Evapotranspiration-Based Irrigation for Agriculture: Sources of Evapotranspiration Data for Irrigation Scheduling in Florida[1]

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This article is part of a series on ET-based irrigation scheduling for agriculture. The rest of the series can be found at https://edis.ifas.ufl.edu/topic_series_ET-based_irrigation_scheduling_for_agriculture.

Introduction

The first step to using evapotranspiration (ET) for irrigation scheduling is to estimate reference ET (ET_o). This document lists some of the public sources of ET_o in Florida.

Evapotranspiration: Basic Concepts

ET is the process through which water is lost to the atmosphere from the soil by evaporation and from plants by transpiration. ET of a specific crop (also referred to as "crop ET" or "actual ET") is affected by several factors including weather, the crop under consideration, its management, and environmental variables (Table 1). The more information available about factors affecting ET, the more accurate the ET prediction will be. Generally, ET is not directly measured but estimated using mathematical or empirical models that have been developed over time and selected site-specific factors listed in Table 1. More information on basic ET concepts can be found in EDIS document ABE 343, *Evapotranspiration: Potential or Reference* (https://edis.ifas.ufl.edu/ae256).

Crop ET (ET_c) is calculated using Equation 1 by multiplying ET_o by the crop coefficient (K_c). ET_o refers to ET from a well-watered hypothetical grass surface of known characteristics (height of 4.72 in, surface resistance of 70 sec 3.2ft^{-1}, and an albedo of 0.23) (Irmak and Haman 2017). It expresses the evaporative demand of the atmosphere at a given location from a well-watered reference grass that is fully shading the ground.

$$Et_c = ET_o \times K_c$$

Equation 1. Formula used to calculate ET_c for a specific crop based on reference ET and crop coefficient.

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Reference ET can be calculated using different equations. The different mathematical equations used for ET_o estimation are based on different concepts, and the variables (inputs) to include depend on the equation selected. ET_o may be determined using a complex equation (i.e., Penman-Monteith) or simpler equations (i.e., Hargreaves). It is important to know which radiation or temperature-based method to use in the calculation of ET_o because some equations are more accurate than others depending on the location where they are applied (Table 2). Basic information on how to estimate ET_o can be found in EDIS document AE446, *Smart Irrigation Controllers: Operation of Evapotranspiration-Based Controllers* (https://edis.ifas.ufl.edu/ae446).

The K_c component of Equation 1 integrates the crop characteristics (e.g., crop height, the fraction of net radiation absorbed at the land surface, canopy resistance, and evaporation from bare soil surface) into the ET_c estimation equation to account for the difference in transpiration from the actual crop compared to that from the reference grass. Typical K_c values for some Florida crops can be found in EDIS document AE456, *Evapotranspiration-Based Irrigation for Agriculture: Crop Coefficients of Some Commercial Crops in Florida* (https://edis.ifas.ufl.edu/ae456). General information on estimating crop water requirements for irrigation from ET_c can be found in EDIS document AE457, *Evapotranspiration-Based Irrigation Scheduling for Agriculture* (https://edis.ifas.ufl.edu/ae457).

Sources of ET_o Data for Implementing ET-Based Irrigation Scheduling in Florida

Two types of ET_o data can be used in ET-based irrigation scheduling: historical ET_o and real-time ET_o. Historical ET_o should represent long-term daily, monthly, or seasonal ET_o averages for a long record of data that includes yearly and 10-year variations. Real-time ET_o used to schedule irrigation is updated daily, which provides an advantage over the historical ET_o-based approach because it accounts for daily variations in weather conditions. Florida growers can easily obtain real-time ET_o and monthly average ET_o data from the Florida Automated Weather Network (FAWN) website at http://fawn.ifas.ufl.edu/, where ET_o is estimated using the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) (1984) modified Penman equation. Daily, average daily, and historic monthly ET_o can be obtained from the FAWN database for numerous locations throughout Florida using the following steps:

- Go to http://fawn.ifas.ufl.edu/.
- Click **Tools** on the top menu.
- Click **Evapotranspiration** (ET) menu under Irrigation.
- A table with daily ET_o for the past 7 calendar days and the 7-day average ET_o for each of the FAWN weather station sites will appear. A graph with the past 14 days' ET_o for selected FAWN sites is also available.

Historical data for FAWN stations can also be obtained from FAWN by clicking on the **Data Access** menu tab and selecting **Report Generator**. Historical data can be 15-minute observation; or hourly, daily, or monthly averages.

Actual ET data in Florida can be obtained from the United States Geological Survey (USGS). Data can be accessed by following the steps below.

- Go to https://www.usgs.gov/centers/car-fl-water/science/evapotranspiration-and-carbon-flux.
- Click **Learn more Link under Evapotranspiration Network** to view a map of monitoring stations and site names with numbers.
- Click on the **Site number** of the station closest to you. This will take you to the USGS **NWIS Web Interface.**
- From the list of available parameters, select **Evapotranspiration (Mean).**
- Choose **Output format.**
- Enter the **Begin date and End date.**
- Daily ET data are then presented in your choice of output format.

Of the two public sources of ET data, data from USGS have the greatest quality control in estimating actual ET over the different land covers where USGS has ET monitoring stations; however, the available data are limited to only a 10-year period (1995–2005) at some sites. FAWN has a wider coverage of weather stations and a more continuous period of record.

Summary

Obtaining ET_o or actual ET values from the above public weather data sources will improve the estimation of crop water requirements, which are key to implementing crop-specific ET-based irrigation schedules. For ET_o estimation using radiation- or temperature-based methods, always select the method most suitable for your area from Table 2.

References

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Table 1. Factors that influence ET.

Factors That Influence ET	Examples			
Weather parameters	Solar radiation	Air temperature	Relative humidity	Wind speed
Crop factors	Crop type	Variety	Stage of development	
Management	Soil water management	Pest control	Poor soil management	Plant density
Environmental	Soil salinity	Impenetrable soil layers		

Table 2. Examples of simpler radiation-based equations that can be used to estimate ET_o for different locations in Florida.

Geographical Location	Radiation-Based Methods
Southeast Florida[1]	Turc (1961) Priestley-Taylor SFWMD-SM[3]
Northeast and north-central Florida[2]	Turc (1961) Hargreaves[4] SFWMD[5]

Note: These simpler radiation-based ET_o estimation equations should only be used when complete weather data sets are not available to evaluate the American Society of Civil Engineers-Environmental and Water Resources Institute (ASCE-EWRI) standardized ET_o estimation equation.

[1] Methods selected are based on a comparison of ET_o estimation equations in southeast Florida (Miami-Dade and Broward Counties) by Kisekka et al. (2009) (unpublished).

[2] Methods selected are based on a comparison of ET_o estimation equations in northeast and north-central Florida (Jacksonville, Gainesville, and Daytona Beach) by Jacobs and Satti (2001).

[3] South Florida Water Management District (SFWMD)-Simple Method.

[4] Jacobs and Satti (2001) classified Hargreaves et al. (1985) as a radiation-based method.

[5] Modified Blaney-Criddle with SFWMD crop coefficients.