Smart Irrigation Controller Demonstration and Evaluation in Orange County, Florida

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Background:

In 2005, Orange County (FL) Utilities began an extensive effort to develop the plans for alternate water sources in Orange County due to the prediction that the primary source of drinking water in Florida (the Floridan Aquifer) would reach its sustainable level by 2013. The most readily available source of new water was the water that could be conserved by the use of more efficiency landscape irrigation.

Since more than 50% of the residential water use is for irrigation, Orange County Utilities became interested in Smart Irrigation Controllers as a potential practice to reduce landscape irrigation water use with the residential customers of the Utility. Since it is not certain what type of control system is best for a particular type of property or how best to implement the technology, this project aims to test SMS controllers, ET controllers, and to evaluate at least one Central Controlled irrigation system across a range of residential and commercial properties.

Research at the University of Florida and in other areas of the U.S. has shown that Smart Irrigation Controllers have the potential to conserve water by efficiently scheduling irrigation. However, most of the work in Florida has been on tightly controlled research plots. The plot work has been valuable to assess the performance potential of these controllers. However, these controllers are relatively complicated to set up and program correctly for efficient irrigation. Thus, it is not known how much feedback or interaction is needed by irrigation professionals to implement these devices to achieve their potential level of water conservation. This scope of work also proposes to have two levels of contractor training and follow-up on controller operation and performance. In addition, the study targeted two areas of Orange County with distinct soil differences, sandy vs. flatwoods soils.

Customer water use is being tracked for at least a three year period and recommendations will be made to the Water Management Districts to support any potential rulemaking regarding the use of Smart Irrigation Devices.

The objective of this study was to evaluate smart controllers in diverse areas of Orange County to assess their potential level of water conservation.

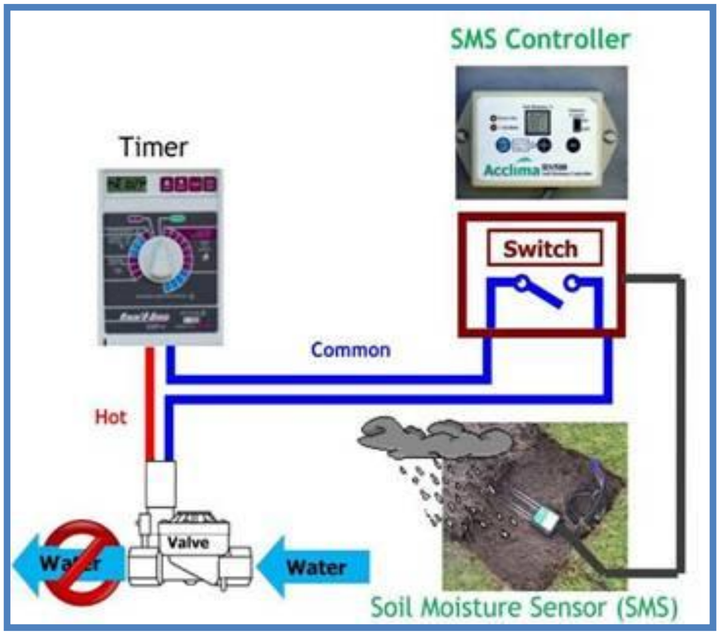
One type of smart controller is commonly called the ET (evapotranspiration) controller, but has also been referred to as a weather-based irrigation controller or climatologically-based irrigation controller. These controllers estimate the plant water needs using weather conditions and incorporate rainfall either by direct measurement or a rain sensor. Unless restricted by the user, the ET controllers schedule irrigation only when the plants need it and the soil can hold it as determined by a soil water balance.

Another type of smart controller is the soil moisture sensor. These sensors are buried in the root zone of the plant material and act as a bypass device based on a programmed soil moisture threshold. Thresholds are typically selected so that irrigation is allowed when the readily available water was depleted. In general, the residential versions of these sensors are add-on devices that connect directly to an existing timer thus requiring the user to program a timer schedule.

The study was commissioned in 2009 and it was not until late 2012 that a full complement of study participants was finalized.

Study Update as of 2013:

A total of 167 residential cooperators were selected across nine locations within the Orange County Utilities service area. Due to the expansive service area, locations were classified based on the general predominant soil type, sandy soil and flat woods soil, determined from a soil map. The sandy soil is an excessively well drained soil with a low available water holding capacity whereas the flatwoods soil, though still a sand, has a larger available water holding capacity than the sandy soils. Each location had the following treatments: ET controller only (ET), soil moisture sensor only (SMS), ET controller with educational training (ET+Edu), soil moisture sensor with educational training (SMS+Edu), and a comparison group that was monitored only (MO). Controllers were installed from March 2011 through January 2012.



The educational training consisted of a follow-up visit after the technology was installed to update the contractor-selected settings to be specific to the site and educate the homeowner on their new technology. Contractor settings for the ET controllers typically included default settings based on general landscape descriptions of the sprinkler type, soil type, plant type, microclimate, and slope. Settings were changed to take into account actual zone application rates, larger root depths, shadier landscapes, and other small changes when applicable. Contractor settings for the SMS included sensor burial at a 6 inch depth and updating the irrigation timer to run for 20 minutes on spray zones and 45 minutes on rotor zones. For the homes that received the education, the contractor was asked to bury the sensor at a 3 inch depth. In addition, the timers were updated to apply 0.25 inches of irrigation per event with the opportunity of two events per day. All technology treatments received variances from day of the week watering restrictions resulting in the possibility of daily irrigation, but the educational groups were programmed for only three days per week.

Orange County Utilities ensured that each cooperator received a dedicated irrigation meter with an automatic meter recording device to record hourly irrigation volume totals. The irrigation volume was converted to a depth using the irrigable area measured at each cooperating home. Irrigation was then totaled into weeks and averaged across treatments. To verify that water reductions were not at the expense of the landscape, turfgrass quality ratings were performed seasonally using a scale of 1 to 9 where 1 represents completely dead turf and 9 represents the perfect turfgrass, with a 5 selected as the minimally acceptable quality for a residential landscape.

Rainfall totals were lower than normal during the winter months of both years (November through March) with significant rainfall events occurring during the summer months. Irrigation was necessary during many periods of the study when rainfall was not able to meet the ET demand.

In the flatwoods locations, the comparison group had significantly higher weekly irrigation (averaging 0.99 inches) compared to all other treatments (Figure 1). Differences between the two ET controller treatments and SMS were not significant, averaging 0.78, 0.69, and 0.77 inches/wk for ET, ET+Edu, and SMS, respectively. The SMS+Edu group had significantly less irrigation (0.53 inches/wk) than all other treatments. The education component and/or specific installation and programming of this type of the SMS controller appear to have significantly lowered the average irrigation application on flatwoods soils.

In the sand locations, the comparison and ET treatments had similar average weekly irrigation application of 1.2 inches and 1.1 inches/wk, respectively (Figure 1), both of which were higher than the other three treatments. Additionally, there were no significant differences between the remaining three treatments with weekly average irrigation application of 0.77, 0.77, and 0.82 inches/wk for ET+Edu, SMS+Edu, and SMS, respectively. However, there was significantly higher irrigation by the comparison and ET treatments compared to the remaining three treatments. On this soil type, the education component and/or site specific installation and programming appears to have significantly lowered the average irrigation application for the ET technology only.

Soil type was a significant factor in analyzing irrigation application. There was more irrigation in each treatment for the sandy soils compared to the flatwoods soils with significant increases ranging from 0.08 inches/wk (ET+Edu) to 0.32 inches/wk (ET). The only treatment that had a negligible increase was the SMS treatment with only a 0.04 inches/wk difference. Increased irrigation would be expected due to the lower available water holding capacity of sand. Additionally, the ET treatment was significantly less than the comparison treatment for the flatwoods soils, but was not different for the sandy soils. Assuming that the comparison group maintained their over-irrigation habits, this may indicate that the default "sand" soil setting on the controllers was not appropriate for this type of sandy soil. The SMS+Edu treatment also behaved differently based on soil type. This treatment was significantly less than the other treatments for the flatwoods soils whereas irrigation application was similar with the ET+Edu and SMS treatments for the sandy soils. A possible explanation for the difference could be that the sandy soils drain more quickly at a three inch sensor burial depth (compared to the six inch depth of the SMS treatment) in a sandy soil resulting in more irrigation.

Turfgrass quality was not significantly different based on treatments or due to over- and under- irrigation totals. Only season affected turfgrass quality with lower but minimally acceptable quality in the non-growing season. Water savings from the comparison treatment were achieved by most technology treatments, ranging from 20% to 48% on the flatwoods soils and 0% to 34% on the sandy soils, without negatively impacting quality. The educational training contributed positively to the overall water savings with all education-related treatments reducing irrigation by more than 30%.

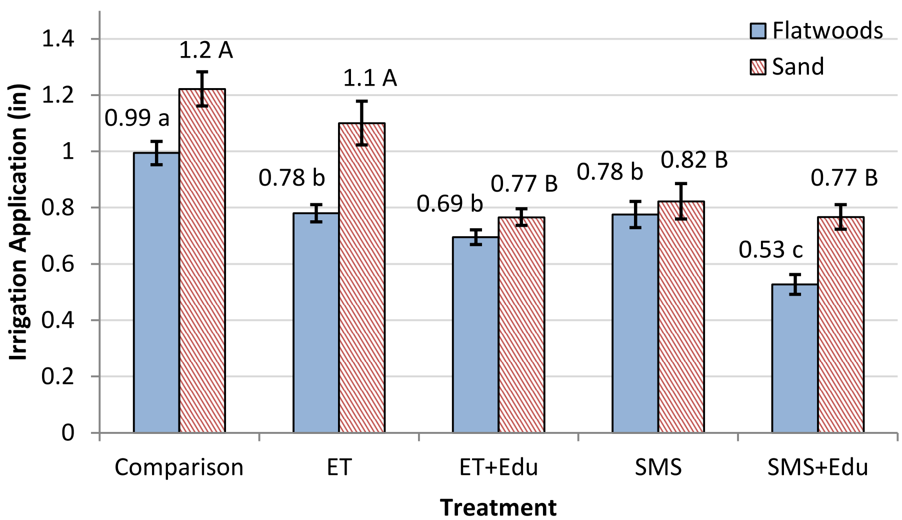


Figure 1. Average weekly irrigation for each treatment for each type of soil. The error bars were generated as the 95% confidence interval from the standard error using the means procedure. Treatments were considered significantly different (differences represented as lowercase letters) if the mean value did not fall within the confidence interval of the average weekly irrigation application of the other treatments.