Irrigation Scheduling Using ET and Soil-Based Methods

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Irrigation Control Systems

- Control
  - Timers

Irrigation is applied based on a fixed, predetermined schedule
Irrigation Control Systems

- Control
  - Timers
  - Sensors

Moisture sensing devices
e.g., Tensiometers

Graphic: L. Oki
Irrigation Control Systems

- Control
  - Timers
  - Sensors

Moisture sensing devices e.g., Tensiometers
Soil Moisture-Based Irrigation

Graphic: L. Oki
Irrigation Control Systems

- Control
  - Timers
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Photo: L. Oki
Irrigation Control Systems

• Control
  – Timers
  – Sensors

Photo: L. Oki
Irrigation Control Systems

- **Control**
  - Timers
  - Sensors

Tensiometers
Granular matrix (gypsum blocks)
Time domain reflectometry (TDR)
Dielectric permittivity

Conductance-based sensors are NOT appropriate

Photo: L. Oki
Irrigation Control Systems

- **Control**
  - Timers
  - Sensors
  - Water use models

- Based on weather data
- Requires previous research
- Crop specific
- Easy to use
Irrigation Control Systems

- **Control**
  - “Hand”
  - Timers
  - Sensors
  - **Water use models**

- Light accumulation
- Evapotranspiration (ET) “weather-based”
Modified Penman-Montieth

Reference ET ($ET_0$) is calculated based on weather data

$$ET_0 = \frac{\Delta (R_n - G)}{\lambda [\Delta + \gamma (1 + C_d u_2)]} + \frac{37}{\Delta + \gamma (1 + C_d u_2)} \frac{u_2(e_s - e_a)}{T_a + 273.16}$$

$ET_0$ = grass reference evapotranspiration (mm h$^{-1}$)
$\Delta$ = slope of saturation vapor pressure curve (kPa °C$^{-1}$) at mean air temperature (T)
$R_n$ = net radiation (MJ m$^{-2}$ h$^{-1}$)
$G$ = soil heat flux density (MJ m$^{-2}$ h$^{-1}$)
$\gamma$ = psychrometric constant (kJ m$^{-2}$ h$^{-1}$)
$T_a$ = mean hourly air temperature (°C)
$u_2$ = wind speed at 2 meters (m s$^{-1}$)
$e_s$ = saturation vapor pressure (kPa) at the mean hourly air temperature (T) in °C
$e_a$ = actual vapor pressure (kPa) at the mean hourly air temperature (T) in °C
$\lambda$ = latent heat of vaporization in (MJ kg$^{-1}$)
$C_d$ = bulk surface resistance and aerodynamic resistance coefficient
Irrigation Control Systems

- Control
  - Water use models

CIMIS

California Irrigation Management Information System

Water use reports are used with a crop or landscape coefficient to estimate site water use.

http://wwwcimis.water.ca.gov/cimis/
Irrigation Control Systems

• Control
  – Water use models

CIMIS

• Reference ET ($ET_0$) is reported
Irrigation Control Systems

- **Control**
  - Water use models

**CIMIS**

- Reference ET ($ET_0$) is reported
- Crop coefficient ($K_c$) is necessary
- Determine $ET_{crop}$ ($ET_c$) to estimate crop water use
  
  $$ET_c = ET_0 \times K_c$$
  
- Can this system be utilized in an urban landscape?
- Water budgets are now required in new larger landscapes.
Irrigation Control Systems

- Control
  - Water use models

Weather-based control

- Weather information
  - Weather station
  - Telephone, internet
  - Wireless
- Landscape information
  - Location
  - Area, size
  - Plant composition
  - Soil type, Slope, Aspect, others
Irrigation Control Systems

• Control
  – Water use models

Weather-based control
  • Determine program for driest month
    • Modify for wetter months
    • Duration
    • Frequency
ET₀ Zones Map

Reference EvapoTranspiration (ET₀) Zones

Monthly Average Reference Evapotranspiration by ET₀ Zone (inches/month)
Irrigation Control Systems

• Things to do
  • Group plants of similar water requirements within an irrigation zone (hydrozones)
  • Obtain information on plant water use
    • WUCOLS

www.water.ca.gov/wateruseefficiency/docs/wucols00.pdf
Irrigation Control Systems

• WUCOLS
  • Water Use Classifications of Landscape Species
  • Landscape Coefficient Method

www.water.ca.gov/wateruseefficiency/docs/wucols00.pdf
Irrigation Control Systems

• SLIDE
  • Simplified Landscape Irrigation Demand Estimator

• Start with $K_p = 0.5$
• Further modify based on morphological characteristics
  • Leaf area
  • Leaf size
  • Color
  • Others
Thank you
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