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Smart Irrigation Controllers: Programming Guidelines for Evapotranspiration-Based Irrigation Controllers, or ET Controllers[1]

Michael D. Dukes, Bernard L. Cardenas-Laihacar, Mary L. Shedd, and Stacia L. Davis[2]

This article is part of a series on smart irrigation controllers. The rest of the series can be found at https://edis.ifas.ufl.edu/TOPIC_SERIES_Smart_Irrigation_Controllers.

Introduction

In landscapes, irrigation systems are installed to supplement rainfall and maintain plant health and aesthetic quality. In Florida, irrigation is typically applied using an automated in-ground system, controlled by an irrigation timer, which is programmed with user-defined irrigation schedules. However, homeowners who use these systems may apply more water for landscape irrigation than those without automatic systems due to a "set it and forget it" mentality, regardless of seasonal fluctuations in plant water needs (DeOreo et al., 2016).

"Smart" technologies have been developed to apply irrigation based on plant water needs while conserving our increasingly limited water resources. This Ask IFAS publication is intended for irrigation professionals, homeowners, Extension agents, and the general public who interact with evapotranspiration controllers (ET controllers). The objective is to provide programming guidelines for several examples of ET controllers currently available in Florida. Though these are specific examples, the general principles apply to other models and brands.

An overview of Smart Irrigation Controllers can be found in *What Makes an Irrigation Controller Smart,* https://edis.ifas.ufl.edu/ae442, and the publication *Operation of Evapotranspiration-Based Controllers,* https://edis.ifas.ufl.edu/ae446, presents the general operating principles associated with ET controllers.

Controller Inputs

ET controllers vary according to the way they receive data, as described in *Operation of Evapotranspiration-Based Controllers,* https://edis.ifas.ufl.edu/ae446, but can also vary based on the types of programmed inputs used for irrigation scheduling. Depending on the manufacturer, each controller can typically be programmed with various conditions specific to the irrigation system and landscape.

Irrigation System Inputs

In-ground automatic irrigation systems have parameters specific to their design and installation. Some common parameters include application rate (the depth of water applied over a specific period) and efficiency (the amount of water that reaches the plant root zone compared to the total amount applied).

Irrigation Type

The type of sprinkler used in a specific irrigation system can generally be selected as an input from a set of choices available in the ET controller (Table 1). The type of sprinkler affects both the rate at which water is applied to the irrigated area and the efficiency of water application.

Application Rate

Rates of water application vary depending on the brand, type, and installation details of sprinklers. Typically, the application rates of rotors are lower than those of spray nozzles. This rate is expressed in units of depth per time (typically expressed in inches/hour) and can be used to calculate the irrigation run time based on the depth determined using the soil water balance (*Operation of Evapotranspiration-Based Controllers,* https://edis.ifas.ufl.edu/ae446). The application rate can be found in the manufacturer's specifications or determined by performing a distribution uniformity test. Trenholm et al. (2009) provides information on how to determine the application rate of your system.

Efficiency

Generally, landscape sprinkler systems are considered inefficient. For scheduling purposes in an ET controller, if the distribution uniformity was calculated (Trenholm, 2009), instead of using the low quarter distribution uniformity (DUlq) value, it is recommended to use the low half distribution uniformity (DUlh) value. In absence of uniformity testing information, the following efficiencies may be used as estimates:

- Rotary or impact sprinklers: 70%–80%
- Spray heads: 60%–80%
- Drip or other microirrigation emitters: 80%–90%.

The lower the efficiency number input into the controller, the more water will be applied because the ET controller will compensate for lower efficiency (i.e., more water losses). It is best to use the highest possible efficiency value to minimize overwatering.

Landscape Inputs

Landscape conditions typically included as inputs to the ET controllers are soil type, plant type, slope, sun, and shade. The controllers generally have options available for each condition. Table 1 lists examples of inputs for an ET controller, including those commonly used in Florida.

Soil Type

Choosing the correct soil type can be extremely important to the soil water balance calculations made by the ET controller. Soil type affects both the amount of water that can be held in the root zone and the infiltration rate of water into the root zone. Sandy soils generally have high infiltration rates but low water-holding capacity, while clay soils have very low infiltration rates but hold water extremely well (see *Operation of Evapotranspiration-Based Controllers*, https://edis.ifas.ufl.edu/ae446).

Soil type also affects the amount of runoff that can occur, as it is determined by the infiltration rate. If the infiltration rate is too low, part of the water being applied will not enter the root zone and will be lost to runoff. Most soils in peninsular Florida can be classified as "sandy," while those in the Panhandle are typically classified as "sandy loam."

Fill soils may also be classified as "sandy." On some construction sites, however, substantial compaction limits infiltration and root growth. For these sites, the soil type selected in the ET controller should be set one level lower (e.g., from "sandy" to "sandy loam," or from "sandy loam" to "loam," etc.). However, it is recommended that the compacted topsoil be tilled to improve infiltration and reduce runoff.

Plant Type

The type of plant in a landscape affects the irrigation required. Plant types are selected for the purpose of defining the appropriate crop coefficient (see *Evapotranspiration-Based Irrigation for Agriculture: Crop Coefficients of Some Commercial Crops in Florida*, https://edis.ifas.ufl.edu/publication/ae456) and possibly defining an appropriate root depth. Crop coefficients and plant water requirements are described in *Operation of Evapotranspiration-Based Controllers*, https://edis.ifas.ufl.edu/ae446. Deeper root systems allow for longer periods between irrigation events. Some controllers allow you to choose custom crop coefficients and root depths that will override the default values given for the plant type option.

Slope

ET controllers may use the slope of an irrigated area to create multiple irrigation start times with shorter durations for each event. This approach allows more time for water to infiltrate into the soil between irrigation events, helping to reduce runoff. This is especially important when the soil has a low infiltration rate, as explained earlier.

Microclimate

The percentage of the irrigated area covered by shade can be used by the ET controller to adjust the amount of water applied. Evapotranspiration in shaded areas is lower than in areas with full sun.

Weather Conditions

ET controllers may offer several options to limit irrigation during windy or rainy conditions. As wind speeds increase, the ability for the irrigation system to apply water efficiently decreases due to wind drift and the evaporative water loss increases. Additionally, irrigation should be reduced or suspended during periods with adequate rainfall.

Rain Sensors

An ET controller may include a rain sensor in the system such as the Weathermatic Smartline Series (see *Residential Irrigation System Rainfall Shutoff Devices, or Rain Sensors,*https://edis.ifas.ufl.edu/ae221, for details on rain sensors). Rain sensors bypass irrigation events when a specific amount of rainfall has occurred. Some ET controllers refill the soil water after a set amount of time has passed following a rain event detected by the rain sensor, whereas other controllers only pause irrigation until the rain sensor is dry. Unless the ET controller model already includes a rain sensor, it is recommended that one be added to the system due to the frequent and site-specific rainfall patterns in Florida. It is important to connect the rain sensor to the "sensor" port of the ET controller, if available.

Rainfall Service

Some signal-based ET controllers receive an input of rain depth from a weather network (see *Smart Irrigation Controllers: What Makes an Irrigation Controller Smart?* https://edis.ifas.ufl.edu/publication/AE442). Irrigation may be paused for a preset number of days as a response to the amount of rainfall measured, or users can manually program the response to a rainfall event if needed. Instead of pausing irrigation, other signal-based ET controllers account for rainfall measured by the weather network as an input to the plant and soil system, adjusting the irrigation schedule accordingly.

Challenges

ET controllers are valuable tools for improving irrigation water application; however, they cannot correct a poorly designed or poorly maintained irrigation system. Thus, it is important to have the automatic irrigation system inspected regularly and to ensure that necessary maintenance is performed in a timely manner.

The various ET controllers operate differently to reduce irrigation water use, depending on whether they are add-on devices that bypass fixed events or complete units that calculate irrigation run times and cycles based on user inputs (Table 1) and weather conditions. While these controllers allow homeowners to "set it and forget it," they still require regular supervision or maintenance to ensure proper functioning and, in the case of signal-based controllers, to ensure that the signal is not lost.

Confusion may arise when programming these controllers, as there are currently more than 700 ET controller models available on the market. Recent industry trends feature Wi-Fi-enabled ET controllers with smartphone app integration and no subscription services, contributing to their growing popularity. The various commercially available ET controllers use different programming terms, inputs, and procedures, as there is no standardized model (Tables 2 and 3). In general, manufacturers design these controllers to be installed by knowledgeable contractors who understand the various inputs. Correctly programming the controller for each unique landscape is critical to its ability to reduce water use while maintaining good landscape aesthetic quality.

References

DeOreo, W.B., Mayer, P.W., Dziegielewski, B., & Kiefer, J.C. 2016. Residential End Uses of Water, Version 2. Water Research Foundation, Denver, CO.

Trenholm, L.E., Unruh, J.B., & Cisar, J.L. 2009. How to Calibrate Your Sprinkler System. University of Florida Cooperative Extension Service, IFAS, EDIS. https://ufdc.ufl.edu/IR00003389/00001

Table 1. Common settings that are programmable in ET controllers to properly schedule irrigation.

Category	Common Settings	Parameter Affected by Setting	Common Florida Inputs
Irrigation Type	Spray head	Application Rate	Spray
	Rotor	Uniformity/Efficiency	Rotor
	Impact		
	Bubblers		
	Drip emitters		
Soil Type	Sandy	Infiltration Rate	Sandy
	Sandy Loam	Water Holding Capacity	Sandy Loam
	Loam		
	Clay Loam		
	Clay		
Plant Type	Warm Season Grass	Crop Coefficient (Kc)	Warm Season Grass
	Cool Season Grass		Mixed
	Combined Grass		Shrubs
	Flowers		
	Trees		
	Shrubs		
	Mixed		
	Trees		
	Native Grasses		
Microclimate	Sunny all day	ET Adjustments	Site Specific
	Sunny most of the day		
	Shady most of the day		
	Shady all day		
Slope	0%–5%	Cycle/Soak	Site Specific
	6%–8%		
	9%–12%		
	13%–20%		
	>20%		

Table 2. Example of program settings for four common commercially available ET controllers irrigating a full-sun St. Augustinegrass lawn, on sandy soil, and using spray heads. Note: The University of Florida and UF/IFAS do not endorse any particular brand. The information provided here is for illustrative purposes only.

Setting	Toro Intelli-sense	Weathermatic Smartline	ET Water Smart Controller 100	Rain Bird ET Manager
Sprinkler Type	Spray Head	Spray	Spray Head	Fixed Spray
Application Rate[1]	1.7 in/hr	1.0 in/hr	1.5 in/hr	User-defined[2]
Soil Type	Sand	Sand	Sand	Sand
Plant Type	Warm Season Turf	Wturf	Lawn - Warm Season	Warm Season Turf

Setting	Toro Intelli-sense	Weathermatic Smartline	ET Water Smart Controller 100	Rain Bird ET Manager
Microclimate	Sunny All Day	NA[3]	Sunny All Day	NA
Slope	0%–5%	1%–5%	0%–5%	0%–3%
Efficiency/Uniformity[4]	80%	NA	80%	80%
Zip Code[5]	NA	32611	NA	NA

[1] Application rates are the default controller values for the spray head program setting. Site-specific information based on catch-can testing should be used if available. Otherwise, use the values provided under the "Efficiency" subheading.

[2] The application rate can be determined using on-site catch-can testing or, after choosing the sprinkler type in the scheduling software, the ET Manager lists various sprinkler manufacturers and corresponding models within the sprinkler category to determine the application rate from the technical specifications.

[3] NA refers to settings that do not apply to the controller program settings.

[4] This factor should be based on a catch-can uniformity measurement and the calculated low half distribution uniformity value. The values here are merely guidelines in the absence of site-specific information. In addition, these values presume coverage of the irrigated area by at least 2-3 overlapping heads.

[5] Zip codes should be updated for the location of the ET controller.

Table 3. Example of program settings for four common commercially available ET controllers irrigating newly planted shrubs, on a sandy soil, and using microsprinkler irrigation. Note: The University of Florida and UF/IFAS do not endorse any particular brand. The information provided here is for illustrative purposes only.

Setting	Toro Intelli-sense	Weathermatic Smartline	ET Water Smart Controller 100	Rain Bird ET Manager
Sprinkler Type	Spray Head	Spray	Spray Head	Micro Spray
Application Rate[1]	User-defined	User-defined	User-defined	User-defined[2]
Soil Type	Sand	Sand	Sandy	Sand
Plant Type	Shrubs – Med Water Use	Shrubs	Shrubs	Shrubs
Microclimate	Sunny All Day	NA[3]	Sunny All Day	NA
Slope	0%–5%	1%–5%	0%–5%	0%–3%
Efficiency/Uniformity[4]	90%	NA	90%	90%
Zip Code[5]	NA	32611	NA	NA

[1] Application rates for microsprinklers should be determined by measurement, as default values do not exist for these controllers. If a value for "drip" irrigation is available in the controller, it could be used; however, it may need adjustment over time to provide adequate water to the plant material.

[2] The application rate can be determined using on-site catch-can testing or, after choosing the sprinkler type in the scheduling software, the ET Manager lists various sprinkler manufacturers and corresponding models within the sprinkler category to determine the application rate from the technical specifications.

[3] NA refers to settings that do not apply to the controller program settings.

[4] Uniformity of microsprinkler assumes that the sprays are targeted to the root zone of the shrubs.

[5] Zip codes should be updated for location of controller.

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[2] Michael D. Dukes, director, UF/IFAS Nutrient Management Program, associate dean for special initiatives, UF/IFAS Extension, professor, Department of Agricultural and Biological Engineering and director, Center for Land Use Efficiency; Bernardo L. Cardenas-Laihacar, research coordinator, Department of Agricultural Education and Communication; Mary L. Shedd, former graduate student, Department of Agricultural and Biological Engineering; Stacia L. Davis, former graduate student, Department of Agricultural and Biological Engineering; UF/IFAS Extension, Gainesville, FL 32611.