Implementation of Smart Controllers in Orange County, FL: Results from Year One

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Abstract. *It is hypothesized that implementing smart controllers on irrigation systems of known high water users can aid in reducing the overall potable water demand. The objective of this study was to evaluate two types of smart controllers to determine whether they can reduce irrigation application of constituents in the Orlando Metropolitan Area. A total of 167 participants were recruited where 66 Rain Bird ESP-SMT ET controllers and 66 Baseline Watertec S100 soil moisture sensors were installed on single-family residential properties grouped in nine locations. Half of the participants receiving smart technologies also participated in a personal, on-site training session about their smart controller provided by the University of Florida that included optimization of program settings and additional educational materials to supplement the user manual. The preliminary results after 9 months indicate that smart technologies can produce water savings for high water users, averaging between 16% and 23%, but maximum savings were achieved with the combination of smart technology and educational training that included site specific programming, averaging as much as 45%. Data collection and analysis is expected to continue through 2014 to determine the long-term performance of smart controllers in central Florida.*

Keywords. Conservation, cooperators, irrigation, smart controllers, turfgrass quality

Introduction

This project was developed to address growing public water demands in Central Florida. The Central Florida Coordination Area Action Plan ruled to limit additional groundwater withdrawals to meet 2013 demands and deny new water permits past 2013 unless supplemental water supplies are found (CFCA, 2010). Orange County Utilities, located within the Central Florida Coordination Area, experienced population growth of over 16% between 2000 and 2006 (USCB, 2006) with a current service area population of over 490,000. The potential for continued population growth past 2013 leads to the need for reducing total potable consumptive use so that demand does not exceed supply.

Multiple University of Florida Institute of Food and Agricultural Sciences (UF-IFAS) field plot studies have shown that smart irrigation controllers have the potential to conserve water by efficiently scheduling irrigation (Cardenas-Lailhacar and Dukes, 2012; Davis et al., 2009; McCready et al., 2009). In Pinellas County, a cooperator study using soil moisture sensors resulted in similar water savings as the plot studies when the technologies were properly installed and programmed (Haley and Dukes, 2012). However, there were only 58 participating cooperators, generally considered a small sample size for cooperator studies, thus making the results less applicable to generalizing to other areas of the state.

The objective of this study was to evaluate two types of smart controllers to determine whether they can reduce irrigation application of constituents in the Orlando Metropolitan Area. Performance results from this study may contribute to future policies and programs concerning smart controllers that would be developed to reduce consumptive water use in the residential sector.

Materials and Methods

There are a total of 167 residential cooperators across the Orange County Utilities service area in nine location clusters. Treatments were distributed within each location so that there are at least three replicates per treatment group. Installations were staggered from March 2011 through January 2012 where a total of 66 Rain Bird ESP-SMT ET controllers and 66 Baseline Watertec S100 soil moisture sensors were installed. Each location cluster 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). There were not enough cooperators in Sweetwater Apopka and North Tanner Road areas to implement all treatments, so cooperators were concentrated into the ET+Edu, SMS+Edu, and MO treatments for good statistical results.

Hourly readings of irrigation volume applied were collected for each cooperator using AMR devices installed and maintained by Orange County Utilities. The volume of irrigation was converted to a depth using the irrigable area measured during the initial irrigation evaluations. Irrigation was then totaled into weeks and averaged across treatments. Statistical analyses were performed using Statistical Analysis Systems (SAS) software (Cary, NC) using the means procedure and treatment differences were determined using confidence intervals (α=0.05).

Turfgrass quality ratings were performed seasonally throughout the treatment periods based on 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. Statistical analysis of turfgrass quality was conducted with the glimmix procedure where the change in turfgrass quality ratings between rating periods was modeled compared to the difference in cumulative irrigation application and cumulative irrigation required based on weather. Other factors that could affect turfgrass quality were treatment, educational effect, and soil type.

To determine irrigation demand, three weather stations were installed near the cooperator locations around the county to collect climatic data such as temperature, relative humidity, solar radiation, wind speed, and rainfall. Two additional rain gauges were installed in locations that did not receive a weather station. In addition to the installed weather stations and rain gauges, the Florida Automated Weather Network (FAWN) maintains a weather station in the Apopka area that will be used for the Sweetwater Apopka area location. Daily values of reference evapotranspiration (ET_O) were calculated from the weather station data using the ASCE-EWRI standardized ET_O equation (ASCE-EWRI, 2005).

Results and Discussion

An analysis of historical monthly ET_O and rainfall using thirty years of Orlando International Airport weather data was performed to determine normal weather patterns for Orange County. In general, ET_O was more predictable, rarely falling outside of the 95% confidence interval, whereas monthly rainfall was much more variable and frequently fell outside the 95% confidence interval. These results are indicative of the variability of rainfall and the difficulty of predicting irrigation requirements.

As with the thirty years of historical rainfall, monthly rainfall totals from all the weather station locations and the two independent rain gauges varied greatly during the study period. Overall, rainfall was low during the first three months of data collection with a maximum of 0.68 inches in one month compared to historical averages of approximately 2.5 inches per month for all three months. Low rainfall totals during these particular months are not unusual due to being in the dry part of the year; however, these rainfall totals are much lower than historical normal amounts. Significant rainfall events began in multiple locations around April and May 2012, with rainfall totals exceeding the upper confidence interval for the Turtle Creek area with 22.7 inches in June.

Location cluster and soil type were not significant to the statistical model over the November to August period. The comparison group averaged the most irrigation per week (1.19 inches) and was significantly different than all other treatments (Figure 1). Additionally, the ET controller treatments were different from each other, averaging 0.99 in/wk for the ET group and 0.78 in/wk for the ET with education group. The soil moisture sensor treatments, with 0.84 in/wk and 0.68 in/wk for non-education and education, respectively, were also significantly different from each other. As a result, the education component has significantly lowered the average irrigation application for both technologies. However, there were not significant differences between the ET with education and the SMS without education treatments, thus no preliminary conclusions can be drawn concerning the performance of each type of technology.

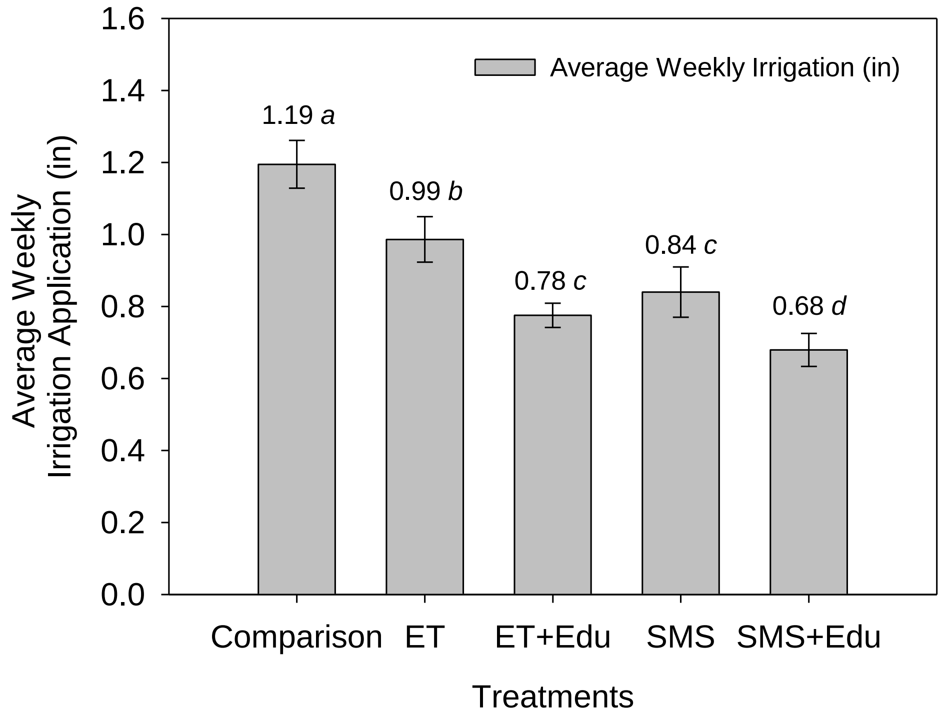

Figure 1. Average weekly irrigation application was calculated for each treatment. The error bars were generated as the 95% confidence interval from the standard error using the means procedure. Treatments were considered significantly different (differences represented as lowercase letters) if the mean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

Cumulatively, the comparison group applied the most irrigation, totaling 46 inches, over the nine-month period (Figure 2). The ET and SMS treatments showed similar water savings of 16% and 23%, respectively. Additionally, the ET+Edu and SMS+Edu treatments also showed similar water savings of 38% and 45%, respectively. Overall, there appears to be a trend of water savings due to installing a smart technology with additional savings from education and detailed programming. However, nine months is a too short of a time period for predicting long-term performance.

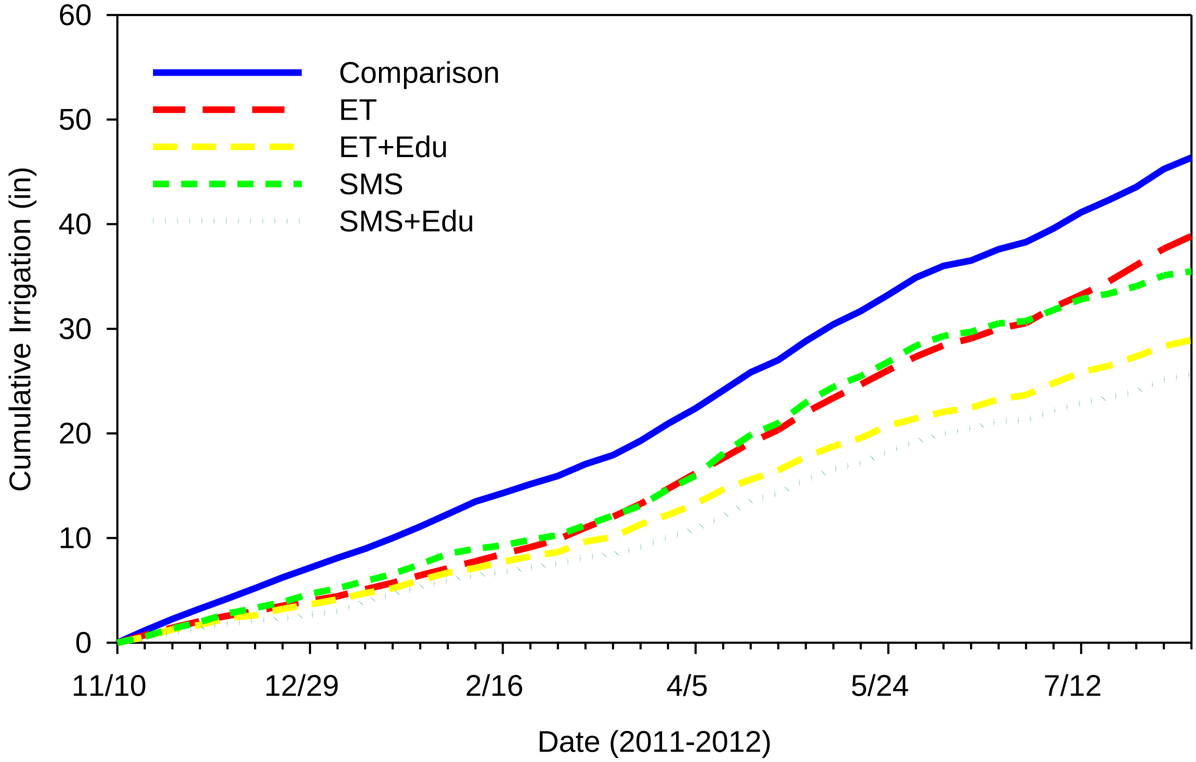

Figure 2. Cumulation irrigation for the study period averaged across locations.

Turfgrass quality ratings were not significantly different based on treatments or due to over- and under- irrigation totals within the same rating period (Table 1). However, ratings varied seasonably with a significant increase in quality for Summer 2012. Rainfall was abundant this summer making it impossible to draw conclusions concerning uncaptured potential water savings despite the increase in average turfgrass quality. Additionally, there was a significant decrease in turfgrass quality for the winter season when some cooperators experienced dormancy while others did not. Other unmeasured factors could affect turfgrass quality such as fertilizer application, mowing practices, and irrigation system maintenance.

Table 1. Turfgrass quality ratings[z] were taken during the initial site evaluation as a baseline as well as seasonally to assess changes in quality due to treatments.

Treatment	Site Evaluation	Fall 2011	Winter 2011-2012	Spring 2012	Summer 2012
Comparison Total	6.3 *abc*	6.3 *a*	6.5 *b*	6.4 *a*	7.6 *c*
ET Total	6.6 *abc*	6.7 *a*	6.2 *b*	6.7 *a*	7.8 *c*
ET+Edu Total	6.4 *abc*	6.8 *a*	6.0 *b*	6.6 *a*	7.7 *c*
SMS Total	6.6 *abc*	6.7 *a*	6.1 *b*	6.5 *a*	7.3 *c*
SMS+Edu Total	6.2 *abc*	7.0 *a*	6.0 *b*	6.7 *a*	7.6 *c*

[z]Different letters within a column and across columns indicate statistical difference at $P<0.05$.

Conclusions

Based on these preliminary results, the smart controllers are showing the potential for water conservation without decline in landscape quality. Average water savings were 16% to 23% for contractor-installed units with increased water savings from additional education and site-specific programming, averaging 38% to 45%. However, assessing the impact of smart technologies on the potable water demand cannot be determined from short-term use. Thus, data collection and analysis is expected to continue through 2014 to obtain a more accurate depiction of smart controller performance in central Florida.

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