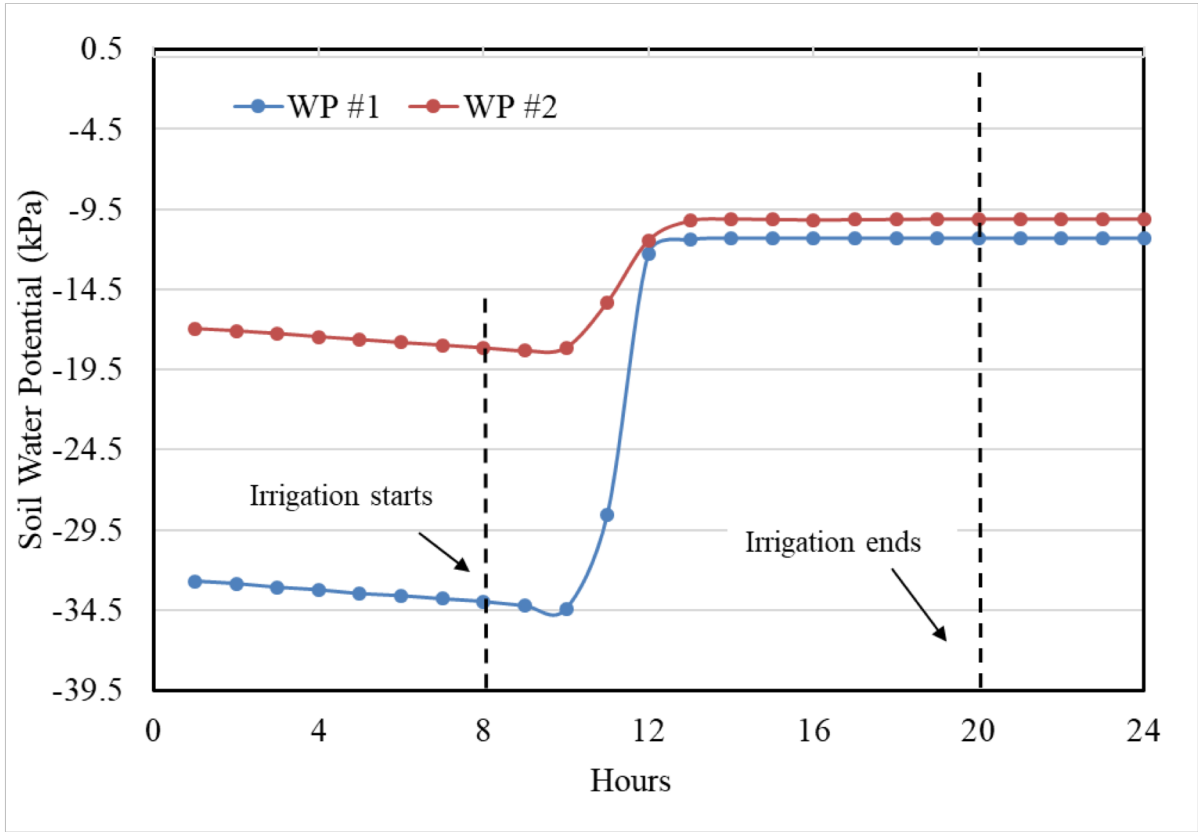
Soil Water Potential – Based Irrigation





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Canopy Temperature– Based Irrigation

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

Crop Water Stress Index:

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

- 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

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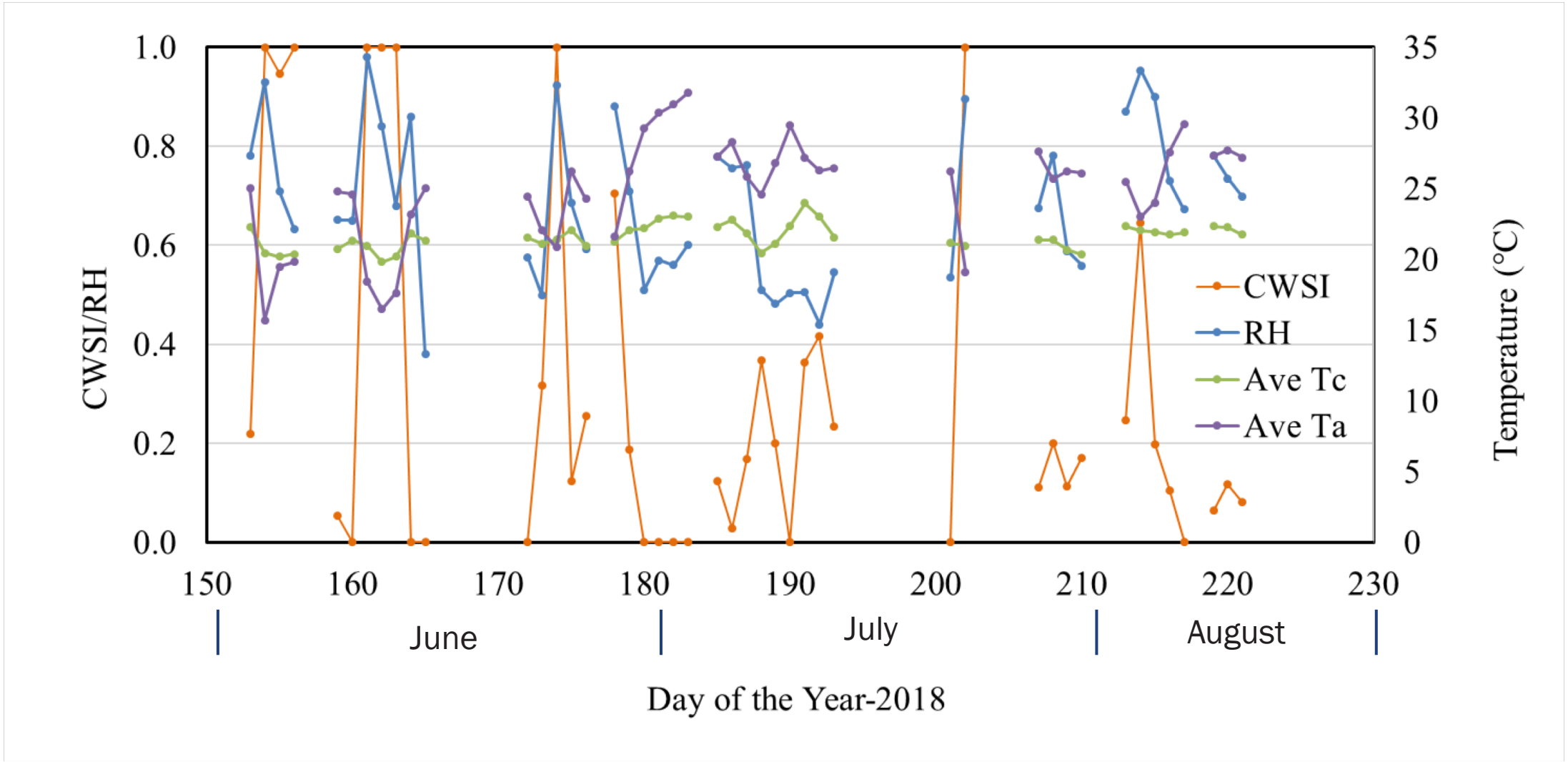
Canopy Temperature–Based Irrigation



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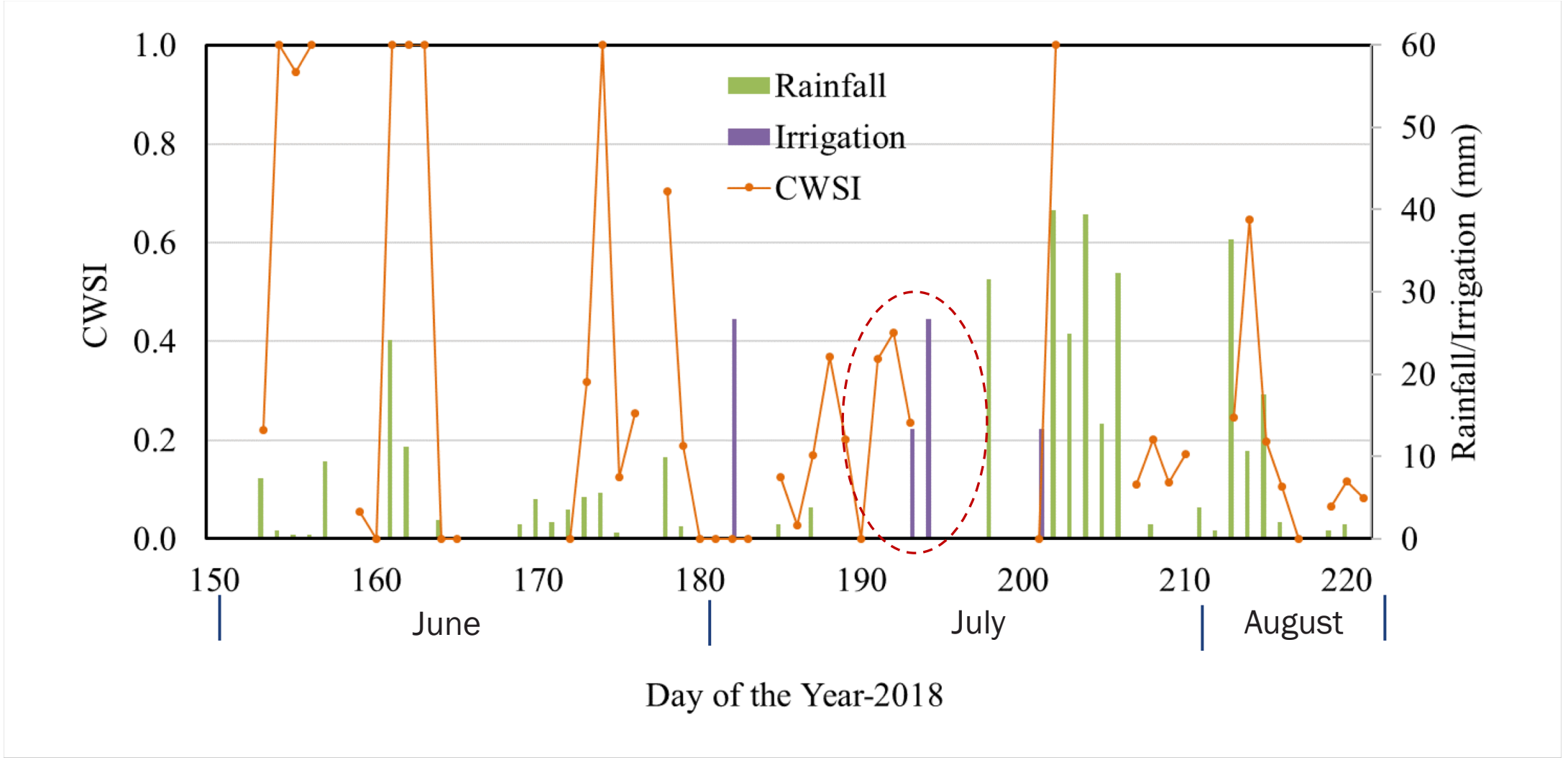
Canopy Temperature–Based Irrigation



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Comparation of the Tested Methods

	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)	

Water use?

Crop production?

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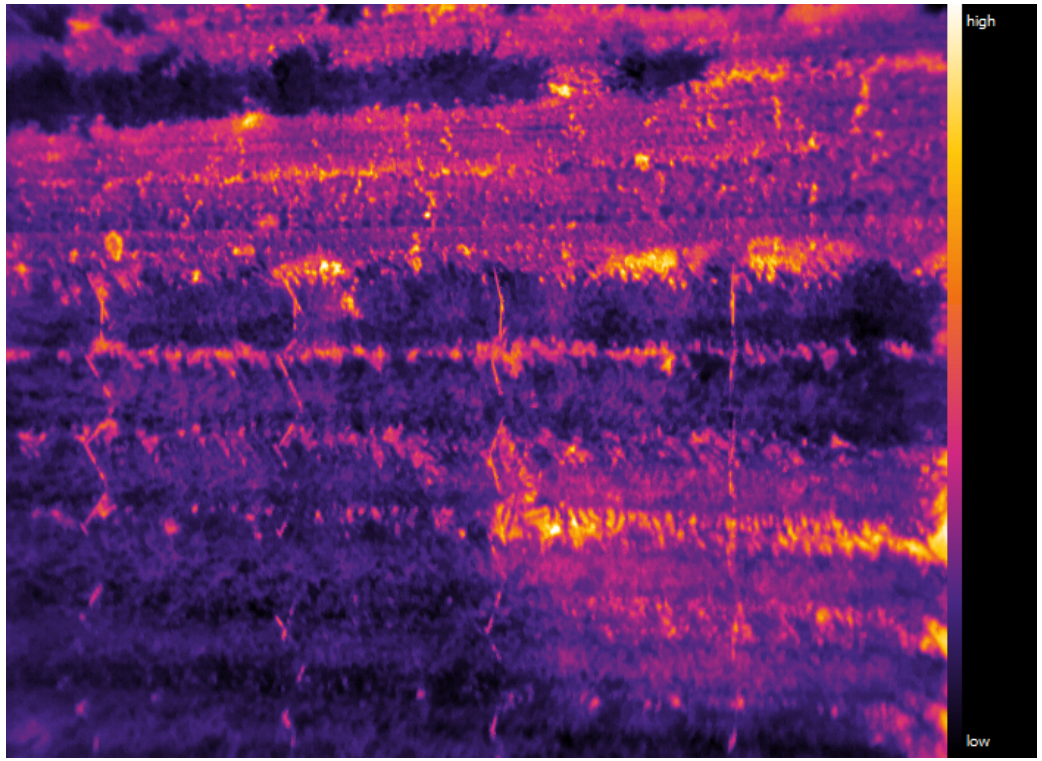
UAV-Based Sensing for Irrigation



UAV based thermal images

NDVI (Near Infrared and RGB) for crop water stress?

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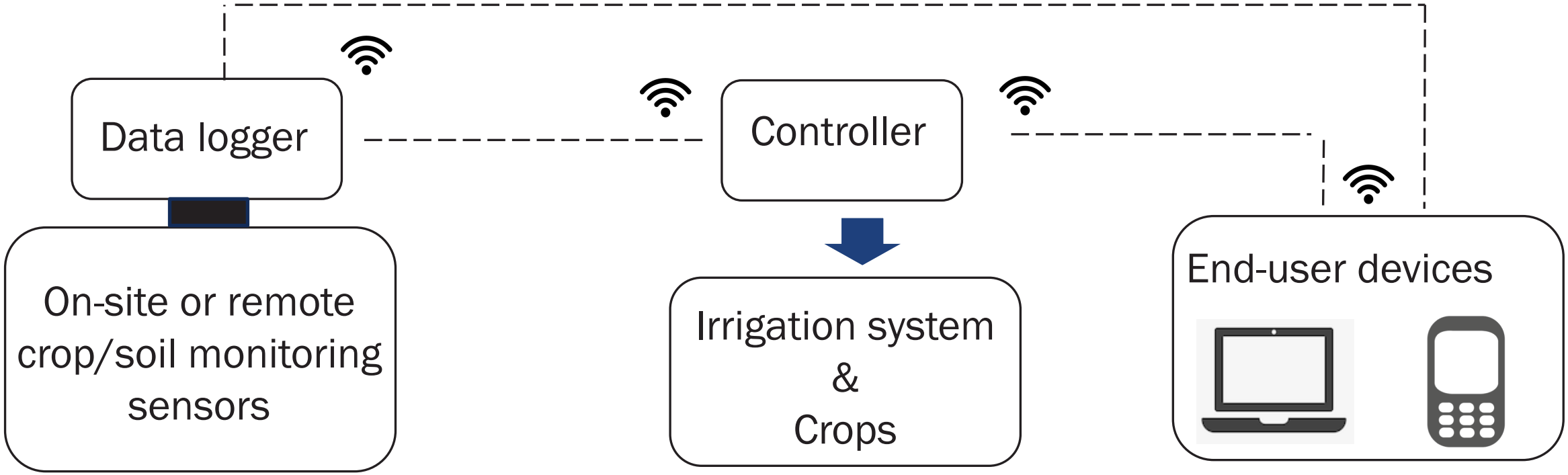
Automated Irrigation system with Real-Time Monitoring



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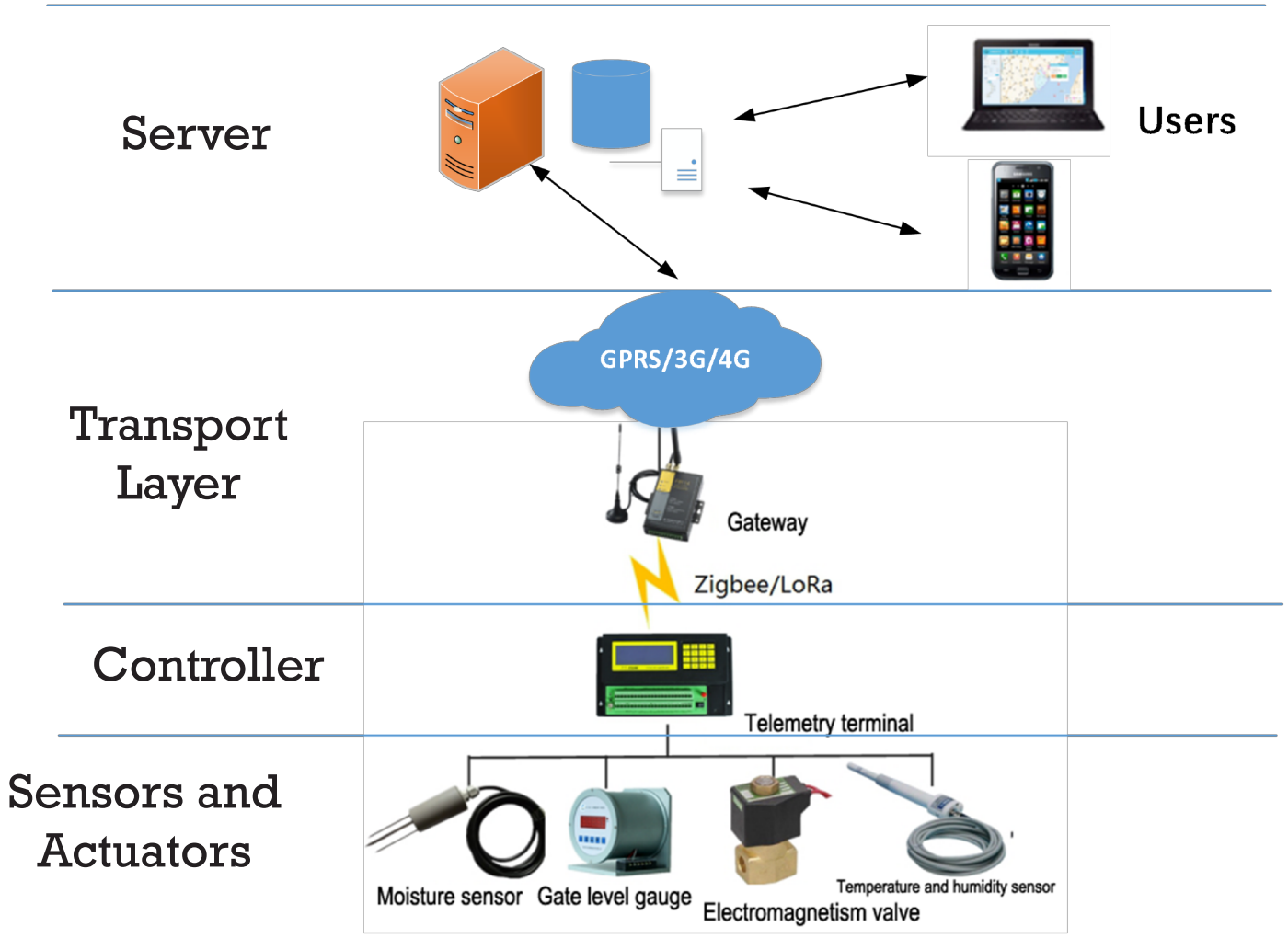
An Example of Remote Control/Communication System



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Thank you !

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