

SPRINKLER SYSTEMS

Welcome to the two-part course on
Landscape Irrigation System Evaluation and Management



THE COURSE

In this course there will be two modules. This is Module 1 which will focus on the following topics:

Overview of landscape irrigation management

- a. The walk-through inspection
- b. System precipitation rates and uniformity
- c. Catch Can Tests
- d. Water use of turfgrass and landscape materials
- e. Calculating ETo
- f. Kc Values



THE GOALS OF IRRIGATION

- The goal of good irrigation management in the landscape is to supply the plant materials with the correct amount of water at the proper time.
- In areas where water costs are high, supplies are limited and there is demand for high quality turf and landscapes, the irrigation manager must maintain irrigation systems for peak performance and make careful decisions on when and how much to irrigate.



EFFECTIVE LANDSCAPING STRATEGIES

Effective landscape irrigation involves 3 strategies:

1. Irrigation systems should be designed installed, and maintained to distribute water as uniformly as possible.
2. To assure adequate irrigation of all areas the irrigation system should be operated long enough to apply a depth of water equal to the water use of the landscape plus extra to compensate for the non-uniformity of the system and leaching requirements.
3. Irrigation systems should be designed, maintained, and operated to avoid runoff



IRRIGATION SCHEDULING

Landscape water use estimates are derived from reference evapotranspiration (ET_o) information and crop coefficient (K_c) values. The overall procedure to develop landscape irrigation schedules consists of the following steps:

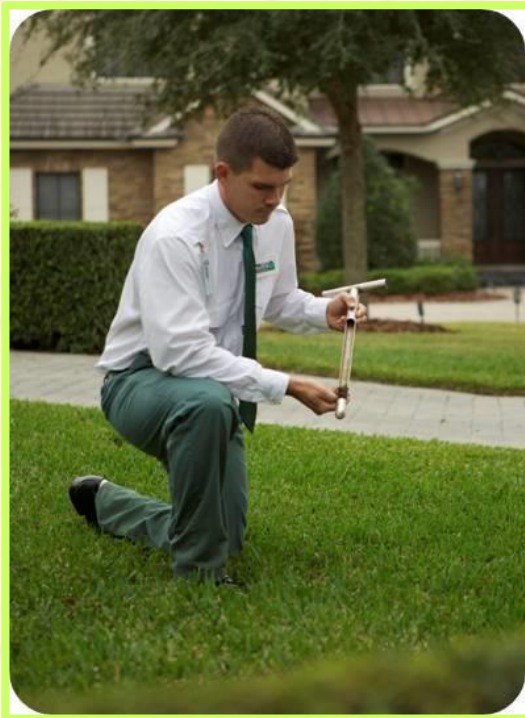
1. Perform a **"walk-through" inspection** of each station
2. Determine the precipitation rate and distribution uniformity of irrigation systems using volumetric measurements or catch can tests.
3. Calculate station run times to meet the water needs of the landscape.
4. Decide the frequency of irrigation and if "cycling" is necessary.
5. Verify the irrigation schedule with field observations and adjust if necessary.



Beautiful landscapes
require proper irrigation.

THE WALK-THROUGH INSPECTION

The purpose of the "walk-through" visual inspection is to identify readily apparent problems. The walk-through inspection should become a regular part of an irrigator's normal routine.



IRRIGATION PRECIPITATION RATES & DISTRIBUTION UNIFORMITY

- The PR is the rate at which water is delivered to the landscaped area and is measured in inches per hour.
- **PR and DU** (distribution uniformity) are the two most important irrigation system performance characteristics used to calculate station run times and indicate how evenly water is applied to all areas of the landscape.
- There are several methods of calculating precipitation rates: Measurement of system flow rate and area irrigated, measurements of head output and spacing and Catch Can Tests. In addition, PR can be estimated in the design stages of a project from design criteria (pressure, flow, spacing, etc.) and manufacturer's performance data for the equipment used.



FLOW & AREA IRRIGATED METHOD

Gross precipitation rates in inches per hour can be determined from the system flow rate and area irrigated using the following formula:

$$\text{PR(IN/HR)} = \frac{\text{GMP} \times 96.3}{\text{Landscape area in sq. ft.}}$$



HEAD OUTPUT & SPACING METHOD

- Field measurement of most single stream sprinkler and emitter outputs, expressed as gallons per minute (GPM) or gallons per hour (GPH), is relatively simple and requires only a few tools: collection buckets and short pieces of 3/4" hose.
- Accurate measurement of multi-stream rotors and spray head sprinklers may be difficult. The formula for calculating the average PR is:

$$\text{PR(IN/HR)} = \frac{\text{Average GMP per head}}{\text{Average head spacing in square feet}}$$

DISTRIBUTION UNIFORMITY

- Distribution uniformity (DU) of an irrigation system describes how evenly water is applied over the irrigated area.
- In landscape irrigation, a DU value is usually calculated for each irrigation valve as the ratio of the lowest one-fourth of the head outputs or catches to the overall average head output or catch within the irrigation valve. This is known as the low quarter DU (DU_{LQ}). Using DU_{LQ} increases runtime dramatically in systems with a low DU.
- The irrigation industry has recently moved toward calculating DU using the lowest 50% of the catches, which results in a lower runtime multiplier.



CATCH CAN TESTS

- Catch can tests are a fast and accurate way to evaluate the PR and DU of sprinkler systems irrigating turfgrass, potted plants, and ground cover areas.
- A variety of containers make suitable catch cans including plastic drinking cups, coffee mugs, and soup, tuna or cat food cans.
- The objective of the catch can test layout is to obtain a representative sample of the true precipitation rate and distribution uniformity of the sprinkler irrigation system.
- Some areas may require that two or more valve stations be operated to completely overlap the test site.
- For a 3.5 inch diameter catch can, one should expect to catch between 20 and 80 milliliters.
- The test run time may range from 10 minutes (high PR greater than 1.5"/hr.) to 90 minutes (low PR less than 0.4"/hr.).

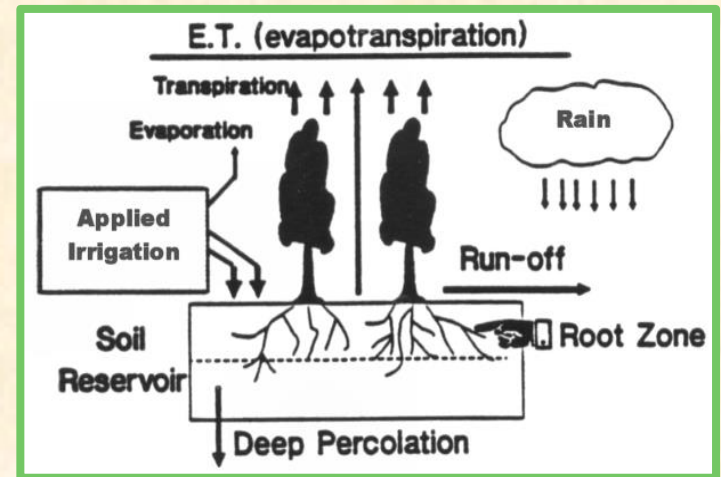
RECORD VOLUMES & TIMES

- Record the individual catch can volumes, preferably in milliliters, and the station(s) test run time in minutes.
- If there is a controller, a stopwatch should be used to verify the accuracy of the controller clock. The stopwatch time should be used to determine the true system PR if inaccuracies exist.
- Then follow these steps: Analyze the data, Identify the low quarter, Calculate average catch, Calculate average quarter, Calculate the DU by dividing the low quarter catch by the average catch, determine the PR from the average of all catch volumes and area of the catch can opening.



WATER USE OF TURFGRASS & LANDSCAPE MATERIALS

- In the landscape, water is transpired by plants and evaporated from the soil. This process is defined as evapotranspiration or **ET**.
- The primary climatic factors that affect ET are solar radiation, air temperature, relative humidity, and wind speed. Studies of pasture water use and weather data have led to the development of relationships for predicting ET from climatic factors and weather data.
- Generally, as sunlight, temperature, and wind increase and as relative humidity decreases, ET increases.



LEARNING ABOUT ETo

- One daily value is called **real-time reference evapotranspiration (ETo)** because it and represents the water use of a standard pasture (the reference plant) and is derived from current weather data (real-time data).
- Historical ETo information is of great value in predicting plant water use for determining generalized irrigation schedules.
- Water needs of plants vary by individual species and their location in the landscape. Most landscape plants such as turfgrass, groundcovers, shrubs and trees need less water than ETo (reference ET) which the estimated water use of the standard pasture, thus, their water needs are expressed as a percentage of ETo.
- This percentage of ETo is often called a crop coefficient (Kc), plant factor (PF), or landscape coefficient (KL). The relationship is: **$ETo \times Kc = \text{Plant ET}$**

MORE ON ETo

- To perform optimally, bermudagrass needs about 60% of the water that the standard pasture needs. Thus, if we knew that ETo for a day was 0.20 inches, then bermudagrass would need 0.20 inches times 0.60, or 0.12 inches of water. Although ETo varies from one climate zone to another, the percentage of it used for a given species (or the crop coefficient) does not change.
- Crop coefficients are dimensionless numbers usually ranging from 0.1 to 1.2.



USING ETo AND CROP WATER

The concept of using the ETo standard to estimate a crop's water needs through a crop coefficient was initially derived by agricultural crop scientists to estimate the water requirements of large tracts of field and orchard crops. The scientific application of ETo to calculate crop coefficients assumes the plant material of interest is:

- Well-watered with soil moisture unlimited at all times.
- Growing vigorously.
- Forming a uniform, nearly continuous canopy that functions as a single big leaf.
- Grown with the goal of optimum growth and development and yield.
- Using water in direct proportion to the rate of ETo.



CROP COEFFICIENTS

Crop coefficients (K_c values) and plant factors are developed by determining the water use of a given species or crop and comparing it to ETo over the same time period. There are several methods used to estimate crop water use by measuring:

- Applied water to the crop and estimating application losses;.
- The weight of water lost from the crop using lysimeters or weighing devices;.
- Water flux from the crop canopy to the atmosphere (aerodynamics);).
- Water flow through plant stems or tree trunks;.
- Water lost through a combination of these methods.



K_c VALUES FOR LANDSCAPES

- Reliable research-based data on landscape water needs is extremely limited primarily because there are hundreds of plant species to evaluate and the scientific process requires a great deal of resources to identify water requirements of an individual species.
 - Research in plant physiology has revealed that water use of some woody landscape plants does not increase proportionally as ETo increases throughout the day especially when site conditions are harsh, such as when trees are planted within paved parking lots.
- The research findings show that many universally used species maintain their aesthetic and functional value when irrigated within a range of 18% to 80% of ETo . These numbers are useful in estimating water budgets and irrigation schedules for landscapes even though the precise water use of the plants has not been quantified.
 - For the many landscape species with unknown water requirements, it is currently recommended to set initial irrigation schedules at 50% ETo for established non-turf landscape plantings.
 - One resource to check out is: *Water Use Classification of Landscape Plants* (or WUCOLS)

IRRIGATION SCHEDULES

Individual station run times are determined from both plant water use estimates (ET) and the system PR and DU using either a hand-held calculator or the U.C. scheduling software (TURFIMP) on a daily, weekly, or monthly basis. Virtually all irrigation scheduling calculations and software use the following information:

The Precipitation Rate (PR) of the irrigation system in inches/hour.

- The Distribution Uniformity (DU) of the irrigation system.
- Historical or Real Time Evapotranspiration (ET_o) Information.
- Crop Coefficient (K_c) Values.



CALCULATING IRRIGATION RUN-TIMES

The following formula is used by both computer software and hand calculations to calculate irrigation run times from the above information:

$$\text{RUN TIME (minutes)} = ETo \times Kc \times 60$$

$$PR \times DU$$

Run time for successive days can be determined by adding daily run times or using the cumulative ETo value.

$$\text{DAILY RUN TIME} = .$$

$$.18 \text{ in/day} \times .50 \times 60$$

$$.75 \text{ in/hr.} \times .80$$



IRRIGATION FREQUENCY

Factors Which Restrict Scheduling Flexibility:

- Mandated irrigation days and/or hours
- Limited water supply
- Cultural or maintenance practices
- Sports or other activities
- High wind conditions

Factors Which Necessitate Frequent Irrigation:

- High plant water use rates
- Shallow rooting depth
- Sandy soils with low water holding capacity
- High runoff potential due to slope or compaction
- Poor infiltration rate due to compaction or clay soils

Factors Which Allow Less Frequent Irrigation:

- Low ET rates or presence of rainfall, dew, or fog
- Deep roots and high root density
- Plants with ability to tolerate drought
- No runoff problems
- Acceptable quality or site use under reduced irrigation

END OF MODULE 1

This concludes Module 1. Please proceed to the quiz, and then Module 2.

