SPRINKLER SYSTEMS

Welcome to Module 2

In this module we'll cover the following topics:

When to irrigate

- Soil moisture depletion or flexible method
- Calendar method
- Soil moisture sensors
- Centralized and smart irrigation controllers
- Water budgets

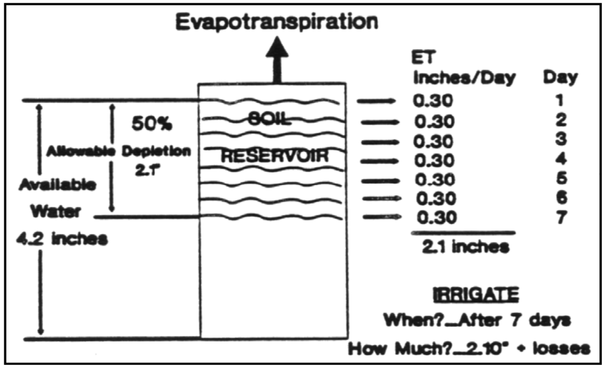
- Managing a drought
- Irrigation system evaluation
- Possible problems
- Irrigation system uniformity
- Importance of delivery systems
- Evaluating irrigation system uniformity and efficiency
- Distribution uniformity
- Evaluation procedures
- Conversion formulas

WHEN TO IRRIGATE

- There are at least three common methods used to decide **when** to irrigate: a "**Flexible Method**" based on an estimated value of root zone soil moisture depletion; a fixed day "**Calendar Method**" to accommodate weekly cultural practices and site use activities; and **Soil Moisture Sensors**.
- Many irrigation controllers provide programming functions for all three methods using a seven or fourteen day calendar, "skip day" features, and sensor inputs.
- Each method is acceptable as long as the proper amount is applied and runoff is minimal.

SOIL MOISTURE DEPLETION

- Using the Flexible Method, the run time per irrigation stays the same and irrigation frequency varies during the year. Irrigation frequency is derived from an estimate of the allowable soil moisture depletion and daily plant water use.
- Irrigation frequency is determined by summing the daily plant water use values (ETo x Kc) until the total water use equals the desired soil moisture depletion (Figure below).
- Rainfall and fog may contribute to soil moisture and their effect can only be assessed by field observation.



THE CALENDAR METHOD

Using the Calendar Method, irrigation frequency is fixed to specific days of the week that accommodate overall site activities. Consequently, the run time per irrigation varies during the year. The Calendar Method is described by the following steps.

First, determine the minutes of **run time per week**.

Second, determine the number of irrigation **days per week**.

Third, calculate **run time per day**:

Run Time per Irrigation Day =

$$\frac{\textbf{Minutes per Week}}{\textbf{Irrigation Days per Week}}$$

Fourth, **observe if runoff occurs**. If so, divide the run time into multiple cycles. If the soils at your site permit a high precipitation rate, you may only need one cycle per irrigation day.

SOIL MOISTURE SENSORS

- Soil moisture sensors are sometimes used to govern landscape irrigation by indicating when to start and stop irrigating. It is very important that these sensors be located in the active root zone and be properly calibrated for the site-specific soil conditions.
- A timely maintenance and physical monitoring program should also be in place to verify sensor readings.
- When using soil moisture sensors, irrigation uniformity remains a critical and important factor and ET information plays a limited role in water management. However, an irrigation schedule may be developed based on historical ETo data and sensors used to shut down the system when water is not needed.

CENTRALIZED & SMART IRRIGATION CONTROLLERS

- These systems adjust irrigation by sensing soil moisture, condition of plant materials, weather or environmental data, or a combination of information.
- Simple systems have utilized a device to interrupt the controller to valve circuit, allowing the system to operate only when the switch is closed. The switch circuitry can be based on a direct electrical measurement.
- Smart Water Application Technology, or SWAT automate the use of historical or real-time reference evapotranspiration (ETo) data or other environmental parameters correlated with evapotranspiration (ET) and plant water demand.

WATER BUDGETS & SETTING PRIORITIES

In many jurisdictions, a first step in establishing a water budget is to determine a site's Maximum Applied Water Allowance (MAWA). It is the maximum amount of irrigation water that can be allocated to the site and is calculated as

MAWA = ETo × AF ×LA × 0.62

MAWA = maximum applied water allowance in gallons per unit of time (year, month, week);

ETo = historic or real-time reference ET in inches per unit of time;

AF = ETo adjustment factor, which varies but is commonly 0.8 or 1.0;

LA = landscaped area in square feet; and,

0.62 = factor for conversion to gallons from inches per square foot.

Since there are 748 gallons per 100 cubic feet, the MAWA can be converted to billing units of hundred cubic feet (CCF) of water as follows:

CCF = MAWA ÷ 748.

MEETING WATER BUDGETS

The actual Water Budget (in inches) for a hydrozone or landscaped area is the estimated amount of water required to maintain the plant material taking into account the uniformity of the irrigation system. It is calculated as:

Hydrozone Water Budget = (ETo × PF) ÷ DU where:

- Water Budget = water required in inches per unit of time (year,
- month, week);
- ETo = historic or real-time reference ET in inches per unit of time;
- PF = plant factor, or crop coefficient (Kc);
- LA = landscaped area in square feet; and,
- DU = distribution uniformity of the irrigation system.

MANAGE A DROUGHT

- Irrigation managers need to make adjustments and set priorities for watering landscape areas to ensure the water allocation is not exceeded.
- This is achieved by determining the types of plant materials and their respective areas (square footage) or their proportion of the total landscaped area represented in each irrigation station or hydrozone.

CALCULATE WATER BUDGET

- 10,000 sq ft during July and the water district has allocated 5.0 inches (100% ETo) of water. This landscape is 50% cool season turfgrass, 10% bedding/color plants, and 40% woody shrubs. The DU for these areas is 70% (0.7) for the turfgrass, 60% (0.6) for the bedding plants and 80% (0.8) for the shrubs.
- For illustration, assume a Kc value of 0.8 for the turfgrass, a PF of 1.0 for the bedding plants, and a PF of 0.5 for the shrubs. The water needed for each area is calculated by multiplying its percent of the total area and then summing the area calculations to find out how close the budget is to the allocation.

MORE ON BUDGET CALCULATIONS

See the example below:

- Turfgrass inches = (ETo x Kc)/DU = (5.0 x 0.8)/0.7 = 5.7 inches x 50% = 2.9 inches.
- Bedding inches = (ETo x PF)/DU = (5.0 x 1.0)/0.6 = 8.3 inches x 10% = 0.8 inches.
- Shrubs inches == (ETo x PF)/DU = (5.0 x 0.5)/0.8 = 3.1 inches x 40% = 1.2 inches.

The total budget is 4.9 inches, which is within the allocation.

IRRIGATION CONTROL SYSTEM EVALUATION – PART 1

This section is used primarily for identification of the controller or time clock, the number of stations, condition and presence of control system components. If no controller is used write in **MANUAL.**

Valve Conditions: Valves should be operational and not leaking. Faulty valves can be identified under remarks.

Wiring Conditions: Wiring is inspected for visible breaks, poor connections, or broken insulation. If a valve is not functioning and wiring is suspected, the wiring voltages should be checked and repaired.

Backflow Prevention: Backflow prevention devices are required to prevent the contamination of domestic water supplies. Either a check valve, anti-siphon valve, pressure vacuum breaker, or reduced pressure backflow prevention device must be present.

IRRIGATION CONTROL SYSTEM EVALUATION – PART 1

- **Soil Moisture Sensor:** Soil moisture sensors are becoming more popular for use in scheduling irrigations. Most read either soil moisture tension or electrical resistance which can be related to soil moisture tension.
- **Rainfall Sensor:** A rain gauge or sensor is used to monitor rainfall and if integrated into the controller, to inactivate programmed irrigations when rainfall is adequate.
- **Pressure Regulators:** A pressure regulator in often needed to reduce water supply line pressure to that needed for proper irrigation system operation. Sprinkler systems are run at pressures ranging from 25 to 85 PSI depending on the type of sprinkler and system used.

PHYSICAL PROBLEMS WITH IRRIGATION SYSTEMS

Broken Components and Heads or Nozzles Not Similar and Uneven Spacing

- Spray pattern blocked, spray misdirected, wrong spray pattern, sunken heads, heads not vertical, heads not turning, clogged heads or emitters, worn heads or emitters, unequal pressures
- Low head drainage

IRRIGATION EFFICIENCY & UNIFORMITY

Irrigation efficiency (IE) is a term used to describe how effectively water was applied to a crop or landscape. Numerically, IE is expressed as a decimal or percentage of the water applied that was used beneficially compared to the total applied water. The formula is often written:

IE = Amount of water used beneficially / Total water applied

This will result in a decimal fraction since it is less than 1.0 and multiplying by 100 will give the number as a percentage of the total applied water.
While IE is usually estimated on a per irrigation basis, average irrigation efficiency can be estimated for several irrigation events or over a given time period such a month or even an irrigation season.

The total applied water is usually determined from a meter reading, water bill, or by measuring the rate of flow and area irrigated.

THE IMPORTANCE OF DELIVERY SYSTEMS

- IE is a function of the irrigation delivery system and the management or control system.
- For example, if the uniformity of the irrigation system is high (say 90%) and the right amount of water is being applied at the right time and runoff is minimal, then the IE would be high (about 90%).
- If the manager under-irrigates, then the IE actually goes up towards 100%, unless irrigations are so light that water does not penetrate into the soil.
- Conversely, if the manager over-irrigates, then IE goes down because percolation and/or runoff is increased.
- IE is maximized by maintaining good irrigation system uniformity and providing accurate scheduling for the landscape. Further increased IE can be achieved precariously through under-irrigation or by collection and reuse of excess water applied.

EVALUATING IRRIGATION SYSTEM UNIFORMITY & EFFICIENCY

Irrigation Efficiency = 100 x (Amount of water used beneficially / Total amount applied)

What is "beneficial" water? Largely, this is the water held in the root zone for plant use.

- However, this definition can be expanded to include the water applied for environmental modification (misting, cooling, or frost control) and leaching of salts.
- Runoff, while usually considered wasted, could also be considered beneficial if it is reused downstream.

WHAT AFFECTS IRRIGATION EFFICIENCY?

- Both system hardware and management affect irrigation efficiency. Rarely can a grower attain high IE with a system that cannot distribute water uniformly to the crop.
- On the other hand, the best irrigation system with high uniformity under poor management can also result in poor efficiency.

Uniformity

Uniformity is the term used to describe how evenly water is applied to a crop. It is an important factor especially when irrigating small plants (turfgrass) or plants in pots because the roots of these crops are contained (or limited in expanse) and the system must have the capability to irrigate each plant.

In tree and shrub areas, while uniformity is needed over generalized areas, it is not necessary to irrigate each square foot of soil equally because these plants have roots that can explore considerable volumes of soil.

DISTRIBUTION UNIFORMITY

- This is probably the most common uniformity statistic because it is easy to calculate. After making 20 or so measurements and converting to gallons per hour, the mean (average) is calculated by adding the measured amounts and dividing by the number of measurements.
- Then the 25% of the measurements which are the smallest are identified and averaged. This is called the average of the 'low quarter'.
- If you used 20 measurements total, the low quarter consists of the five smallest measurements. Then the DU is calculated as:
- DU = 100 x (Average of the LQ / Average of All)

EVALUATION PROCEDURES

1. Make note of the type of equipment…. Yep, that means everything… Map?
2. What is the crop? Where are the roots?
3. Turn on the system and look for leaks and obvious problems.
4. Take some volumetric measurements for uniformity and rate calculations.
5. Make your calculations and determine results.
6. If uniformity is poor, WHY?
7. If necessary, take pressure or spacing measurements.
8. Fix problems and re-test.

CONVERSION FACTORS, FORMULAS & REFERENCE NUMBERS

- 1 inch water = 0.62 gallons per square foot
- 1 Acre Foot = 325,851 Gallons
- 1 Acre Inch = 27,154 Gallons
- 1 Gallon water = 8.3 pounds
- 1 Gallon water = 3.785 litres
- To convert inches of water applied to an area to gallons of water applied:
- Gallons applied = inches of water applied × sq. ft. of area irrigated × 0.623 gal/sq. ft.
- To convert gallons of water applied to an area to inches of water applied:
- Inches applied = × (sq. ft. of area irrigated × 0.623 gal/sq. ft.) ÷ gallons of water applied
- CCF = 100 cubic feet water = 748 gallons (this is a standard billing unit for most urban water agencies)

- Precipitation Rate in./hr. = (GPM × 96.3) ÷ sq. ft. of irrigated area

END OF MODULE 2

This concludes Module 2. Please proceed to the 10-question quiz. Once you have completed that, you will have completed the course.