CROPWAT

CROP WATER REQUIREMENT AND IRRIGATION SCHEDULING

FAO CROPWAT model

- CROPWAT is a computer programme that can calculate crop water and irrigation requirements
- Model is based on a water balance model
- Net Irrigation Water Requirement:

$$IR_n = ET_c - (Pe + Ge + Wb) + LR_{mm}$$

IRn = Net Irrigation Requirement (mm)

Etc = Crop evapotranspiration (mm)

Pe = Effective dependable rainfall (mm)

Ge = Ground water contribution from water table (mm)

Wb = Water stored in the soil at the beginning of each period (mm)

LRmm = Leaching requirement (mm)

Overview

Data	Input	Output
Climatic	▪ Monthly means of min. and max. temperature, relative humidity, sunshine duration, wind speed ▪ Rainfall data Monthly	✓Reference Evapotranspiration ✓ crop water requirement irrigation requirement ✓ Actual crop Evapotranspiration ✓ Soil moisture deficit ✓ Estimated yield reduction due to crop Stress ✓ Irrigation scheduling
Crop	▪ Kc, crop description, max. rooting depth, % area covered by plant	
Soil	▪ Initial soil moisture condition and available soil moisture	
Irrigation	▪ Irrigation scheduling Criteria	

Reference Evapotranspiration

- ETo can be calculated from meteorological data
- FAO Penman-Monteith method is now recommended as the sole standard method for the definition and calculation of the reference crop evapotranspiration

$$ET_o = \frac{0.408\,\Delta\,(R_n - G) + \gamma\,\frac{900}{T + 273}\,u_2\,(e_s - e_a)}{\Delta + \gamma\,(1 + 0.34\,u_2)}$$

- Input data required : Temperature(max and min), wind speed, humidity, sunshine hours

Effective Rainfall

- To account for the losses due to runoff or percolation, a choice can be made of one of the four methods given in CROPWAT 8.0
  - Fixed percentage
  - Dependable rain
  - Empirical formula
  - USDA Soil Conservation Service
- It is suggested to select the Option “Fixed percentage” and give 80% as requested value.

Crop Evapotranspiration

- Characteristics that distinguish field crops from grass are integrated into the crop coefficient(Kc).
- Crop Evapotranspiration (ETc) = Kc * Eto
- ETo represents an index of climatic demand
- Kc varies predominately with the specific crop characteristics
- Kc represents an integration of the effects of four primary characteristics that distinguish the crop from reference grass : Crop height, Albedo, Canopy Resistance, Evaporation from soil.
- Kc for a given crop will vary over the growing period(initial, crop development, mid-season and late season)

Estimation of Kc value : Refer Pereira et al 1998

Crop and soil data required:

- Kc values for each stage
- Length of each stage
- Rooting depth of each stage
- Critical depletion fraction : normally vary between 0.4 and 0.6
- Yield Response : Ky is a factor to estimate yield reductions due to water stress
- Total available soil moisture content = FC – PWP
- Initial soil moisture depletion : Default value of 0 % represents a fully wetted soil profile at FC
- Maximum rooting depth
- Maximum rain infiltration rate

Adjusted Evapotranspiration

- ETc adjusted = Ks * ETc
- Ks = (TAW – Dr)/(TAW – RAW)

TAW = Total Available Water

Dr = Root zone depletion

RAW = Readily Available Water

Crop Water Requirement

- Gross irrigation requirements account for losses of water incurred during conveyance and application to the field.

$$IR_g = \frac{IR_n}{E}$$

Where:

IR_g = Gross irrigation requirements (mm)

IR_n = Net irrigation requirements (mm)

E = Overall project efficiency

Efficiencies for different irrigation systems

Irrigation system	Overall efficiency
Surface	45%
Sprinkler	75%
Localized	90%

Softwares required

CLIMWAT : https://www.fao.org/land-water/databases-and-software/climwat-for-cropwat/en/

CROPWAT : https://www.fao.org/land-water/databases-and-software/cropwat/en/

Demonstration

Crop Water Requirement and Irrigation Scheduling of Selected Crops using Cropwat: A Case Study of Pattambi Region in Palakkad

Assignment

1. Analyze the effect of deficit irrigation on the yield of banana cultivation in Pattambi, Palakkad. Compare different deficit irrigation scenarios with the full irrigation condition (till field capacity) in terms of yield. The scenarios that needs to be considered are

   - Stress during different stages (initial, development, mid and end)
   - Stress in all stage
   - Control condition of irrigation (without stress).

2. Consider a water deficit scenario (take fixed percentage = 50 % while calculating the effective rainfall) where sufficient water is unavailable to irrigate at critical depletion. Develop an irrigation schedule based on the available water and determine the maximum level of depletion possible that does not affect the yield.

3. Plot soil water balance of banana for an optimal irrigation condition and write the inferences.

4. Also, develop an irrigation schedule for 20% reduction in the yield. The planting date is 1st June.