Operation of Residential Irrigation Controllers[1]

Michael D. Dukes and Dorota Z. Haman[2]

Introduction

Automatic landscape irrigation systems have become quite common in Florida in recent years. Electronic irrigation controllers are used to control these systems; however, it is not always obvious how to program these controllers to apply the desired amount of irrigation water.

Irrigation Controllers

The document "Irrigation System Controllers" (UF/IFAS Publication SS-AGE-22; on the web at: http://edis.ifas.ufl.edu/AE077) discusses various types of typical irrigation controllers in detail. In general, commercially available controllers are mechanical, electromechanical, electronic, or computer based. Electronic controllers are commonly installed in residential and small commercial landscape irrigation systems. We will discuss the general operation common to most residential irrigation controllers. For details specific to a given controller the reader should refer to the owner's manual.

Electronic Controller Operation

Generally, electronic controllers allow flexible scheduling of irrigation systems (Figure 1).

Figure 1. Typical residential irrigation controller.

Some scheduling options provided by controllers are:

Days of the week

Controllers may be set for irrigation every day, every second day, every third day, etc. Typical controllers will allow for selection of certain days of the week in a "custom" option or frequency, such as "every 2 days," for setting frequency of irrigation. The "custom" option is the one normally used during times of water restrictions, when irrigation is limited to one or two days each week.

1. This document is CIR1421, one of a series of the Agricultural and Biological Engineering Department, UF/IFAS Extension. Original publication date July 2002. Revised March 2009. Reviewed June 2015. Visit the EDIS website at http://edis.ifas.ufl.edu.

2. Michael D. Dukes, professor; and Dorota Z. Haman, professor; Agricultural and Biological Engineering Department, UF/IFAS Extension, Gainesville, FL 32611.

Run time

The amount of time that each zone runs may be set from several minutes to several hours. Generally run time should be less than 60 minutes for Florida's sandy soils. The exact time depends on system application rate which can be determined as discussed in the next section. Irrigating longer will lead to movement of water below the root zone, which wastes water.

Percent

Most controllers have percentage settings so that the relative time may be adjusted. For example, if the controller is set to run 60 minutes per cycle the controller may be set to water at 75%. This will result in 60 minutes * 0.75 = 45 minute run time. Likewise, the run times in the other zones will be reduced to 75% of the zone time setting. This is helpful in Florida when the summer rains begin and irrigation can be cut back.

Program

Controllers usually have the capacity to run multiple programs. For example, on program "A", the controller may be set to water six rotor zones for 60 minutes twice each week. If new plants are planted in a landscape bed, they may need more frequent watering to become established. In this case, program "B" can be used to water that zone every day of the week.

Application Rates

The application rate is an amount of water applied over an area, such as a yard with landscape plants and turfgrass, in a given amount of time. Usually this is expressed as inches per hour (in/hr) and implies an even application of water. The application rate of an individual irrigation zone must be known to properly set the irrigation controller.

There are several ways to find the application rate of an irrigation zone. It may be:

1. given by the designer or contractor,
2. calculated from system and or sprinkler specifications,
3. calculated based on measurements of flow from a water meter, or
4. measured directly by placing catch containers in the irrigated zone of interest.

1. **Application rate given by the designer or contractor.**

Although application rates of each individual zone should be calculated by the designer, in practice this is rare.

2. **Application rate calculated from system or sprinkler specifications.**

Application rate may be calculated from the system specifications according to the total area method (Equation 1) or from the sprinkler specifications assuming they are all alike according to the sprinkler spacing method (Equation 2). Actual application rates may not match calculated rates due to misadjusted sprinklers, wind drift, pressure problems, etc. For these reasons, it is preferred that the actual application rate be verified by measurement as described in the sections 3 and 4.

Total area method:

$$AR = \frac{96.3 \times GPM}{AREA}$$

Equation 1.

where:

AR = application rate (in/hr)

GPM = system or zone flow rate (gpm)

AREA = total or zone irrigated area (ft^2)

Sprinkler spacing method:

$$AR = \frac{96.3 \times GPM}{ROW \times COL}$$

Equation 2.

where:

AR = application rate (in/hr)

GPM = individual nozzle flow rate (gpm)

ROW = spacing of sprinkler rows (ft)

COL = spacing of sprinklers within the rows (ft)

3. **Application rate calculated based on measurements of flow from a water meter.**

The application rate for each irrigation zone can be determined from flow meter records. If a separate irrigation meter is not installed (which is typical on most homes), the utility meter must be used for this method. To use the utility meter, conduct the test when water is not being used in the home. If a separate irrigation meter is available, household water use does not have to be considered for the test. If a well is used to supply the irrigation system, then a meter must be installed after the pump to use this method.

Example: The meter reading prior to irrigation of a single zone was 1895750 gallons and after irrigation the meter reading was 1900600 gallons. The amount of water used during the irrigation cycle was 1900600-1897750 = 2850 gallons. The irrigation time for the zone was 2.5 hours (2.5 hours * 60 = 150 minutes). The irrigated area is approximately square and was known to be approximately 6750 ft^2. Now the average application rate for the irrigated zone can be calculated by Equation 3.

$$AR = \frac{96.3 \times GAL}{AREA \times TIME}$$

Equation 3.

where:

AR = application rate (in/hr)

GAL = total volume of water measured by the flow meter (gal)

AREA = irrigated area (ft^2)

TIME = total time of irrigation cycle (min)

According to Equation 3:

$$TIME = \frac{GAL}{GPH / 60}$$

Although this method is relatively easy, unless it is performed for each zone it will not give the accurate representation of individual zones that is needed to set the controller. For example, rotors (see Figure 2) typically have application rates of 0.25-1.0 in/hr, while spray heads (see Figure 3) have application rates of 0.75–1.5 in/hr. Therefore, these equipment types should be tested separately.

Figure 2. Gear-driven rotor irrigation head.

Figure 3. Fixed spray irrigation head.

4. **Application rate measured directly using catch containers.**

Application rate can be measured directly by placing several containers in a given irrigation zone during an irrigation event (see How to Calibrate Your Sprinkler System, http://edis.ifas.ufl.edu/LH026). This is similar to testing the system uniformity (see Lawn Sprinkler Selection and Layout for Uniform Water Application, http://edis.ifas.ufl.edu/AE084). Essentially, the containers must be the same shape and size. Old coffee cans are one example of a good container for this purpose. The rim of the can should be above the turf and the cans should be level. At least six cans per zone should be used and they should be distributed randomly. Next, run the irrigation system over a normal cycle. Then you can calculate the application rate according to the following example.

Example: One irrigation zone is to be tested. Several catch cans are positioned throughout the zone such that overlap from other zones does not contribute to those cans. Average depth of water measured in the cans was 1.25 inches after an irrigation run of 45 minutes.

$$AR = \frac{96.3 \times 2850}{6750 \times 150} = 0.27 \text{ in/hr}$$

Equation 4.

where:

AR = application rate (in/hr)

DEPTH = average depth in catch cans for any one zone (in)

TIME = run time of irrigation zone tested (min)

According to Equation 4,

$$AR = \frac{DEPTH}{TIME / 60}$$

Setting the Time on Irrigation Controllers

Once the application rate is known, then the irrigation controller can be set for a desired irrigation depth according to Equation 5 with the parameters defined as in Equation 4.

$$AR = \frac{1.25}{45 / 60} = 1.67 \text{ in/hr}$$

Equation 5.

Table 1 gives the calculated times according to Equation 5 based on desired application amount or depth and the application rate of the individual zone or system.

Seasonal Setting of Irrigation Controllers

The objective of irrigation is to replenish the water in the plant roots to avoid excessive plant stress. For landscape plants, especially turf, where the objective is to maintain the appearance and not to produce the highest amount of biomass, it is usually sufficient to aim for 60%–100% replacement of water in the root zone.

Augustin (see "Water Requirements of Florida Turfgrasses", UF/IFAS Publication BUL 200) calculated the net irrigation requirement of turfgrass for several geographical areas and based on effective rainfall. Effective rainfall takes into account the low water-holding capacity of Florida's soils (see Watering Your Florida Lawn, http://edis.ifas.ufl.edu/LH025 and Turf Irrigation for the Home, http://edis.ifas.ufl.edu/AE144). Net irrigation requirement is the amount of irrigation water that must be delivered to the crop. This does not consider irrigation losses such as pipeline leakage, wind drift, non-uniform application, etc.

Tables 2–9 present a suggested irrigation controller time setting assuming two irrigation events per week, and an irrigation system efficiency of 60% for application rates of 0.50, 0.75, 1.00, 1.25, and 1.50 in/hr, respectively. Three regions are represented in Tables 2–9, north (Gainesville), central (Orlando), and south (Miami). In addition, three levels of replacement are presented. It is desirable to irrigate at the lowest possible level of replacement without an acceptable degradation in turf or landscape quality. Two irrigation events per week were assumed since this is a common practice due to water restrictions. Any irrigation time exceeding 60 minutes should be split into two applications at least four hours apart with the time in between applications during the day when the plants will use the water (i.e., morning and afternoon). If the measured or calculated application rate does not exactly correspond to those given in the table, use the closest rate. For example, a homeowner measures an application rate of 0.6 in/hr. The table with the 0.5 in/hr application rate (Table 3) would be used.

Setting Microirrigation Zones

Microirrigation zones are sometime called "drip" or "trickle" irrigation and are becoming popular for landscape beds due to their ease of use and low use of water. There are several types of microirrigation emitters (see Figures 4, 5, 6, 7). More information on those emitters and how they are defined can be found in "Retrofitting a traditional in-ground sprinkler irrigation system for microirrigation of landscape plants" (UF/IFAS Publication ABE324; on the web at: http://edis.ifas.ufl.edu/AE222). Typically microirrigation does not wet the entire root zone; therefore, the application rate concept does not apply. These emitters have various emission rates, usually in gallons per hour. General guidelines on how many gallons are required for landscape plants can be found in “Fertilization and Irrigation Needs for Florida Lawns and Landscapes” (UF/IFAS Publication ENH860; on the web at: http://edis.ifas.ufl.edu/EP110). Once the gallons required are known, then the irrigation controller may be set according to Equation 6, assuming one emitter per plant. Since application depth may be difficult to calculate, microirrigation zones should be set initially for one-hour run time, two times each week. These zones can be reduced 15 minutes each cycle every week until plants show stress.

$$TIME = \frac{60 \times DEPTH}{AR}$$

Equation 6.

where:

TIME = microirrigation run time (min)

GAL = volume of irrigation water required for a plant (gal)

GPH = emission rate of a drip emitter (gph)

Figure 4. Individual drip emitters.

Figure 5. Drip tube or tape.

Figure 6. Bubbler.

Figure 7. Microjet or microspray.

References

Turf Irrigation for the Home (UF/IFAS Publication Circular 829; on the web at: http://edis.ifas.ufl.edu/AE144)

Turf Irrigation With a Hose and Sprinkler (UF/IFAS Publication AE265)

Reduced Irrigation of St. Augustinegrass Turfgrass in the Tampa Bay Area (UF/IFAS Publication AE264)

Fertilization and Irrigation Needs for Florida Lawns (UF/IFAS Publication ENH860; on the web at: http://edis.ifas.ufl.edu/EP110)

Coping with Drought in the Landscape (UF/IFAS Publication ENH70; on the web at: http://edis.ifas.ufl.edu/MG026)

How to Calibrate Your Sprinkler System (UF/IFAS Publication ENH61; on the web at: http://edis.ifas.ufl.edu/LH026)

Watering Your Florida Lawn (UF/IFAS Publication ENH9; on the web at: http://edis.ifas.ufl.edu/LH025)

Water Requirements of Florida Turfgrasses (UF/IFAS Publication Bulletin 200)

Irrigation of Lawns and Gardens (UF/IFAS Publication Circular 825; on the web at: http://edis.ifas.ufl.edu/WI003)

Lawn Sprinkler Selection and Layout for Uniform Water Application (UF/IFAS Publication Bulletin 230; on the web at: http://edis.ifas.ufl.edu/AE084)

Irrigation System Controllers (UF/IFAS Publication SS-AGE-22; on the web at: http://edis.ifas.ufl.edu/AE077)

Retrofitting a Traditional In-ground Irrigation Sprinkler System for Microirrigation (UF/IFAS Publication ABE324; on the web at: http://edis.ifas.ufl.edu/AE222)

Abbreviations

in—inches

gal—gallons

hr—hour

gpm—gallons per minute

gph—gallons per hour

min—minutes

ft—feet

ft^2—square feet

Table 1. Irrigation zone run time (min) for a given application rate and a desired application depth.

Application rate (in/hr)	**Desired Application Amount (in)**			
	0.25	0.50	0.75	1.00
0.00	0	0	0	0
0.25	60	120	180	240
0.50	30	60	90	120
0.75	20	40	60	80
1.00	15	30	45	60
1.25	12	24	36	48
1.50	10	20	30	40
1.75	9	17	26	34
2.00	8	15	23	30

Table 2. Irrigation controller run time for each of two irrigation events per week at an application rate of 0.25 in/hr, assuming system efficiency of 60%, and considering effective rainfall*.

	North Florida			**Central Florida**			**South Florida**		
	Percent Replacement								
	60%	**80%**	**100%**	**60%**	**80%**	**100%**	**60%**	**80%**	**100%**
Jan	0	2	0	23	31	38	57	76	94
Feb	0	2	0	17	22	28	61	80	100
Mar	10	14	17	34	46	57	85	113	141
Apr	59	79	99	81	108	134	91	121	151
May	100	134	167	128	171	214	83	110	138
Jun	90	120	150	100	133	167	75	100	126
Jul	84	112	140	97	130	162	117	156	195
Aug	77	103	129	127	169	211	129	172	215
Sep	98	131	164	95	127	159	77	102	128
Oct	64	86	107	86	115	143	31	41	51
Nov	40	54	67	64	85	106	80	106	133
Dec	16	21	26	32	43	54	71	94	118

*If the controller only allows 15 incremental changes, use the increment closest to the numbers in the table.

Table 3. Irrigation controller run time for each of two irrigation events per week at an application rate of 0.50 in/hr, assuming system efficiency of 60%, and considering effective rainfall*.

	North Florida			Central Florida			South Florida		
	Percent replacement								
	60%	80%	100%	60%	80%	100%	60%	80%	100%
Jan	0	0	0	12	15	19	28	38	47
Feb	0	0	0	0	11	14	30	40	50
Mar	0	0	0	17	23	28	42	56	70
Apr	30	40	49	40	54	67	45	60	76
May	50	67	84	64	85	107	41	55	69
Jun	45	60	75	50	67	83	38	50	63
Jul	42	56	70	49	65	81	59	78	98
Aug	39	51	64	63	85	106	64	86	107
Sep	49	66	82	48	64	80	38	51	64
Oct	32	43	54	43	57	72	15	20	26
Nov	20	27	34	32	43	53	40	53	67
Dec	0	10	13	16	21	27	35	47	59
*If the controller only allows 15 incremental changes, use the increment closest to the numbers in the table.									

Table 4. Irrigation controller run time for each of two irrigation events per week at an application rate of 0.75 in/hr, assuming system efficiency of 60%, and considering effective rainfall*.

	North Florida			Central Florida			South Florida		
	Percent replacement								
	60%	80%	100%	60%	80%	100%	60%	80%	100%
Jan	0	0	0	0	10	13	19	25	31
Feb	0	0	0	0	0	0	20	27	33
Mar	0	0	0	11	15	19	28	38	47
Apr	20	26	33	27	36	45	30	40	50
May	33	45	56	43	57	71	28	37	46
Jun	30	40	50	33	44	56	25	33	42
Jul	28	37	47	32	43	54	39	52	65
Aug	26	34	43	42	56	70	43	57	72
Sep	33	44	55	32	42	53	26	34	43
Oct	21	29	36	29	38	48	10	14	17
Nov	13	18	22	21	28	35	27	35	44
Dec	0	0	0	11	14	18	24	31	39
*If the controller only allows 15 incremental changes, use the increment closest to the numbers in the table.									

Table 5. Irrigation controller run time for each of two irrigation events per week at an application rate of 1.00 in/hr, assuming system efficiency of 60%, and considering effective rainfall*.

	North Florida			Central Florida			South Florida		
	Percent replacement								
	60%	80%	100%	60%	80%	100%	60%	80%	100%
Jan	0	0	0	0	0	0	14	19	24
Feb	0	0	0	0	0	0	15	20	25
Mar	0	0	0	0	11	14	21	28	35
Apr	15	20	25	20	27	34	23	30	38
May	25	33	42	32	43	53	21	28	34
Jun	22	30	37	25	33	42	19	25	31
Jul	21	28	35	24	32	41	29	39	49
Aug	19	26	32	32	42	53	32	43	54
Sep	25	33	41	24	32	40	19	26	32
Oct	16	21	27	21	29	36	0	10	13
Nov	10	13	17	16	21	27	20	27	33
Dec	0	0	0	0	11	13	18	24	29

*If the controller only allows 15 incremental changes, use the increment closest to the numbers in the table.

Table 6. Irrigation controller run time for each of two irrigation events per week at an application rate of 1.25 in/hr, assuming system efficiency of 60%, and considering effective rainfall*.

	North Florida			Central Florida			South Florida		
	Percent replacement								
	60%	80%	100%	60%	80%	100%	60%	80%	100%
Jan	0	0	0	0	0	0	11	15	19
Feb	0	0	0	0	0	0	12	16	20
Mar	0	0	0	0	0	11	17	23	28
Apr	12	16	20	16	22	27	18	24	30
May	20	27	33	26	34	43	17	22	28
Jun	18	24	30	20	27	33	15	20	25
Jul	17	22	28	19	26	32	23	31	39
Aug	15	21	26	25	34	42	26	34	43
Sep	20	26	33	19	25	32	15	20	26
Oct	13	17	21	17	23	29	0	0	10
Nov	0	11	13	13	17	21	16	21	27
Dec	0	0	0	0	0	11	14	19	24

*If the controller only allows 15 incremental changes, use the increment closest to the numbers in the table.

Table 7. Irrigation controller run time for each of two irrigation events per week at an application rate of 1.50 in/hr, assuming system efficiency of 60%, and considering effective rainfall*.

	North Florida			Central Florida			South Florida		
	Percent replacement								
	60%	80%	100%	60%	80%	100%	60%	80%	100%
Jan	0	0	0	0	0	0	0	13	16
Feb	0	0	0	0	0	0	0	13	17
Mar	0	0	0	0	0	0	14	19	23
Apr	0	13	16	13	18	22	15	20	25
May	17	22	28	21	28	36	14	18	23
Jun	15	20	25	17	22	28	13	17	21
Jul	14	19	23	16	22	27	20	26	33
Aug	13	17	21	21	28	35	21	29	36
Sep	16	22	27	16	21	27	13	17	21
Oct	11	14	18	14	19	24	0	0	0
Nov	0	0	11	11	14	18	13	18	22
Dec	0	0	0	0	0	0	12	16	20

*If the controller only allows 15 incremental changes, use the increment closest to the numbers in the table.

Table 8. Irrigation controller run time for each of two irrigation events per week at an application rate of 1.75 in/hr, assuming system efficiency of 60%, and considering effective rainfall*.

	North Florida			Central Florida			South Florida		
	Percent Replacement								
	60%	80%	100%	60%	80%	100%	60%	80%	100%
Jan	0	0	0	0	0	0	0	11	13
Feb	0	0	0	0	0	0	0	11	14
Mar	0	0	0	0	0	0	12	16	20
Apr	0	11	14	12	15	19	13	17	22
May	14	19	24	18	23	31	12	16	20
Jun	13	17	21	14	19	24	11	14	18
Jul	12	16	20	14	19	23	17	22	28
Aug	11	15	18	18	23	30	18	25	31
Sep	14	19	23	14	18	23	11	15	18
Oct	0	12	15	12	16	20	0	0	0
Nov	0	0	0	0	12	15	11	15	19
Dec	0	0	0	0	0	0	10	13	17

*If the controller only allows 15 incremental changes, use the increment closest to the numbers in the table.

Table 9. Irrigation controller run time for each of two irrigation events per week at an application rate of 2.00 in/hr, assuming system efficiency of 60%, and considering effective rainfall*.

	North Florida			Central Florida			South Florida		
	Percent Replacement								
	60%	80%	100%	60%	80%	100%	60%	80%	100%
Jan	0	0	0	0	0	0	0	0	12
Feb	0	0	0	0	0	0	0	0	12
Mar	0	0	0	0	0	0	11	14	18
Apr	0	0	12	10	13	17	11	15	19
May	13	17	21	16	21	27	10	14	17
Jun	11	15	19	12	17	21	0	13	16
Jul	10	14	17	12	16	20	15	20	24
Aug	0	13	16	16	21	26	16	21	27
Sep	12	16	20	12	16	20	0	13	16
Oct	0	11	13	11	14	18	0	0	0
Nov	0	0	0	0	11	13	0	13	17
Dec	0	0	0	0	0	0	0	12	15

*If the controller only allows 15 incremental changes, use the increment closest to the numbers in the table.